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Cover Photograph

The Spring 2013 hackNY student hackathon brought in hundreds of students to Columbia University's Fu Foundation School of Engineering and Applied Science for 24 hours of creative collaborative hacking for New York City startups. Photo by Matylida Czarnecka. www.flickr.com/photos/61623410@N08/8650384822.

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Executive Summary

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. This volume, the *NMC Horizon Report: 2014 Higher Education Edition*, examines emerging technologies for their potential impact on and use in teaching, learning, and creative inquiry within the environment of higher education. While there are many local factors affecting the practice of education, there are also issues that transcend regional boundaries and questions common to higher education; it was with these questions in mind that this report was created. The *NMC Horizon Report: 2014 Higher Education Edition* is the 11th in the annual higher education series of reports and is produced by the NMC in collaboration with the EDUCAUSE Learning Initiative (ELI).

Each of the three global editions of the *NMC Horizon Report* — higher education, primary and secondary education (K-12), and museum education — highlights six emerging technologies or practices that are likely to enter mainstream use within their focus sectors over the next five years. Key trends and challenges that will affect current practice over the same period frame these discussions. For the *NMC Horizon Report: 2014 Higher Education Edition*, an expert panel identified 18 topics very likely to impact technology planning and decision-making: six key trends, six significant challenges, and six important developments in educational technology. The discussions of trends and technologies have been organized into three time-related categories; challenges are discussed within a similar three-part framework related to the scope of the challenge.

To create the report, an international body of experts in education, technology, and other fields was convened as a panel. Over the course of three months in the Fall of 2013, the 2014 Higher Education Expert Panel came to a consensus about the topics that would appear here in the *NMC Horizon Report: 2014 Higher Education Edition*. The examples and readings under each topic area are meant to provide practical models as well as access to more detailed information.

Once identified, the framework of the Up-Scaling Creative Classrooms (CCR) project (go.nmc.org/scaleccr), developed by the European Commission Institute for Prospective Technological Studies (IPTS) and pictured in the chart on page 4, was used to identify implications for policy, leadership, and practice that are related to

Over the decade of the NMC Horizon Project research, more than 850 internationally recognized practitioners and experts have participated on the panels.

each of the six trends and six challenges detailed in the report's first two sections. The six technologies are described in detail in the third section 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.

Each topic closes with an annotated list of suggested readings and additional examples that expand on the discussion in the report. These resources, along with a wide collection of other helpful projects and readings, can all be found in the project's open content database that is accessible via the free NMC Horizon EdTech Weekly App for iOS (go.nmc.org/ios) and Android devices (go.nmc.org/android). All the background materials for the *NMC Horizon Report: 2014 Higher Education Edition*, including the research data, the preliminary selections, the topic preview, and this publication, can be downloaded for free on iTunes U (go.nmc.org/itunes-u).

The process used to research and create the *NMC Horizon Report: 2014 Higher Education Edition* is rooted in the methods used across all the research conducted within the NMC Horizon Project. All editions of the *NMC Horizon Report* are informed by both primary and

secondary research. Dozens of meaningful trends, critical challenges, and emerging technologies are examined for possible inclusion in the report for each edition.

Every report draws on the considerable expertise of an international expert panel that first considers a broad set of important trends, challenges, and emerging technologies, and then examines each of them in progressively more detail, reducing the set until the final listing of trends, challenges, and technologies is selected. This process takes place online, where it is captured in the NMC Horizon Project wiki. The wiki is intended to be a completely transparent window into the work of the project, one that not only provides a real-time view of the work as it happens, but also contains the entire record of the research for each of the various editions published since 2006. The wiki used for the *NMC Horizon Report: 2014 Higher Education Edition* can be found at horizon.wiki.nmc.org.

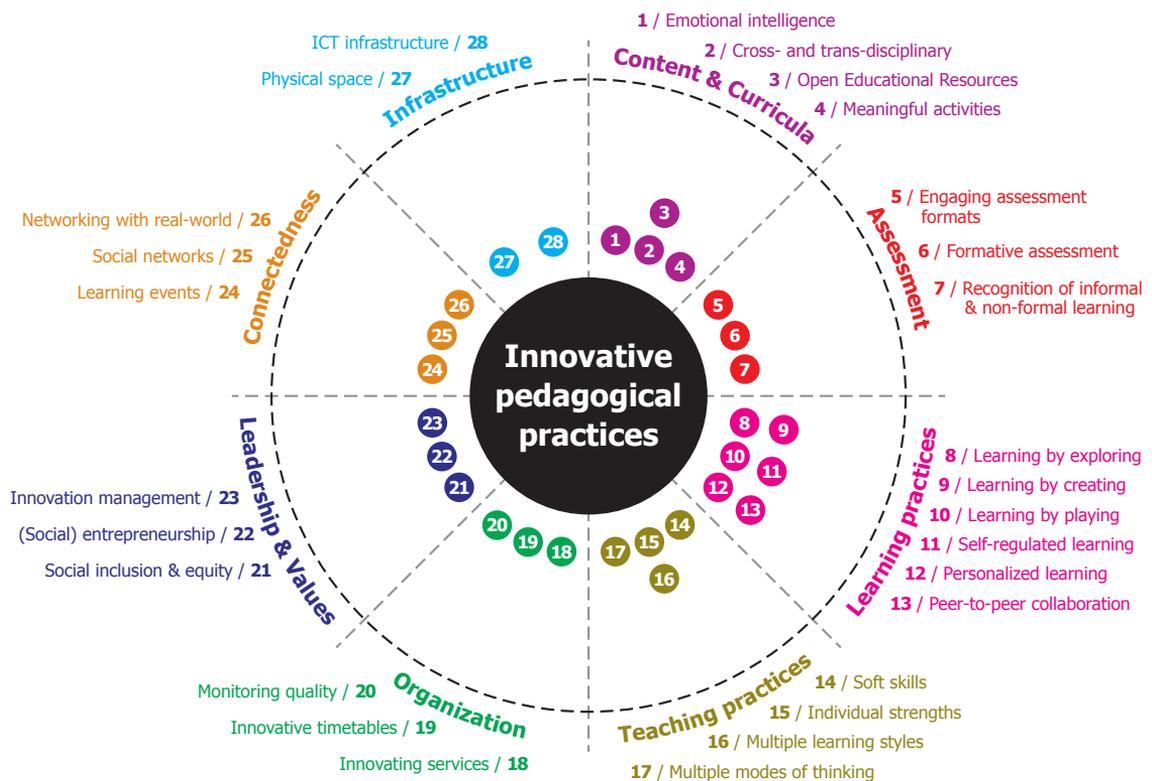
The panel was composed of 53 technology experts from 13 countries on six continents this year; their names and affiliations are listed at the end of this report. Despite their diversity of backgrounds and experience,

they share a consensus view that each of the profiled technologies is going to have a significant impact on the practice of higher education around the globe over the next five years. The key trends driving interest in their adoption, and the significant challenges higher education institutions will need to address if they are to reach their potential, also represent their perspective.

The procedure for selecting the topics in the report is based on a modified Delphi process refined over the now 12 years of producing the *NMC Horizon Report* series, and began with the assembly of the panel. The panel represents a wide range of backgrounds, nationalities, and interests, yet each member brings a relevant expertise. Over the decade of the NMC Horizon Project research, more than 850 internationally recognized practitioners and experts have participated on the panels; in any given year, a third of panel members are new, ensuring a flow of fresh perspectives each year. Nominations to serve on the expert panel are encouraged; see go.nmc.org/horizon-nominate.

Once the panel for a particular edition is constituted, their work begins with a systematic review of the literature —

Elements of the Creative Classroom Research Model



press clippings, reports, essays, and other materials — that pertains to emerging technology. Members are provided with an extensive set of background materials when the project begins, and are then asked to comment on them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic in this edition is its potential relevance to teaching, learning, and creative inquiry in higher education. A carefully selected set of RSS feeds from hundreds of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants.

Following the review of the literature, the expert panel engages in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions were designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the panel:

1 Which of the key technologies catalogued in the NMC Horizon Project Listing will be most important to teaching, learning, or creative inquiry within the next five years?

2 What key technologies are missing from our list? Consider these related questions:

- > **What would you list among the established technologies that some educational institutions are using today that arguably *all* institutions should be using broadly to support or enhance teaching, learning, or creative inquiry?**
- > **What technologies that have a solid user base in consumer, entertainment, or other industries should educational institutions be actively looking for ways to apply?**
- > **What are the key emerging technologies you see developing to the point that learning-focused institutions should begin to take notice during the next four to five years?**

3 What trends do you expect to have a significant impact on the ways in which learning-focused institutions approach our core missions of teaching, learning, and creative inquiry?

4 What do you see as the key challenges related to teaching, learning, or creative inquiry that learning-focused institutions will face during the next five years?

In the first step of this approach, the responses to the research questions are systematically ranked and placed into adoption horizons by each expert panel member using a multi-vote system that allows members to weight their selections. Each member is asked to also identify the timeframe during which they feel the topic

A key criterion for the inclusion of a topic in this edition is its potential relevance to teaching, learning, and creative inquiry in higher education.

would enter mainstream use — defined for the purpose of the project as about 20% of institutions adopting it within the period discussed. (This figure is based on the research of Geoffrey A. Moore and refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.) These rankings are compiled into a collective set of responses, and inevitably, the ones around which there is the most agreement are quickly apparent.

From the comprehensive list of trends, challenges, and technologies originally considered for any report, the 36 that emerge at the top of the initial ranking process — four per horizon — are further researched and expanded. Once these interim results are identified, the group explores the ways in which these topics impact teaching, learning, and creative inquiry in higher education. A significant amount of time is spent researching real and potential applications for each of the topics that would be of interest to practitioners. For every edition, when that work is done, each of these interim results topics is written up in the format of the *NMC Horizon Report*. With the benefit of the full picture of how the topic will look in the report, the topics in the interim results are then ranked yet again, this time in reverse. The top 18 topics identified are those detailed in the *NMC Horizon Report*.



Key Trends

The six trends featured in the *NMC Horizon Report: 2014 Higher Education Edition* were selected by the project's expert panel in a series of Delphi-based voting cycles, each followed by an additional round of desktop research and discussions. Once identified, the framework of the Up-Scaling Creative Classrooms (CCR) project, developed for the European Commission and pictured in the executive summary, was used to identify implications for policy, leadership, and practice that were related to each of the six trends discussed in this section. These trends, which the members of the expert panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three time-related categories — fast-moving trends that will realize their impact in the next one to two years, and two categories of slower trends that will realize their impact within three to five or more years. All of the trends listed here were explored for their implications for global higher education in a series of online discussions that can be viewed at horizon.wiki.nmc.org/Trends.

The expert panel was provided with an extensive set of background materials when the project began that identified and documented well-known existing trends, but the panel was also encouraged to consider emerging trends or trends slow to take form as well.

Once the semifinal list of trends was identified, each was viewed within the CCR framework, which served as a lens to identify implications for policy, leadership, and practice.

Policy

While all of the identified trends had policy implications, two trends in particular are expected to have a strong impact on policy decisions in the next five years. Data-driven learning and assessment, currently on the rise in universities in the developed world, will reach its maximum impact in higher education in about two to three years, but many leading institutions are moving considerably faster. At the University of Wisconsin, for example, the pilot program known as the Student Success System was initiated in Spring 2013 to identify struggling students and their behavioral patterns. Early results

have provided methods to improve policies and include making infrastructure changes, documenting issues and concerns, and identifying areas for improvement for future data collection and analysis at scale.

Likewise, more universities are working to make their institutions more comfortable with change, using agile approaches to be more responsive, nimble and flexible. The expert panel placed the ultimate peak

Institutional leaders are increasingly seeing their students as creators rather than consumers.

of this trend's impact out at least five years, but some universities are already putting policies into place that will make their institutions more agile. The University of Virginia's School of Medicine, for example, was one of the first programs in the United States to incorporate entrepreneurial activities in its promotion and tenure criteria for faculty in the same manner in which technology startups reward employees for innovating new projects, products, and ideas.

Leadership

While there are leadership implications for all the identified trends that are discussed in the following pages, two trends stand out as unique opportunities for vision and leadership. Social media, already very well established in the consumer and entertainment sectors, is rapidly integrating into every aspect of university life; with its maximum impact expected to manifest itself within the next year, there is considerable room for creative ideas. For example, in the Faculty Thought Leadership Series, developed by the University of Hawaii Professional Assembly, faculty across several campuses convened to re-envision the future of the higher education teaching profession, with social media as a major component. Recordings of the meetings were broadcast on YouTube and anyone could join the real-time discussions through Twitter. Examples abound

in which social media is being used by decision-makers to engage with stakeholders in new and highly cost-effective ways.

Further away, but trending strongly for leaders especially, is the broad integration of creative processes and hands-on learning exemplified by the growing interest in makerspaces. Institutional leaders are increasingly seeing their students as creators rather than consumers; the expert panel expects this trend to peak within three to five years. Creating an organizational climate in which students are encouraged to develop ideas big and small, and bring to market creative solutions to real world problems, will require visionary leaders, but many campuses are already far along in this process. A student at Cornell University, for example, is using Kickstarter to develop Kicksat, a project intended to launch a small spacecraft into low earth orbit.

Practice

Each of the six trends identified by the expert panel has numerous implications for teaching and learning practice, and current examples are easy to find, even in the long-term category. The integration of online, hybrid, and collaborative learning in face-to-face instruction, highlighted as one of two fast trends in the following pages, is already impacting the way courses are structured at The Ohio State University, where faculty in the Department of Statistics are creating a “HyFlex” model of learning that leverages a variety of online technologies. They reported that the use of interactive polling, recording, and a backchannel for synchronous communication during class time has enabled students to engage with the material in ways that suit how they learn best.

Online learning in general is in the midst of a long-term reinvention, with much learned from the recent forays into massive open online courses. While the focus within instructional design on genuinely matching the level of student engagement in face-to-face courses is increasing, online learning is still at least five years away from generating its maximum impact. Pearson’s efforts to integrate adaptive learning in online courses are a good example of the current state of the art. In the summer of 2013, Pearson partnered with Knewton to offer more than 400,000 college students enrolled in first-year science and business courses access to adaptive, personalized tutoring services that detect patterns of students’ successes and failures with the course material and provide guidance accordingly.

The following pages provide a discussion of each of the trends highlighted by this year’s expert panel that

includes an overview of the trend, its implications, and curated recommendations for further reading on the topic.



Growing Ubiquity of Social Media

Fast Trend: Driving changes in higher education over the next one to two years

Social media is changing the way people interact, present ideas and information, and judge the quality of content and contributions. More than 1.2 billion people use Facebook regularly according to numbers released in October 2013; a recent report by Business Insider reported 2.7 billion people — almost 40% of the world population — regularly use social media. The top 25 social media platforms worldwide share 6.3 billion accounts among them. Educators, students, alumni, and the general public routinely use social media to share news about scientific and other developments. The impact of these changes in scholarly communication and on the credibility of information remains to be seen, but it is clear that social media has found significant traction in almost every education sector.

Overview

Today's web users are prolific creators of content, and they upload photographs, audio, and video to the cloud by the billions. Producing, commenting, and classifying these media have become just as important as the more passive tasks of searching, reading, watching, and listening. Sites such as Facebook, Twitter, Pinterest, Flickr, YouTube, Tumblr, Instagram, and many others make it easy to share and find stories and media. In addition to interacting with the content, social media makes it easy to interact with friends and institutions that produced the content. Relationships are ultimately the lifeblood of social media as people share information about themselves, find out what their peers and favorite organizations think about topics of interest, and exchange messages. The experience augments already-established relationships while providing spaces for people who are separated by physical distance or other barriers to connect with each other. This helps institutions to garner broader audiences while communicating with existing ones.

Social media has now proliferated to the point where it spans all ages and demographics. A recent study by *Fast Company* revealed that the fastest growing group on Facebook and Google+ is the 45-54 year-old age bracket, while Twitter is experiencing the largest growth for users aged 55-64. More people are turning to social media for recreational and educational purposes than

to television and other popular mediums. YouTube, for example, reaches more U.S. adults aged 18-34 than any cable networks. Furthermore, Reuters reported that visiting social media websites is the most common activity that people engage in on the web. People log on daily to catch up on news and share content, which has prompted social media sites to become major news sources with more and more journalists and media outlets breaking news stories there.

For educational institutions, social media enables two-way dialogues between students, prospective students, educators, and the institution that are less formal than with other media. As social networks continue to flourish, educators are using them as professional communities of practice, as learning communities, and as a platform to share interesting stories about topics students are studying in class. Understanding how social media can be leveraged for social learning is a key skill for teachers, and teacher training programs are increasingly being expected to include this skill.

Implications for Policy, Leadership, or Practice

A study conducted by the University of Massachusetts Dartmouth found that 100% of surveyed universities and colleges use social media for some purpose. Faculty cited the inclusion of video and blogs as among the most common applications of social media for instruction.

Relationships are ultimately the lifeblood of social media.

Another survey by the Babson Research Group and Pearson revealed that 70.3% of faculty use social media in their personal lives, which mirrors that of the general population, and 55% use these networks specifically in professional contexts. However, faculty and administrators who are involved in policymaking still harbor concerns over maintaining privacy as they want classrooms to be perceived as safe spaces for open discussion and to preserve the integrity of student submissions. It will be up to policymakers over the next year to create guidelines for effective and secure uses of social media, including

the prevention of cyberbullying and the formalization of penalties. A recent report, “Cyber Bullying in Higher Education,” from researchers at Walden University revealed that even instructors have been subject to this virtual form of ostracism. The report stated that some faculty in the study did not report their encounters because they simply did not know where to report them.

There is room for leadership among universities and colleges to document creative social media projects that demonstrate the benefits of social media for education. Efforts such as Vanderbilt University’s YouTube channel give students, faculty, and the general public a glimpse into important work happening on campus, for instance, while Texas State University leverages Facebook and Twitter as formal and informal discussion forums. Ultimately, social media is fostering opportunities for thousands of students to collaborate — even across institutions. A prime example is how Murdoch University in Australia partnered with Duke University on a social mapping project in which students could contribute their observations about Northwestern Australian ecosystems. Then there is the compelling dimension that field experts can be easily contacted on social networks to bring real world perspectives to the subject matter, which can supplement knowledge gained from formal lectures.

What also makes social media exciting for higher education is the inherent public aspect. Whether through posting a video, image, or a text response in a conversation, anyone in the social network can engage with the content. The University of Hawaii Professional Assembly launched the Faculty Thought Leadership Series in which they invited faculty across various campuses to re-envision the future of the higher education teaching profession, with social media as a major component. Recordings of face-to-face sessions were broadcast on YouTube and anyone could participate in real-time discussions that were encouraged and tracked with a special hashtag on Twitter. Social media has changed the nature of these important conversations so that they are not always behind doors, but instead viewed as an opportunity for substantial collective thinking and action.

For Further Reading

The following resources are recommended for those who wish to learn more about the growing ubiquity of social media:

In Higher Education, Social Media Is Your Job

go.nmc.org/hiedsoc

(James Nolan, *The Huffington Post*, 16 September 2013.)

The author believes that academics can no longer afford to ignore social media — it is an increasingly important vehicle for institutions to continuously build relationships and constituencies.

Is it Time to Start Using Social Media to Promote Academic Projects?

go.nmc.org/time

(Annett Seifert, *School of Advanced Study Blogs*, 14 August 2013.) This post describes how the School of Advanced Study at the University of London is using social media channels to increase awareness and engagement about the impact of individual research projects.

Is Social Media Good for Education?

go.nmc.org/medgoo

(Vanessa Doctor, *Hashtags.org*, 31 July 2013.) The author discusses the pros and cons of social media use in education. She lists four positive and two negative points about its effectiveness in education — ease of communication is cited as a benefit and the accuracy of sources is identified as a con.

Social Media for Teaching and Learning

go.nmc.org/socmed

(Jeff Seaman and Hester Tinti-Kane, Babson Survey Research Group and Pearson Learning Solutions, October 2013.) A series of reports launched in 2009 and published annually has shown that faculty are embracing social media, but privacy concerns must be addressed in order to accelerate the adoption of professional use.

Using Social Media in the Classroom: A Community College Perspective

go.nmc.org/asa

(Chad M. Gesser, *Footnotes*, January 2013) A professor at Owensboro Community and Technical College describes his applications of social media to organize courses and discuss complex sociological concepts.

Visitors and Residents: Students’ Attitudes to Academic Use of Social Media

go.nmc.org/visres

(*Science Daily*, 29 April 2013.) A recent study shows that some students, referred to as residents, use social networking to share information about their studies with their academic peers in a similar way they would talk to friends on Facebook.



Integration of Online, Hybrid, and Collaborative Learning

Fast Trend: Driving changes in higher education over the next one to two years

Education paradigms are shifting to include more online learning, blended and hybrid learning, and collaborative models. Students already spend much of their free time on the Internet, learning and exchanging new information. Institutions that embrace face-to-face, online, and 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.

Overview

The tremendous interest in the academic and popular press in new forms of online learning over the past few years has also heightened use of discussion forums, embedded videos, and digital assessments in more traditional classes, with the intention of making better use of class time. An increasing number of universities are incorporating online environments into courses of all kinds, which is making the content more dynamic, flexible, and accessible to a larger number of students. These hybrid-learning settings are engaging students in creative learning activities that often demand more peer-to-peer collaboration than traditional courses.

Online learning has amplified the potential for collaboration because it incorporates outlets that students can access outside of the classroom to meet and exchange ideas about a subject or project. In a commentary for *The Chronicle of Higher Education*, David Helfand, one of the founders of Quest University Canada, makes a case for more collaboration in 21st century learning. In an age where multi-tasking is second nature and modes of communication are becoming more efficient, Helfand argues that it is the university's responsibility to foster students' collaboration skills so they are better prepared to confront the problems of the globalized world. Many educators are finding that online platforms can be used to facilitate group problem-solving and build

communication skills, while advancing students' knowledge of the subject matter.

The quality of community and interaction is becoming a key discriminator among hybrid learning environments, as emerging digital tools make it easier for students to ask and respond to each other's questions and for instructors to provide feedback in real-time. At The Ohio State University, for instance, educators in the Department of Statistics are experimenting with a combination of technologies to create a "HyFlex" model of learning that incorporates online interactive polling, lecture recording, and a backchannel for synchronous communication. According to the instructors, this exploratory endeavor has succeeded in creating a model that suits the interests and desires of students, who are able to choose how they attend lecture — from the comfort of their home, or face-to-face with their teachers. Additionally, findings from the formal study show that students felt the instructional technology made the subject more interesting, and increased their understanding, as well as encouraged their participation via the backchannel.

Implications for Policy, Leadership, or Practice

To encourage collaboration and reinforce real world skills, universities are experimenting with policies that allow for more freedom in interactions between students when working on projects and assessments. The experience of Peter Nonacs, a professor of Behavioral Ecology at UCLA, is a strong example of how an innovative testing situation can lead to deeper understanding of a subject. To determine how well his students understood game theory, Nonacs prepared a challenging exam that his students were able to work on together. Nonacs told them they could use any resources for the test. This was the ideal scenario for them to authentically experience game theory as they hypothesized, debated, and devised a system to find the best answers. Nonacs argues that there is no detriment in allowing students to use the intellectual resources they need to answer questions because the best assessments go beyond memorization, and instead inspire thinking in creative ways through discussion, collaboration, and critical thinking.

Universities are staying ahead of the curve in best teaching practices by experimenting with online learning environments and tools that promote peer-to-peer collaboration. At Indiana University-Purdue University Indianapolis (IUPUI), student researchers are working with instructional technologists and professors to explore how web-conferencing platforms can be used for Peer-Led Team Learning (PLTL), a model of teaching used in the sciences in which small groups of students solve problems together in workshops led by peer leaders. The team tested commercial and no-cost platforms, and they evaluated how effectively the tools in web-based environments such as Adobe Connect, Vyew, Blackboard Collaborate, and Google Hangouts allowed students to work together. After determining the best solution, the PLTL was implemented in the first semester of general chemistry courses at IUPUI and introductory biology courses at Purdue University and Florida International University. Further research will address how technology-enhanced PLTL models can expand to other disciplines and incorporate e-texts, virtual labs, and more video assets into these online environments.

Instructors can also leverage components of online learning to make personalized learning scalable in large introductory classes. Compared to the traditional model of learning, in which space is needed to accommodate hundreds of students, hybrid learning can address the learning path of each individual student. The University of Texas, for example, launched an initiative in 2013 to incorporate new technologies in lower-division history, calculus, statistics, government, and classics courses, with the aim of establishing a hybrid model to improve undergraduate engagement. Based on increases in persistence rates among freshmen in the past three years, as well as marked improvements in grades, attendance, and passing rates, three-year \$50,000 grants will be given to each department to support the development of online content, such as video modules and tools that promote in-class discussion.

For Further Reading

The following resources are recommended for those who wish to learn more about the integration of online, hybrid, and collaborative learning:

After Setbacks, Online Courses are Rethought

go.nmc.org/setb

(Tamar Lewin, *The New York Times*, 11 December 2013.) Though MOOCs alone have not proven to be as successful as hyped, the publicity around them has nudged many universities toward developing an Internet strategy and incorporating quality online

resources from professors worldwide to enhance their own curriculum.

Arizona State University Selects HapYak Interactive Video for eLearning Video Initiatives

go.nmc.org/hapyak

(HapYak, 2 December 2013.) Arizona State University uses an interactive video platform HapYak in their hybrid courses to add interactive elements such as quiz questions, chapters, and links. The software also creates engagement reports that let ASU faculty and staff know who is watching which videos, what segments are most important, and how they can improve them.

Blended Learning: College Classrooms of the Future

go.nmc.org/colcla

(*The Huffington Post*, 16 July 2013.) Blended learning initiatives at the University of Maryland have led to more time for clarifying, hands-on activities, and discussions during class time rather than introducing material for the first time.

Is Blended Learning the Best of Both Worlds?

go.nmc.org/blen

(*Online Learning Insights*, 17 January 2013.) This article explores the purpose, definitions, and implications of the blended learning model in higher education, which is a balance of web-based and traditional face-to-face instruction.

A New Way of Learning: The Impact of Hybrid Distance Education on Student Performance

go.nmc.org/neww

(Rosa Vivanco, George Mason University, accessed 17 December 2013.) A study at George Mason University showed students who collaborated with others outside of the classroom for online components of a management course reported enjoying it more and learning more.

Watering the Roots of Knowledge Through Collaborative Learning

go.nmc.org/roots

(David J. Helfand, *The Chronicle of Higher Education*, 8 July 2013.) The author shows how a progressive collaborative learning system in higher education can produce graduates who are skilled in communication, quantitative reasoning, and teamwork.



Rise of Data-Driven Learning and Assessment

Mid-Range Trend: Driving changes in higher education within three to five years

There is a growing interest in using new sources of data for personalizing the learning experience and for performance measurement. As learners participate in online activities, they leave an increasingly clear trail of analytics data that can be mined for insights. Learning analytics experiments and demonstration projects are currently examining ways to use that data to modify learning strategies and processes. 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.

Overview

Data have been measured, collected, and analyzed in the consumer sector since the early 1990s to inform companies about customer behavior and preferences. A recent trend in education has sought to employ similar analytics to improve teaching and learning at the course and institutional levels. As students and educators generate more and more data, especially in online environments, there is a growing interest in developing tools and algorithms for revealing patterns inherent in those data and then applying them to the improvement of instructional systems. While interest is considerable, higher education in general has yet to fully embrace these sorts of processes. Privacy and ethics issues are just beginning to be addressed, but the potential of using data to improve services, student retention, and student success is clearly evident.

The emerging science of learning analytics, discussed in more detail later in this report, is providing the statistical and data mining tools to recognize challenges early, improve student outcomes, and personalize the learning experience. With recent developments in online learning in particular, students are generating an exponential amount of data that can offer a more comprehensive look at their learning. Dashboards, a feature of many learning management systems that provides both students and teachers with an overview of such data, are currently being used by a number of universities as a way to improve student retention and personalize the learning experience. These sorts of tools can provide students with the means of understanding

their progress and can help instructors identify which students are at risk of failing a class and deploy the appropriate support services before a student drops out. Examples of commercially available dashboards include Ellucian's Course Signals, Blackboard's Retention Center, and Desire2Learn's Student Success System.

Implications for Policy, Leadership, or Practice

In online environments especially, students and professors are generating a large amount of learning-related data that could inform decisions and the learning process, but work remains on structuring appropriate policies to protect student privacy. An increasing

As learners participate in online activities, they leave an increasingly clear trail of analytics data that can be mined for insights.

number of universities are formalizing policies regarding the gathering and use of data in making instructional decisions. This shift in attitude, documented by the U.S. Department of Education's report *Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics*, has the potential to improve services across the university landscape.

A five-year initiative at Eastern Connecticut State University is using a data-driven approach to increase the success of low-income, minority students and first-generation students. Gathering data from sources such as residential, library, tutoring programs, and surveys, the university is hoping to understand and predict why some students are more likely to drop out than others. At the University of Wisconsin, the pilot program Student Success System (S3) was initiated in spring 2013 to identify struggling students and behavioral patterns. Early results have provided methods for tackling infrastructure changes, documenting issues

and concerns, and identifying areas for improvement for future iterations.

Adaptive learning software is a related area where considerable development is under way, and many education leaders and policymakers see promise in incorporating these tools into online offerings, where they are already being used to measure student comprehension in real time and adjust content and strategy as needed. Another use of adaptive learning software is to provide expanded tutoring and practice opportunities to students more efficiently.

For Further Reading

The following resources are recommended for those who wish to learn more about the rise of data-driven learning and assessment:

How Can Educational Data Mining and Learning Analytics Improve and Personalize Education?

go.nmc.org/datamin

(*EdTech Review*, 18 June 2013.) This post explores how educational data mining uses new tools and algorithms to discover patterns and illuminates how learning analytics then applies those tools and techniques to answer questions regarding student progress and grading.

How Data is Driving the Biggest Revolution in Education Since the Middle Ages

go.nmc.org/revo

(Rebecca Grant, *VentureBeat*, 4 December 2013.) Udacity founder, Sebastian Thrun, advocates that we study learning as a data science to reverse engineer the human brain so that curriculum can be designed based on evidence.

Mixed Signals

go.nmc.org/mix

(Carl Straumsheim, *Inside Higher Ed*, 6 November 2013.) Purdue's claims that using the early-warning system Signals improves student retention rates have recently come into question, bringing to light the importance of evaluating learning analytics technologies.

Smart Analytics in Education

go.nmc.org/smarta

(Jay Liebowitz, *The Knowledge Exchange*, 6 June 2013.) To ensure student, faculty, and institutional success, more higher education institutions are leveraging the power of big data to inform learning analytics.

Smart Education Meets 'Moneyball' (Part I)

go.nmc.org/moneyb

(John Baker, *Wired*, 9 April 2013.) Universities and

colleges are beginning to use predictive analytics to transform data into active intelligence. This post examines where the data originates and how it can be most effectively applied.

University Data Can Be a Force for Good

go.nmc.org/forc

(Ruth Drysdale, *Guardian Professional*, 27 November 2013.) Many higher education institutions are now looking at a variety of data in addition to attendance to determine student engagement and anticipate retention. An analysis by Manchester Metropolitan University has revealed a direct correlation between the two.



Shift from Students as Consumers to Students as Creators

Mid-Range Trend: Driving changes in higher education within three to five years

A *shift is taking place in the focus of pedagogical practice on university campuses all over the world as students across a wide variety of disciplines are learning by making and creating rather than from the simple consumption of content. Creativity, as illustrated by the growth of user-generated videos, maker communities, and crowd-funded projects in the past couple years, is increasingly the means for active, hands-on learning. University departments in areas that have not traditionally had lab or hands-on components are shifting to incorporate hands-on learning experiences as an integral part of the curriculum. Courses and degree plans across all disciplines at institutions are in the process of changing to reflect the importance of media creation, design, and entrepreneurship.*

Overview

There is a growing trend on university campuses in which students are doing more content creation and design, across the spectrum of disciplines. More colleges, universities, and libraries are developing environments and facilitating opportunities to harness this creativity and building physical spaces where students can learn and create together, integrating content- and product-centered activities as part of their instruction. This trend is gaining strength and should reach its full impact in about three to five years.

Makerspaces (also known as hackerspaces) began to appear around 2005 in communities as locations where individuals could experiment using a range of metal-working, wood, plastics, and electronics tools that were purchased by and shared amongst the group via a number of strategies including memberships, time-sharing and fee structures, or collective ownership. In the past few years, academic makerspaces and fabrication labs have popped up on university campuses in a variety of places, including libraries. These dedicated spaces are equipped not only with traditional craft tools, but also digital equipment such as laser cutters, microcontrollers, and 3D printers. The availability of these expensive resources has turned maker labs into communal spaces where students can work on class and self-directed projects, in addition to participating in managing and maintaining the facilities. University

makerspaces are beginning to demonstrate the value of these sites for teaching and learning in interesting new ways. The Maker Lab in the Humanities at the University of Victoria, for example, is currently conducting research into humanities physical computing, which brings digital and analog materials into dialogue through the construction of interactive systems. This maker-centered research is helping to foster the growth of the field of digital humanities.

A continuous stream of new ways for creative ideas to be funded and brought to reality has put university students more in control of the development of their research than ever before. Through the crowdfunding websites like Kickstarter or Indiegogo, student-led projects that might have stalled at the concept or model stage can now be brought to fruition. A student at Cornell University, for example, is using Kickstarter to develop Kicksat, a project intended to launch a small spacecraft into low earth orbit. Greater access to media production tools and outlets has also allowed students to move from consumers of video to producers.

Campus libraries increasingly host not only makerspaces, but also other services that support creativity and production, such as video equipment loans and studios, digitizing facilities, and publication services. At Dartmouth College, researchers are exploring how student-generated video can be used to further learning and evaluate a student's academic performance through the collection of various assignments housed on the Media Projects page of the college's website. For example, one architecture assignment involves students capturing video of the built environment from their personal perspective to reveal the history and character of a specific site.

Implications for Policy, Leadership, or Practice

The National Science Foundation's new initiative, *Cyberlearning: Transforming Education*, is providing grant money to study the educational benefits of makerspaces and the transferability of that type of learning to math and science skill improvement. The results of these research projects will help to establish a Cyberlearning Resource Center that will benefit educators, curriculum

specialists, and others interested in learning the impact of making activities. Indiana University's Make-to-Learn Initiative is a higher education example that brings together makers, educators, and researchers to understand how DIY culture can advance learning outcomes, be effectively integrated into educational institutions, and engage different learning styles.

Vanderbilt University is actively shifting the emphasis of teaching on their campuses to include more opportunities for creative exploration and applied learning. Their *Student as Producer* initiative creates semester-long opportunities for students across multiple disciplines and courses to engage in production activities. At the core of this initiative, students work on problems or questions that have not

Campus libraries increasingly host services that support creativity and production.

been fully answered, sharing their work with others outside of the classroom, seeking feedback and insights from experts, and working on projects in a largely self-directed manner. Student-centered activities include biology students designing their own experiments, engineering students creating podcasts about their projects, and English students expressing their ideas through multimedia entries on course blogs. The approach demonstrates how students can actively collaborate with their teachers in the production of knowledge and meaning-making.

The University of Michigan's Center for Entrepreneurship and several student-led organizations sponsored a number of content creation activities in Spring 2013. MHacks was a 36-hour nonstop hackathon. OptiMize was a competition where students created social innovation projects centered around the topics of health, poverty, environment, or education. As part of this, student business developers set up a storefront in the Student Union to sell their products directly to other students. 1000 Pitches was a contest where students created short video business pitches to solicit their ideas. The involvement of student leadership was key to the success of these events.

For Further Reading

The following resources are recommended for those who wish to learn more about the shift from students as consumers to students as creators:

The Case for a Campus Makerspace

go.nmc.org/mspa

(Audrey Watters, *Hack Education*, 6 February 2013.) The author explains why the maker culture has the potential to reinvigorate higher education institutions by inciting more collaboration, participatory, project-based, and peer-to-peer learning.

Commandeering the Decks: Baltimore's Digital Harbor Tech Center

go.nmc.org/timc

(Tim Conneally, *Forbes*, 18 January 2013.) After not being used for decades, the South Baltimore Rec Center reopened as the Digital Harbor Tech Center, a community makerspace where students can access tools to help them design and then create objects using 3D printers and circuit boards. This article discusses how this is an example of the growing maker movement recognizing the value of experiential learning.

Creativist Manifesto: Consumer vs. Creator

go.nmc.org/creama

(Olivia Sprinkel, *Rebelle Society*, 9 January 2013.) Being a creator rather than a consumer requires a shift in attitude in terms of how a person engages with the world around them; the creativist trend is more active and informs the choices made on a daily basis.

Is Making Learning? Considerations as Education Embraces the Maker Movement

go.nmc.org/makelea

(Rafi Santo, *Empathetics: Integral Life*, 12 February 2013.) The potential to impact learning through the maker culture has rejuvenated educators. According to this article, the most important aspect of this approach is not in the product but rather the process behind making.

Stanford FabLearn Fellows Program

go.nmc.org/fabl

(Stanford University, accessed 31 October 2013.) The Transformative Learning Technologies Lab at Stanford University is leading an initiative to generate an open-source curriculum for makerspaces and Fab Labs all over the world.

What Is the Maker Movement and Why Should You Care?

go.nmc.org/mamove

(Brit Morin, *The Huffington Post*, 2 May 2013.) The essence behind the do-it-yourself movement, traditionally related to how-to instructional books, has shifted into a movement where people in all industries are creating new goods, crafts, foods, and technology.



Agile Approaches to Change

Long-Range Trend: Driving changes in higher education in five or more years

There is a growing consensus among many higher education thought leaders that institutional leadership and curricula could benefit from agile startup models. Educators are working to develop new approaches and programs based on these models that stimulate top-down change and can be implemented across a broad range of institutional settings. The Lean Startup movement uses technology as a catalyst for promoting a culture of innovation in a more widespread, cost-effective manner. Pilots and other experimental programs are being developed for teaching and improving organizational structure to more effectively nurture entrepreneurship among both students and faculty.

Overview

Institutions are increasingly experimenting with progressive approaches to teaching and learning that mimic technology startups. In October 2013, the U.S. Department of Commerce published a report entitled *The Innovative and Entrepreneurial University*, which highlighted the ways in which universities around the country are nurturing entrepreneurship within their infrastructure and teaching practices. Their research revealed a growing emphasis on both formal and informal programs that build students' interests in solving social and global problems, creating products, and contributing content to help existing businesses. One noted example is the University of Illinois' Patent Clinic, in which law students work with student inventors to draft real patent applications.

With the demand from employers for graduates to have real world experience before entering the workforce, more institutions are structuring learning activities that forge these opportunities early. Rice University, for example, recently raised over one million dollars to launch a business planning competition where students presented strategies to start their own companies; the money was also used to provide funding for the winning plans to get off the ground. Additionally, more institutions are developing mentorship programs for students to nurture this spirit of innovation. Institutions such as the University of Washington and the University of Florida are bringing in successful professionals

to mentor students as they formulate business and product ideas. Leveraging expertise from local business professionals is a way to ensure that students are receiving the latest insights into the workforce. Students at Chapman University can participate in Entrepreneurs in Residence and the Entrepreneur Mentor Program, which pairs them with successful professionals who provide expert guidance. George Washington University provides the same service for faculty who are developing their own startup companies.

Historically, university technology transfer and licensing offices have helped innovators on campus to commercialize their products, but the growing focus on entrepreneurship has expanded their roles to help both faculty and students connect with technology investors and industry leaders. According to the U.S. Department of Commerce, this is leading to institutional culture changes and has even prompted companies to locate themselves in college communities. One of the most effective examples of the growing relationship universities are forging with industry is Cornell University's IP & Pizza and IP & Pasta outreach programs that guide faculty and students in not only better understanding intellectual property issues, but more importantly, how their research can be made most useful to society. Similarly, University of Delaware's College of Engineering and Lerner College of Business launched Spin In to help local entrepreneurs who have developed new technologies that require further revisions and iterations.

Implications for Policy, Leadership, or Practice

By nature, many startups are equipped to quickly change processes and workflows; if higher education institutions adopt startup models, it could lead to the more efficient implementation of new practices and pedagogies. One well-known, low-cost model is Penn State University's One Button Studio, which is a video recording set-up that enables users with no production experience to create high quality videos with only a flash drive and the push of a button. When educators are able to experiment with new technologies and approaches before implementing them in courses, they have the opportunity to evaluate them and

make improvements to teaching models. Faculty are using One Button Studio to create introductions for online courses along with demonstration modules to better illuminate complex concepts. Students are also encouraged to use the One Button Studio for green screen recording and class presentations, changing the scope of what is expected of them. Other institutions are taking note and launching similar studios, including Abilene Christian University.

The growing emphasis of university programs on entrepreneurship has created a need for policies that more aggressively support innovative faculty and student work. The University of Southern California, for example has garnered attention for its policies in rewarding and funding faculty-created projects, while just a few years ago the University of Virginia's School of Medicine was one of the first programs to incorporate entrepreneurial activities in its promotion and tenure criteria. The University of Nebraska Medical Center's Entrepreneur in Residence supports the development of new companies that are based on the work and innovations of their faculty and staff researchers.

There are many opportunities for higher education institutions to become leaders in promoting innovation across their campuses. The University of Colorado Denver, for example, offers an international entrepreneurship experience for faculty who wish to study abroad and learn about the most effective pedagogies related to teaching business courses with global applications. Similarly, the Rady School of Management at the University of California San Diego incorporates faculty training in their Entrepreneur Development Services Program. A growing number of external organizations, such as the Coleman Foundation, are also targeting faculty development as a major space for nurturing campus innovation. They provide a Fellows program to faculty to build capacity for areas such as boosting the frequency and quality of interdisciplinary entrepreneurship, as many other programs are limited to business schools.

For Further Reading

The following resources are recommended for those who wish to learn more about agile approaches to change:

Are Edutech Startups Plugging an Innovation Gap in Our Universities?

go.nmc.org/gap

(Claire Shaw, *The Guardian Higher Education Network*, 27 March 2013.) The CEO of Mendeley, a UK-based edtech startup, encourages universities to choose small

companies over the leaders in the market for technology services because they offer more personalized solutions to an institution's problems.

Change Is Coming

go.nmc.org/isco

(Dan Greenstein, *Inside Higher Ed*, 16 December 2013.) This article argues that including technology is the only way to facilitate new business models that provide students with an education that is tailored to their needs, their learning styles, and their goals, including appropriate coaching and advising.

John Kolko on Finding Purpose Working at an Edtech Startup (Video)

go.nmc.org/flag

(*Capture Your Flag*, 30 October 2013.) The VP of Design at an edtech startup and founder of Austin Center for Design explains what he has learned working from a venture capital funded company as a designer of MyEdu, a software solution for matching students and their future employers.

Rutgers President Barchi Calls for New Business Model in Higher Education to Focus on Public-Private Partnerships

go.nmc.org/rut

(Rutgers University, accessed 16 December 2013.) Rutgers University President Robert Barchi wants to forge public-private partnerships to gain new sources of revenue and resources, and he believes that an important aspect of this is creating research collaborations.

Stanford University Is Going To Invest In Student Startups Like A VC Firm

go.nmc.org/inves

(Billy Gallagher, *TechCrunch*, 4 September 2013.) Stanford University is working with StartX, a non-profit startup accelerator, to help students get their companies off the ground. Stanford Hospital and Clinics will be investing in companies alongside Stanford in the Stanford-StartX Fund.

U-M's Ross School Student-Led Venture Invests in EdTech Startup

go.nmc.org/ross

(Greta Guest, *UM News*, 18 April 2013.) University of Michigan's student-led investing group, the Social Venture Fund, provided funds for Mytonomy, a Maryland startup company that is developing a video-based social learning environment for first generation students.



Evolution of Online Learning

Long-Range Trend: Driving changes in higher education in five or more years

Over the past several years, there has been a shift in the perception of online learning to the point where it is seen as a viable alternative to some forms of face-to-face learning. The value that online learning offers is now well understood, with flexibility, ease of access, and the integration of sophisticated multimedia and technologies chief among the list of appeals. Recent developments in business models are upping the ante of innovation in these digital environments, which are now widely considered to be ripe for new ideas, services, and products. While growing steadily, this trend is still a number of years away from its maximum impact. Progress in learning analytics, adaptive learning, and a combination of cutting-edge asynchronous and synchronous tools will continue to advance the state of online learning and keep it compelling, though many of these are still the subjects of experiments and research by online learning providers and higher education institutions.

Overview

As online learning garners increasing interest among learners, higher education institutions are developing more online courses to both replace and supplement existing courses. According to a study by the Babson Survey Research Group published at the beginning of 2013, more than 6.7 million students, or 32% of total higher education enrollment in the United States, took at least one online course in Fall 2011 — an increase of more than half a million students from the prior year. As such, the design of these online experiences has become paramount. A recent article from *The Chronicle of Higher Education* suggests that in order for online courses to engage students from start and finish, they must encompass interactive features, along with fostering a robust community that is supported by a strong instructor presence.

The discussions among members of the 2014 Higher Education Expert Panel indicate that the advent of voice and video tools is not only increasing the number of interactive activities between online instructors and students, but also greatly improving their quality. In a brick-and-mortar lecture hall, the instructor's presence is easily felt because of the physical nature of someone standing in front of a room. Audio tools

such as VoiceThread and SoundCloud, along with video creation tools such as iMovie and Dropcam, enable faculty to capture important human gestures, including voice, eye contact, and body language, which all foster an unspoken connection with learners.

Part of engaging students in deep learning across online environments is personalizing the experience. Efforts such as Pearson's to integrate adaptive learning in online courses are leading this charge. In the summer of 2013, Pearson took their partnership with big data technology-provider Knewton to the next level by offering more than 400,000 college students enrolled in first-year science and business courses access to adaptive tutorial services. The technology detects patterns of students' successes and failures with the course material and provides personalized tutoring accordingly. An initial pilot with a subset of a few hundred students revealed better student performance and attitude. As adaptive learning services gain traction in online environments at scale, it is easy to envision courses that genuinely cater to all types of learning styles and appeal to more students.

Implications for Policy, Leadership, or Practice

The role of the instructor as leader and guide is pivotal and can be the single largest influencer of how effectively students learn in online settings. According to StudyMode, 65% of the population consists of visual learners. When faculty share personally recorded videos that demonstrate complex concepts in action, such as a chemical process or electrical circuiting, the footage naturally appeals to this majority demographic. Through synchronous discussions, using tools such as Google Hangout as leveraged by Clemson and the University of Minnesota, students can better detect and interpret the nuances inherent in the speech and gestures of the instructor. Some of the most popular online education websites, such as the Khan Academy, make use of videos to make learning more engaging.

Stanford University makes extremely effective use of iTunes U, where it publishes professional videos and other learning materials, produced by experts. This model aims to equalize access to education, and

teach complex concepts through multimedia. While individual instructors may not be able to replicate the quality of content published to Stanford's collections, there is an increasing expectation that universities and colleges be leaders in online learning, and thus equip their faculty and staff with the tools and training needed to create top-quality resources. The University of California, Irvine, for example, launched the Faculty Institute for Online Learning to better equip faculty with the skills to create more effective content for e-learning.

Central to the discussion of online learning are explorations of the policies needed to support and encourage the effort, and to guarantee quality. In MITx's privacy policy, as one example, there is a clause that suggests that different students may see different

Part of engaging students in deep learning across online environments is personalizing the experience.

variations of the same content in order to personalize the learning experience. This kind of policy gives course designers and instructors the flexibility to match student needs with instructional strategies on the fly using machine intelligence, which is an area where considerable development is unfolding.

For Further Reading

The following resources are recommended for those who wish to learn more about the evolution of online learning:

Creating Conceptual Capacity through Intelligent Tutoring

go.nmc.org/macq

(Thomas Kern et al., Macquarie University, accessed 16 December 2013.) A team at Macquarie University in Australia created an online Intelligent Tutoring System to assist in the teaching of Cash Flow Statement construction and analysis within the financial accounting curriculum.

A New Pedagogy is Emerging...And Online Learning is a Key Contributing Factor

go.nmc.org/pedag

(Contact North, accessed 6 January 2014.) Technology and student expectations are driving changes in pedagogy that favor knowledge management

through digital fluency and lifelong learning skills. Hybrid learning, use of multimedia, and increased learner control are some of the smaller trends that are converging to create new online-centered pedagogies in higher education.

Online Code School Bloc Raises \$2 Million For Its Web Development "Apprenticeship" Program

go.nmc.org/bloc

(Sarah Perez, *TechCrunch*, 5 December 2013.) Bloc is an online web development school founded by University of Illinois at Urbana-Champaign grads that uses an apprenticeship model to connect students directly with an experienced mentor who serves as a student's tutor and code reviewer.

The Online Education Revolution Drifts Off Course

go.nmc.org/drif

(*WFPL News*, 1 January 2014.) Leading MOOC providers are now recognizing that a more expansive, human-centered support structure is vital so that students retain information and complete their courses.

Online Learning Gets More Interactive

go.nmc.org/semi

(*The Wall Street Journal*, 18 November 2013.) An organization called Semester Online offers for-credit online courses from colleges and universities worldwide using asynchronous content and live classes so that students engage in real-time interaction with the professors, meeting once a week for 80 minutes on a webcam to discuss the content.

Shindig CEO Speaks at Education Innovation Summit (Video)

go.nmc.org/shindig

(Steve Gottlieb, *Shindig*, 28 August 2013.) Steve Gottlieb presents Shindig, an online teaching platform that uses a new architecture of communication that allows for asynchronous communication and private chats between audience members or students.



Significant Challenges

The six challenges featured in the *NMC Horizon Report: 2014 Higher Education Edition* were selected by the project's expert panel in a series of Delphi-based voting cycles, each followed by an additional round of desktop research and discussions. Once identified, the framework of the Up-Scaling Creative Classrooms (CCR) project, developed for the European Commission and pictured in the executive summary, was used to identify implications for policy, leadership, and practice that were related to each of the six challenges discussed in this section. These challenges, which the expert panel agrees are very likely to impede technology adoption over the next five years, are sorted into three categories defined by the nature of the challenge — solvable challenges are those that we both understand and know how to solve, but seemingly lack the will; difficult challenges are ones that are more or less well-understood but for which solutions remain elusive; wicked challenges, the most difficult, are complex to even define, and thus require additional data and insights before solutions will even be possible. All of the challenges listed here were explored for their implications for global higher education in a series of online discussions that can be viewed at horizon.wiki.nmc.org/Challenges.

The expert panel was provided with an extensive set of background materials when the project began that identified and documented well-known existing regional challenges, but the panel was also encouraged to consider emerging challenges as well as those that have been slow to take form.

Once the semifinal list of challenges was identified, each was viewed within the CCR framework, which served as a lens to identify implications for policy, leadership, and practice.

Policy

While all of the identified challenges had policy implications, two specific challenges are driving policy decisions on many campuses at the moment. The easiest one for universities to address is to revise policies that inequitably favor academic research over teaching. In Europe, ministers of education have acknowledged this problem with the belief that academic culture

must be changed accordingly. *The Guardian* elaborated the challenge in "University Reputations: Will Teachers Pay the Price?" noting that universities in the EU are competing to earn funding within the Research Excellence Framework (REF), an initiative of the UK government that will provide funding to institutions with outstanding rankings. Because of REF, universities are putting increased pressure on faculty to publish research; perhaps unsurprisingly, teaching staff feel the process undervalues their part of the university mission.

A more challenging policy area is that faculty that are using new pedagogies effectively often face environments that hinder the scalability of those innovations. Some institutions and programs are already taking steps to gain a better understanding of and solve this challenge. Researchers from the De

Competition from unexpected corners is challenging traditional notions of higher education, and especially its business models.

Montfort University and the University of London International programs, for example, reviewed the five projects within the UK's Joint Information Systems Committee (JISC) Curriculum Design and Delivery program. All five aim to introduce new systems to facilitate ongoing professional development and the design of interdisciplinary curricula. They concluded that teaching innovations can most effectively be scaled when they leverage a participatory, collaborative method with top-down policy development.

Leadership

Again, while all the identified challenges have leadership implications that are discussed in the following pages, three pose roadblocks to employing effective vision and leadership. There is an urgent need to address the lack of digital fluency among faculty. The challenge is widely recognized and some major organizations are taking matters into their own

hands. The Andrew W. Mellon Foundation, for example, provided Davidson College with an \$800,000 grant to create a comprehensive curricular model of digital studies to support the faculty's development of digital skills. Staff will meet semi-weekly in teaching institutes, workshops, and seminars to explore emerging tools and approaches.

Competition from unexpected corners is challenging traditional notions of higher education, and especially its business models. Institutions are increasingly expected to better infuse traditional, face-to-face learning with online learning strategies, but early for-credit experiments with some of the new online models indicate that the appeal of formalized online learning may not be widespread. In the fall of 2012, Colorado State University-Global Campus became the first college to offer students the chance to book college credits (for a fee) when they passed a MOOC. A year later, the college reported that not a single student had taken advantage of the program.

Where online programs are being relatively successful, however, is helping expand access to learning materials, a phenomenon noted by MIT president, L. Rafael Reif in a recent essay in *Time Magazine*. The gap in access is particularly felt by third-world countries where enrolling in brick-and-mortar institutions is not a feasible option for many. Queen Rania of Jordan has established a foundation that will support Edraak, a partnership with MIT and Harvard University's edX, to develop Arabic versions of courses, opening the door to these materials to tens of thousands of potential learners. The Queen believes these MOOCs can help democratize education for minorities in Arab nations by increasing and strengthening online programs. Of course, issues of sufficient or affordable Internet access still limit the availability of online courses in many regions.

Practice

Each of the six challenges identified by the expert panel presents numerous impediments for advancing teaching and learning, but perhaps the most wicked challenge related to these practices is keeping education relevant. Employers have reported disappointment in the lack of real world readiness they observe in recent graduates who are prospective or current employees. With both technology and the value of skills rapidly evolving, it is difficult for institutions to stay ahead of workforce needs. Northern Arizona University hopes to overcome this challenge with their Personalized Learning Program, where they are using transcripts that show student competencies in an effort to track learning in a way that can be more valuable to future employers.

The following pages provide a discussion of each of the challenges highlighted by this year's expert panel that includes an overview of the challenge, its implications, and curated recommendations for further reading on the topic.



Low Digital Fluency of Faculty

Solvable Challenge: Those that we understand and know how to solve

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.

Overview

The American Library Association's Digital Literacy Task Force defines digital literacy as the ability to use information and communication technology to find, evaluate, create, and communicate information. Digital literacy has been deemed critically important to both students and instructors in higher education, but it is widely acknowledged that there is a lack of effective training to ensure that faculty are getting the skills they need to guide students. A large part of the challenge is based on insufficient professional development, which is the result of a number of issues that range from a lack of funding, low administrative support, the paucity of formal digital literacy agendas, or ambiguity around the definition of digital fluency. Another facet of this challenge is in the attitude shift required of instructors; if they are reluctant to embrace new technologies and the promotion of digital literacy, students will not see the importance of these competencies to succeed in the workforce.

Current digital literacy trainings for faculty vary in effectiveness and availability. Boot camps, such as the ones held in the summer of 2013 by Xavier University, or workshops that provide introductions to new tools are the most common form of professional development, but what is missing is a deep intellectual and experiential engagement with underlying concepts. To

address this challenge requires a shift in mindset from the deployment of individual trainings to a continuous process of exploration and definition especially because of how rapidly technologies evolve. Additionally, for universities to progress in this area, there needs to be greater institutional support and leadership from the presidential level down to the departmental level.

The Director of Secondary and Middle School Teacher Preparation Programs at Mount Holyoke College published an article that proposed professional development offerings where digital literacy is forged through partnerships, mentorships, or peer-to-peer learning, rather than a loose connection of various trainings, as key to overcoming this challenge. The pairing of digitally savvy students with professors, for instance, offers valuable insight into how students currently use technology. Social media also engages students in new forms of learning through their networks outside of class. Instructors can take a more active role in learning from students, showing them in turn how to navigate digital media for learning. Libraries have also been very active in this area by providing valuable resources for university staff and instructors seeking help with digital literacy. Individual librarians, such as those at University of Cincinnati, along with faculty partnerships are helping instructors efficiently locate, vet, and cite information sources for use in the classroom.

Implications for Policy, Leadership, or Practice

The urgency of addressing low digital literacy for both faculty and students has been recognized and addressed by large funders such as the Andrew W. Mellon Foundation. The agency recently provided Davidson College with an \$800,000 grant to create a comprehensive curricular model of digital studies that will develop faculty's familiarity and fluency with digital tools. The grant will fund the development and expansion of digital studies throughout the college's curriculum, including support for faculty professional development. Instead of only focusing on developing digital tools and databases for professors, Davidson's approach is to spread digital studies as widely as possible throughout the curriculum and institution. Teaching

institutes, workshops, and seminars will be reinforced with ongoing support in the form of digital learning communities where faculty and staff meet semi-weekly to explore particular tools or methodologies.

Similarly, JISC supports the use of digital technologies in UK education and research, including a program that explores digital fluency across several university campuses. The JISC-funded Developing Digital Literacy Program promotes the development of coherent, inclusive, and holistic institutional strategies and organizational approaches for developing digital literacies for all staff and students in UK further and higher education. The results of the three-year project include the development of a set of recommendations to support institution-wide digital literacy, examples of best practice, case studies, and free workshops. Project Digidol, a JISC-funded project at Cardiff University, addressed the importance of changing attitudes regarding digital literacy across all areas and levels of the university. They began by establishing a baseline of current levels of digital literacy skills and sentiments and then developed an organizational model, gap analysis, and change in management approach for embedding digital literacy into all staff development courses and academic programs.

As leaders in information and digital media literacy, academic libraries currently provide services that help faculty build their confidence with learning new tools and processes. At Fresno State University's Henry Madden Library, faculty and staff can obtain information and digital literacy resources — librarians assist with syllabus redesign and digital literacy tutorials, as well as the creation of digital objects, modules and videos. Librarians at the University of Texas are helping to integrate information and digital literacy in curriculum planning as well as through collaborations with faculty where they work together to create effective research assignments and activities that help reinforce information literacy concepts to both students and instructors.

For Further Reading

The following resources are recommended for those who wish to learn more about the low digital fluency of faculty:

5 Keys to Engaging Faculty With IT

go.nmc.org/keys

(Linda L. Briggs, *Campus Technology*, 6 June 2013.) This article highlights several technology programs for faculty development that have been successful, explaining why analytics, communication, mutual

mentoring, collaboration, and grants or stipends have played crucial roles for universities in creating engaging development programs.

ASTI: The Formation of Academic Support, Technology and Innovation at Plymouth University

go.nmc.org/ply

(Neil Witt et al., Plymouth University, 9 July 2013.) This report details how Plymouth University's professional staff have been reorganized into a new department of Academic Services, Technology and Innovation, which develops resources and works with the academic community to successfully integrate technology into their pedagogies.

Digital Library Center Launches at Notre Dame

go.nmc.org/diglib

(*Inside Indiana Business*, 18 December 2013.) The University of Notre Dame's Hesburgh Libraries launched the Center for Digital Scholarship. This is one of a number of institutions that has transformed its library into a fertile learning space complete with digital tools, workshops, and technology training for faculty and students.

Digital Literacy for Digital Natives and Their Professors

go.nmc.org/native

(Steven Berg, *HASTAC*, 22 March 2013.) Responding to an article about student learning via informal social network discussions, the author agrees that students are taking control of their learning, but argues that they need guidance when it comes to choosing effective technologies to meet their academic objectives.

Incentives and Training

go.nmc.org/ince

(Marian Stoltz-Loike, *Inside Higher Ed*, 18 December 2013.) Though many colleges and universities across the country are requiring professors to teach at least one online course in an effort to cut costs, often instructors are not provided with the necessary tools to move to an online format.

Why Universities Should Acquire — and Teach — Digital Literacy

go.nmc.org/literacy

(Fionnuala Duggan, *The Guardian*, 23 April 2013.) The author believes that as more undergraduates become attached to technology, digital literacy training should be implemented so that they are aware of the best practices for online collaboration and communication.



Relative Lack of Rewards for Teaching

Solvable Challenge: Those that we understand and know how to solve

Teaching is often rated lower than research in academia. In the global education marketplace, a university's status is largely determined on the quantity and quality of its research. According to the Times Higher Education's World University Rankings methodology, research and citations account for 60% of a university's score, while teaching is only half that. There is an overarching sense in the academic world that research credentials are a more valuable asset than talent and skill as an instructor. Because of this way of thinking, efforts to implement effective pedagogies are lacking. Adjunct professors and students feel the brunt of this challenge, as teaching-only contracts are underrated and underpaid, and learners must accept the outdated teaching styles of the university's primary researchers. To balance competing priorities, larger universities are experimenting with alternating heavy and light teaching loads throughout the school year, and hiring more adjunct professors.

Overview

Faculties face increasingly high expectations from universities that make it apparent that research efforts are rewarded with positions of tenure, disregarding the breadth of an instructor's experience as a teacher. Yet research shows that adjuncts can have as great or even greater impact on students than tenured professors. A recent study by the National Bureau of Economic Research found that data from eight cohorts of first-year students at Northwestern University who took introductory courses with adjunct professors were significantly more likely to enroll in a second course in the subject than those taught by tenured professors. Moreover, lower-performing students made the greatest gains in the most challenging subjects when taught by adjuncts.

There is also a body of work that indicates that professors acknowledge that teaching is not a priority in higher education, yet many make conscious efforts to improve their methods with each new session of students, even without incentives. The SUNY Press published a qualitative study in 2012 that surveyed 55 faculty members across disciplines at the University of Washington about the ways in which they adapted their teaching to improve learning outcomes and student

behavior. The study revealed that nearly all educators had changed course assignments and content, and experimented with ways to engage students with each passing semester. The findings also demonstrated that there were a few highly regarded professors who reported a lack of confidence in teaching a course they had taught many times in the past, suggesting that there may be a need for instructors to update and practice their teaching methodologies continuously. Professors generally want to improve their pedagogies, but lack the resources and encouragement from their institutions to do so.

In Europe, this challenge has been articulated by major stakeholders who believe that the importance placed on research is a facet of academic culture that must be changed. A recent study of over 17,000 undergraduates in the UK by the consumer reporting website Which? showed a decrease in interaction between professors and students. Students reported that they received less feedback, as compared to UK learners in 1963. The downward trend in quality teaching standards has also been elaborated in the 2013 *Report to the European Commission on Improving the Quality of Teaching and Learning in Europe's Higher Education Institutions*, which laid out three main points of this challenge: it addressed the need to prioritize teaching and learning over research, the importance of training faculty members to teach at a first-rate standard, and for policymakers and thought leaders to push institutions of higher education to reevaluate their missions so that teaching is a keystone.

Implications for Policy, Leadership, or Practice

There is a need for governments to develop strategies that are informed by current research, with the ultimate goal of fostering an academic culture that financially rewards the quality of interaction in its classrooms. *The Guardian* explored this dilemma in "University Reputations: Will Teachers Pay the Price?" in which the author noted that universities in the EU are competing to earn funding from the Research Excellence Framework (REF), an initiative of the UK government that will provide funding to institutions with outstanding rankings. Because of REF, universities

are putting pressure on faculty to publish research, invoking negative reactions among teaching fellows who believe that they are being undervalued. While the quality of research and teaching may be tightly linked, some university stakeholders think that there should be government initiatives to allocate funds for the express purpose of improving teaching and learning.

University leaders may begin requiring doctoral and graduate students to fulfill training requirements, in order to make a greater impact on students. While there are plenty of resources dedicated to training K-12 teachers, there is a scarcity of programs with the singular aim of training pre-service and in-service professors to be better teachers. Former president of Harvard University and author of *Higher Education in America*, Derek Bok, has used *The Chronicle of Higher Education* as a forum for discussing the apparent lack of preparation pre-service faculty receive. Bok remarked that even though more centers have emerged to help graduate students learn to be teaching assistants, this type of training is optional, intermittent, and superficial in nature. As online learning plays a bigger part in higher education, this training will become essential because professors will be expected to be familiar with teaching techniques that address technology-facilitated learning.

A 2013 survey conducted by Faculty Focus polled 1,247 higher education professionals and found that over half believe that their job is more difficult today than it was five years ago. Among the sources of stress were working in highly competitive, research-intensive environments where the value of teaching is not recognized. According to the National Education Association, the number of faculty working outside of tenure is steadily increasing, a trend that is unfavorable for graduates who have a knack for teaching, but desire job security and benefits. Even professors with PhDs are accustomed to working several part-time teaching positions to earn their livelihood, giving them less time to publish research that will increase their standings. To address this issue, institutions must reevaluate their missions so as to uphold excellence in teaching as a core tenet, which will transform the rigid process of gaining tenure.

For Further Reading

The following resources are recommended for those who wish to learn more about the relative lack of rewards for teaching:

The Adjunct Advantage

go.nmc.org/tenure

(Scott Jaschik, *Inside Higher Ed*, 9 September 2013.) A

study by the National Bureau of Economic Research found that first year students at one university learned more from adjunct professors than from tenured professors, encouraging institutions to employ more teachers who do not have research obligations.

Helping Professors Use Technology Is Top Concern in Computing Survey

go.nmc.org/help

(Hannah Winston, *The Chronicle of Higher Education*, 17 October 2013.) The Campus Computing Project's annual survey of senior technology administrators found that helping faculty acclimate to new classroom technologies as classes move to online platforms will be the biggest IT concern over the next two to three years.

Teaching to Teach

go.nmc.org/tote

(Carl Straumsheim and Doug Lederman, *Inside Higher Ed*, 22 November 2013.) The growing popularity of online education leads more faculty members to recognize shortcomings of their own teaching styles, but faculty members also have a hard time breaking away from their existing commitments for training.

Training the Faculty

go.nmc.org/tra

(Carl Straumsheim, *Inside Higher Ed*, 16 October 2013.) At the most recent annual EDUCAUSE conference, two IT education thought leaders discussed the importance of investing in faculty development at the same rate as investing in any new hardware.

Uni Teaching Underrated, Lecturer Says

go.nmc.org/otago

(John Lewis, *Otago Daily Times*, 10 July 2013.) During his acceptance speech for an excellence in teaching award, a long-time educator shared his concerns that the quality of higher education is suffering because universities largely reward teachers solely for research.

Universities Putting Research Before Teaching, Says Minister

go.nmc.org/minister

(Peter Walker, *The Guardian*, 20 October 2013.) A minister of higher education discusses a recent survey of undergraduates that showed students received insufficient feedback, thus supporting his argument that there should be a cultural change to promote teaching over research.



Competition from New Models of Education

Difficult Challenge: Those we understand but for which solutions are elusive

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. Massive open online courses 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. At the same time, issues have arisen related to the low completion rates of some MOOCs. As these new platforms emerge, there is a growing 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.

Overview

With free, high-quality content accessible via the Internet, both formal and informal online learning is on the rise, which some fear could dampen the appeal of higher education institutions. MOOCs are currently dominating discussions about alternative forms of education. The term massive open online course, coined in 2008 by Stephen Downes and George Siemens, came into broad use in 2012. Since then, MOOCs gained public awareness with a ferocity not seen in some time. World-renowned universities, including MIT and Harvard University (edX) and Stanford University (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. The notion of 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, however, believe that the current manifestation of MOOCs has deviated from the initial premise outlined by Downes and Siemens 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 that emerges from the process helps to sustain and evolve the MOOC environment. Despite their philosophical distinctions, one aspect that contemporary MOOCs share is that there is little common ground in any of this landscape. Each MOOC example puts forth its own model of how online learning should work at scale.

While this new form of learning has immense promise, pundits are troubled by MOOCs' low completion rates — 5-16% overall. In Udacity's Introduction to Programming MOOC, for example, only 14% of the 160,000 enrolled students actually passed the course. What makes this

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

challenge more difficult is that while MOOCs were widely embraced in 2012, 2013 brought a major sea change in attitude. After these initial statistics were published, many turned skeptical about how engaging these learning environments actually were. Critics 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. Adding to the challenge is that many stakeholders see competition as threatening to the very notion of public universities and colleges, which complicates the exploration of alternative models and strategies.

Implications for Policy, Leadership, or Practice

The reach of MOOC providers and their free offerings has called the value of degrees and certificates into question. If one can learn online from some of the best instructors in the world for free, what can more

traditional institutions offer that can compete? According to recent stories in *The New York Times* and by *CBS*, there is a growing number of students concerned about what they are actually getting in exchange for the tremendous costs of their education. Average university tuition is already steep (and rising), along with the costs of student housing and travel to and from physical campuses; MOOCs present an appealing alternative, especially for graduates who are already in the workforce and looking for fast-track professional development opportunities. One of the foremost policy challenges is determining how to weave in formal credits to these new online experiences.

In one notable experiment, Indiana University-Purdue University Indianapolis and the Purdue University Department of Music and Arts Technology offered a MOOC that could be converted into credit. The six-week course covered the music of western civilization from 600 AD to the present and was delivered with full translation features, rich media, and social networking tools integrated. Most institutions are now investing in the development of similar online courses and producing content that will entice potential students to enroll for formal credit. However, some early for-credit experiments demonstrate that the appeal of formalized online learning may not be as broad as initially thought. In the fall of 2012, Colorado State University-Global Campus became the first college to offer credit to students who passed a MOOC if they registered and paid a fee. A year later, not a single student had taken advantage of the offer. Furthermore, in January 2013, San Jose State University partnered with Udacity to develop a for-credit course, but early results were mixed, and the effort was put on hold.

One of the biggest challenges for institutions is to find a way to design for-credit MOOCs that are both cost-effective for students and transcend traditional teaching practices. Many instructors who facilitate online courses are discovering that using rich media and incorporating plentiful opportunities for interaction are key. One prime example of an effective online course that is organized around the original connectivist model is the digital storytelling course at University of Mary Washington, which anyone can take and has now been adapted at several other institutions. They are currently exploring how to give credit to incoming high school students who complete it.

For Further Reading

The following resources are recommended for those who wish to learn more about competition from new models of education:

Can Virtual Classrooms Beat Face-to-Face Interaction?

go.nmc.org/face

(Libby Page, *The Guardian*, 13 November 2013.) The trend toward online learning has many questioning if education will become an impersonal experience that will leave learners isolated. In this article, a number of experienced educators share their insights.

The Disruptive Business Model for Higher Education is Open Source

go.nmc.org/opso

(Brian Reale, *OpenSource*, 15 October 2013.) This article argues that if higher education providers focus on talent identification, the payoff for universities will come not from selling courses but rather from finding and nurturing talent and receiving payback in the form of contributions to their endowments.

Educational Model Change Rattles Teachers

go.nmc.org/rat

(Chelsea Davis, *The World*, 16 October 2013.) The University of Wisconsin is introducing a competency-based alternative education Flex Option that only costs \$2,250 for three months of “all you can study” access with the possibility of finishing a degree in three months or moving at a slower pace, depending on personal preference.

Employers Receptive to Hiring IT Job Candidates with MOOC Educations

go.nmc.org/rece

(Fred O’Connor, *PCWorld*, 9 December 2013.) This article contains examples of students furthering their education through MOOCs to help them land new jobs or change directions in their careers.

The Future Is Now: 15 Innovations to Watch For

go.nmc.org/now

(Steven Mintz, *The Chronicle of Higher Education*, 22 July 2013.) A shift in the way students consume higher education is challenging traditional colleges to become more nimble and student-focused.

Higher Education: New Models, New Rules

go.nmc.org/mode

(Louis Soares, Judith S. Eaton, Burck Smith, *EDUCAUSE Review Online*, 7 2013.) Three essays what needs to change in the current education system to enable an education model that incorporates outcome-driven pedagogy, ubiquitous access, and cheaper tuition.



Scaling Teaching Innovations

Difficult Challenge: Those we understand but for which solutions are elusive

Our organizations are not adept at moving teaching innovations into mainstream practice. Innovation springs from the freedom to connect ideas in new ways. Our schools and universities generally allow us to connect ideas only in prescribed ways — sometimes these lead to new insights, but more likely they lead to rote learning. Current organizational promotion structures rarely reward innovation and improvements in teaching and learning. A pervasive aversion to change limits the diffusion of new ideas, and too often discourages experimentation.

Overview

In a 2013 report on innovation in higher education, two scholars on educational policy from the American Enterprise Institution, Frederick M. Hess and Andrew P. Kelly, surmised that the accreditation system has helped uphold traditional teaching practices in universities and discouraged the consideration of new tools and approaches. Hess and Kelly highlighted four principles for guiding meaningful change in higher education while confronting the challenges that impede the uptake of best practices. Their recommendations for universities include approaching new market entrants with openness; pursuing the trend toward the unbundling of higher education; and considering portability, or the notion of students being able to choose distinct parts of their learning from various providers to compose their credentials. Above all, they emphasize the need for universities to move beyond their standard practice of retrofitting their institutions with the latest technologies. The overarching vision is a diverse higher education paradigm in which providers are competing for students who are paying for discrete components of a degree, rather than the degree itself.

Universities are being increasingly pressured to closely examine cutting-edge technological solutions and teaching practices, but there are many barriers preventing institutions from implementing new strategies. There is a movement in the US to smooth the path to accreditation, with advocates proposing more opportunities to experiment with new teaching models that lower prices and bolster student learning. Supporters of this reform argue that the potential of technology to improve learning and scale quality

instruction for large audiences has already been realized, yet the red tape surrounding the process of accreditation is an impediment for universities to expand their institutions into unexplored territory. Still, regional accreditors defend their status in the higher education ecosystem, as they have started approving more competency-based paths and accelerated degrees, which are not based on the standard credit-hour. Stakeholders question the motives behind efforts to change the traditional mode of accreditation to a system where funds will be rerouted to private companies that have special interests in the matter.

Even when more innovative curricula have been developed, universities face capacity issues that limit the depth and speed of integration. There is no core of faculty to do the work that is needed for meaningful implementation, argues Adrianna Kezar, the co-director of the Pullias Center for Higher Education at USC. This is because of how universities function as employers; the number of non-tenure track faculty and part-time adjunct professors outnumber those on tenure tracks. This disparity contributes to the lack of impact part-time faculty have in the integration of teaching innovation. Without the support of an invested staff, the potential of innovative teaching practices cannot reach beyond the research methods used to develop them. Kezar emphasizes the need for key stakeholders to work together on a vision for the future of faculty, and what their roles and responsibilities will be as higher education inevitably evolves.

Implications for Policy, Leadership, or Practice

Online learning environments show promise for extending best teaching practices to educators everywhere. The WIDE World is an online resource for teachers, professors, teacher trainers, and administrators that has been promoting the development of constructivist teaching practices since its inception in 2004. Developed by the Harvard Graduate School of Education, the WIDE World delivers semester-long courses in which participants study new, research-based pedagogies, apply the approaches they have learned with their students, interact regularly with expert coaches, and contribute to ongoing dialogues

with their peers. While this approach aims to bridge the knowledge-action gap with ample research and strong instructional design, the scale remains limited because its success relies on demonstrated demand for the courses.

The European Commission has demonstrated the impact a principle vision can have in guiding innovation in teaching practices with the Opening Up Education Initiative, which proposes actions at national levels. Founded on the idea that open educational resources can be leveraged to provide professional development to teachers, the project will fund efforts to develop open online courses and scale up existing teachers' communities of practice, such as e-Twinning and SCIENTIX, to make training in best practices more accessible to European educators across sectors. Supporting research behind this initiative has revealed that rigid governance structures, inflexible budgets, and lack of reward for innovative educators are all factors that inhibit the spread of emerging teaching practices among the Member States.

Some institutions are determining what characteristics of university culture make it challenging to scale new teaching practices in meaningful ways. Researchers from the De Montfort University and the University of London International programs, for example, reviewed the methods in which five projects within the JISC Curriculum Design and Delivery program were employed from a management perspective. These projects introduce new technical systems to facilitate various activities, including delivering ongoing professional development and designing interdisciplinary curricula. Each strategy addressed the dynamic and behavior of personnel who are working within a culture where change happens as a result of influence, personal credibility, and the decision-making tactics of sub-cultures and committees. The researchers looked critically at the top-down versus a bottom-up approach to implementation, and concluded that innovations are most effectively scaled using a participatory, collaborative method to identify problems and solutions, with leadership distributed among the stakeholders.

For Further Reading

The following resources are recommended for those who wish to learn more about scaling teaching innovations:

2014 is the Perfect Time to Reform Our Schools

go.nmc.org/refor

(Gene Budig and Alan Heaps, *The News-Gazette*, 5

January 2014.) This article discusses components of the educational landscape that make reform and innovation in teaching difficult. The author urges a strategy that is nationally supported with long-term goals.

Beyond Retrofitting: Innovation in Higher Education

go.nmc.org/huds

(Andrew P. Kelly and Frederick M. Hess, Hudson Institute, June 2013.) Existing higher education institutions are offering online courses, implementing LMS, and creating technology-enhanced student services, but the authors believe that these new products do not change existing cost structures or prices.

The Dean of Parsons: Design Education Must Change

go.nmc.org/pars

(Katherine Allen, *ArchDaily*, 10 November 2013.) The Parsons New School for Design is pioneering a design program that uses exploratory methods of cross-disciplinary and technology-based learning, teaching students to apply design in the real world.

Higher Education: A Canary in a Privatization Coalmine

go.nmc.org/cana

(Christina Gonzalez, *University World News*, 8 November 2013.) Chilean universities are among the most expensive in the world, making upward mobility in Chile difficult, but the system remains fundamentally unchanged despite escalating student protests.

Innovation — Doomed to Fail?

go.nmc.org/doom

(Adrianna Kezar, *Inside Higher Education*, 6 December 2013.) In order to innovate effectively, there are underlying capacity issues that must be addressed at the same rate in which institutions incorporate new technologies. The article reveals that unfortunately, many current high-tech pedagogies reinforce memorization or cater to highly privileged learners.

Time to Change the Rules?

go.nmc.org/rule

(Paul Fain, *Inside Higher Ed*, 1 November 2013.) During a hearing of the U.S. Senate's Committee on Health, Education, Labor and Pensions, lawmakers discussed education reform, looking at competency-based accreditation options and the changing financial aid policy.



Expanding Access

Wicked Challenge: Those that are complex to even define, much less address

The global drive to increase the number of students participating in undergraduate education is placing pressure across the system. The oft-cited relationship between earning potential and educational attainment plus the clear impact of an educated society on the growth of the middle class is pushing governments to encourage more and more students to enter universities and colleges. In many countries, however, the population of students prepared for undergraduate study is already enrolled — expanding access means extending it to students who may not have the academic background to be successful without additional support. Many in universities feel that these institutions do not have sufficient time and resources to help this set of students.

Overview

The current shift from labor-oriented economies towards knowledge-based economies, compounded by a growing global population, is putting pressure on countries around the world to expand access to higher education. According to the World Economic Forum, 40% of global youth are unemployed; a postsecondary education is becoming less of an option and more of an economic imperative. Universities that were once bastions for the elite need to re-examine their trajectories in light of these issues of access, and the concept of a credit-based degree is currently in question. Complicating the challenge are wide-ranging factors such as financial constraints, lack of capacity, national priorities, and the digital divide, which make the scope of this problem very hard to grasp. Options such as the construction of more college campuses, bolstering online learning, and removing barriers to learning are only working the edges of this wicked challenge.

The numbers of anticipated global college students are staggering. Over the next 12 years, the World Bank estimates a 25% increase in global higher education attendance from 200 to 250 million. In Africa alone, the continent would need to build four universities with capacities of 30,000 people every week just to accommodate the students reaching enrollment age by 2025. With a population of 234 million people between the ages of 15 and 24, India is also faced with major decisions on how to effectively educate current and

future students. Countries such as Singapore, Dubai, and Qatar are currently working to solve this growing capacity issue by enticing leading international universities to establish new satellite campuses by providing free infrastructure and facilities. India is following the lead of these nations through the passing of a Foreign Education Providers bill, designed to encourage partnerships with quality overseas higher education institutions.

Exacerbating the challenge is the digital divide where access to opportunity increasingly calls for access to technology. In both the developed and developing world, this gap continues to widen, and the technology-based solutions for providing greater access to knowledge, such as MOOCs, have little effectiveness if the proper infrastructure or connectivity are not readily available. Minority groups and the disabled too often encounter physical and financial barriers that need to be overcome if they are to succeed in higher education. Nonprofit Byte Back is working to solve the problem locally for low-income Washington D.C. residents by providing computer training and teaching job readiness skills. Similarly, in the Middle East, where access to computers and broadband is limited in remote areas, the online education service Edraak is partnering with community-based organizations to provide computer hubs for those seeking further education.

Implications for Policy, Leadership, or Practice

Over the next decade, the fastest growing jobs in the United States will require postsecondary degrees, and the need to fill these middle class jobs is stimulating policy action at the federal level. The White House reports that the United States currently ranks 16th in the world in degrees and certificates awarded to adults ages 25-34. Additionally, just over half of United States high school graduates from the nation's poorest quarter of families seek further formal education. In response to these statistics, the Obama administration has set a new goal that the United States would have the highest proportion of graduates in the world by 2020. To address access and affordability issues, the government proposes formal policies to help families afford college, lower tuition costs, strengthen community colleges,

and improve transparency and accountability. These efforts are designed to bridge the opportunity gap that currently exists between privileged and underprivileged students.

Online learning is seen as a key strategy for increasing access to higher education. Although most of the new online education providers are based in the United States, their offerings are provided in many local languages in recognition of the over two-thirds of

Over the next 12 years, the World Bank estimates a 25% increase in global higher education attendance from 200 to 250 million.

students that live abroad. In response to the gaps inherent in different cultures, as mentioned earlier, Queen Rania of Jordan has established a foundation that will, as part of a partnership with MIT and Harvard University's edX, create Arabic versions of the courses offered on that platform. The Queen believes MOOCs have the potential to democratize education, especially among young women. In Africa, MOOCs are seen as a low-cost solution to providing college educations to countries with low college degree attainment rates. The nonprofit Generation Rwanda is currently developing a university based entirely on teaching assistant-facilitated MOOCs with starter courses from Harvard University and the University of Edinburgh.

For Further Reading

The following resources are recommended for those who wish to learn more about expanding access:

Access to Higher Education Must Be a Global Priority

go.nmc.org/prio
(Aengus Ó Maoláin, *University World News*, 5 November 2013.) Two major demonstrations in Thailand and in Canada reveal a student movement that is defending the right to education as a public good, a public responsibility, and an inalienable human right.

Community Colleges are On the Front Lines of Battling Inequality

go.nmc.org/commu
(Eduardo J. Padron, *Aljazeera America*, 3 December 2013.) The latest figures show income disparity in

the U.S. has reached levels not seen since the Great Depression, putting the cost of a college education out of reach for many students. Community colleges are critical to support these low-income students because they are cheaper to attend, but funding for them is currently much lower than state and private universities.

Digital Divide Not Just About Hardware, But People (Video)

go.nmc.org/peop
(Kelley Ellsworth, *The Washington Post*, 6 November 2013.) Educating people is not just about what technologies are available, but also fostering a safe environment that gives learners confidence in their ability to learn. Once comfortable, they will be able to learn on their own and adapt to new technologies.

How is Technology Addressing the College Access Challenge?

go.nmc.org/chall
(*Getting Smart*, 5 December 2013.) A report released by Get Schooled reveals that the available online resources to support college readiness are few and far between. Improving college access and completion rates cannot be achieved without support and guidance that begins early and lasts until graduation. Additionally, technology is an important factor in scaling advising resources.

How Jordan's Queen Plans to 'Democratize Access' to Education

go.nmc.org/jord
(Christina Farr, *Venture Beat*, 18 November 2013.) In Jordan, Queen Rania Al Abdullah's foundation has announced a new Arabic online education service called Edraak, formed in partnership with edX, that will partner with community-based organizations to offer a computer hub for people who do not have Internet access at home.

Online Learning Could Provide Answer

go.nmc.org/could
(Nontobeko Mishali, *iOL scitech*, 12 November 2013.) This article concludes that if institutions in Africa are to accommodate the students who will reach university enrollment age between now and 2025, four universities will need to be built every week with a capacity of 30,000. Additionally, for MOOCs to be successful in the developing world, all of the necessary infrastructure that is currently not there, including hardware and connectivity, must be in place.



Keeping Education Relevant

Wicked Challenge: Those that are complex to even define, much less address

Many pundits worry that if higher education does not adapt to the times, other models of learning (especially other business models) will take its place. While this concern has some merits, it is unlikely that universities as we know them will go away. There are parts of the university enterprise, however, that are at risk, such as continuing and advanced education in highly technical, fast-moving fields. As online learning and free educational content become more pervasive, institutional stakeholders must address the question of what universities can provide that other approaches cannot, and rethink the value of higher education from a student's perspective.

Overview

The higher education sector has reached a critical point where it must address the innovations that have changed the way its learners, and the rest of society, seek and engage with knowledge. Students are turning to the Internet to acquire information and news, and are spending more time there than sitting in classrooms. Textbook providers were among the first to acknowledge this intrigue in digital media by including supplemental material that could be accessed via CD. Today, many of these vendors have moved all of their content online, offering subscription models for institutions or individual students. The transformation observed in higher education has been compared to that of the newspaper industry, when many long-standing businesses failed because they ignored how technology was influencing their audiences. Some education leaders believe that if universities do not adapt quickly enough to change, they will suffer the same fate.

Open online learning environments, particularly in the form of MOOCs, are at the forefront of discussions surrounding this challenge. Since the explosion of MOOCs in 2012, a number of top-tier universities have offered free, high-quality courses taught by their best instructors. According to a recent survey by the Consumer Financial Protection Bureau, total US student debt is over \$1.2 trillion, with 39 million young people owing an average of \$24,803. With mounting fears of debt and an unfavorable job market ahead, some

high school graduates are reconsidering the value of a traditional college degree. It is generally accepted that the return on investment of attending a brick-and-mortar institution is not immediately guaranteed, especially for professions in the humanities, including law. This notion is forcing university leadership to rethink what the experience of learning at the institution through a formal education provider is worth, at a time when there is an abundance of free resources to attain employable skills without a degree.

Higher education stakeholders are facing a reality that is difficult to digest; the paradigm that has worked for over a century is gradually becoming obsolete, and universities must renovate — or in some cases, rebuild — their foundations if they want to stay relevant. Some thought leaders believe that the bulk of this transformation will happen when the credit hour system is overhauled. Established in 1893, this basic unit of college education has become foundational for many other facets of university life. With the costs of tuition steadily rising and a documented lack of skilled workers in the global marketplace, many are questioning whether class time can be equated with meaningful learning. This and related concerns have led many university leaders to propose more student-centered programs that focus on the demonstration of learning outcomes. Northern Arizona University's Personalized Learning Program is one such initiative that is based on transcripts that show student competencies rather than credits, in an effort to track learning in a way that can be applicable to future employers.

Implications for Policy, Leadership, or Practice

Adapting higher education systems to current technological trends requires progressive leadership and the ability to envision how formal institutions will remain relevant in a time when quality learning materials are more accessible than ever. The future of higher education is being shaped by those who acknowledge how online learning will redefine the value of a degree, and are open to exploring alternative means of proving skill acquisition through certificates, badges, and e-portfolios. Institutional leaders must take these options seriously if they are to make decisions

that will keep a university education relevant in a time when it is widely acknowledged that a college degree does not guarantee a direct return on investment. Determining how to develop the most effective online learning scenarios and integrate them with face-to-face learning is among the most critical considerations related to this issue.

University stakeholders need to take into account the progress that has been made by their predecessors when designing and implementing new approaches. This requires a thorough survey of institutions that have already been exploring creative ways of demonstrating learning outcomes. There are a number of universities

The paradigm that has worked for over a century is gradually becoming obsolete.

that have been offering competency and assessment based learning programs for years, for example. Other online learning programs award degrees based on tests, papers, and projects instead of number of credits completed, such as College for America at Southern New Hampshire University. The latest developments in competency-based higher education are in newly-conceptualized “flex” programs, such as those being developed by the University of Wisconsin, which are offered in a subscription period of three months, and combine online learning and in-person practicums along with access to mentors and academic coaches.

Instructors are often confronted with major uncertainties that stem from this challenge, especially as the trend toward increased implementation of hybrid models sets new expectations of university faculty. Some on campuses wonder if these kinds of courses will become the norm, and what that means for faculty workloads, noting that it is impossible to undermine the value of experiences and interactions students share with their professors. There is considerable need for models that leverage high-quality online learning platforms while taking into account what professors do best — facilitating inquiry, guiding learners to resources, and imparting wisdom that comes with experience in the field.

For Further Reading

The following resources are recommended for those who wish to learn more about keeping education relevant:

Are You Competent? Prove It.

go.nmc.org/compe

(Anya Kamenetz, *The New York Times*, 29 October 2013.) Many universities are introducing competency-based programs that let students earn credit for what they already know so they can focus their time and money more in the areas in which they need to expand their knowledge and skills.

Can Policy Keep Up with Technology?

go.nmc.org/poli

(Todd Bishop, *GeekWire*, 13 September 2013.) Microsoft is donating \$1.7 million to the University of Washington for their Tech Policy Lab, which will address the gap between policy and technology by studying and testing new technologies to inform and shape national policies.

Change: An Unstoppable Force of Nature — and Information Technology

go.nmc.org/uns

(Greg Hunt, *CIO New Zealand*, 7 November 2013.) This article explores the idea that the way organizations navigate change dictates their long-term success, and these approaches can be adopted to help respond in a positive manner to forces beyond their control.

Tech Launching New STEM-Focused MBA Program

go.nmc.org/focu

(Blake Ursch, *A-J Media*, 5 December 2013.) Texas Tech's Rawls College of Business is launching a one-year MBA program specifically tailored for students with backgrounds in STEM education, to give them a wider skillset than a purely technical background offers and allow them to market their ideas.

Vocational Education 2.0: Employers Hold the Key to Better Career Training

go.nmc.org/voc

(Tamar Jacoby, *Insider Online*, 25 November 2013.) This report discusses how employers must recognize their responsibility to help prepare tomorrow's workforce by partnering with educators and government to create better training options.

WISE — Can Universities Keep Up with the Future?

go.nmc.org/keep

(Yojana Sharma, *University World News*, 1 November 2013.) The International Association of University Presidents' session at the WISE conference in Doha sparked debate over how universities can survive through technological advances and globalization.



Important Developments in Educational Technology for Higher Education

The six technology topics featured in the *NMC Horizon Report: 2014 Higher Education Edition* were selected by the project's expert panel in a series of Delphi-based voting cycles, each followed by an additional round of desktop research and discussions. These technologies, which the members of the expert panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three time-related categories — near-term technologies that are expected to achieve widespread adoption in one year or less; mid-term technologies that will take two to three years; and far-term technologies, which are forecasted to enter the mainstream of education within four to five years. The initial list of topics was also arranged through particular lenses, or categories that illustrate the primary origin or use of the technology. All of the technologies featured here were explored for their implications for global higher education in a series of online discussions that can be viewed at horizon.wiki.nmc.org/Horizon+Topics.

The expert panel was provided with an extensive set of background materials when the project began that identifies and documents well-known existing technologies, but the panel was also encouraged to consider emerging technologies whose impact may still be distant. A key criterion for the inclusion of a new technology in this edition is its potential relevance to teaching, learning, and creative inquiry in higher education.

In the first round of voting, the expert group selected 12 technologies, which were then researched in-depth by the NMC staff and written up as interim results intended to inform the final round of voting. Technologies that do not make the interim results or the final report are often still thoroughly discussed on the project wiki at horizon.wiki.nmc.org. Sometimes they do not get voted in because the expert panel believes a technology has already arrived, or, in many cases, they believe the technology is more than five years away from widespread adoption. Some technologies, while intriguing, do not have enough credible project examples to substantiate them. The technologies tracked for the *NMC Horizon Report: 2014 Higher Education Edition* were organized into categories.

There are currently seven categories of technologies that the NMC monitors continuously. These are not a closed set, but rather are intended to provide a way to illustrate and organize emerging technologies into

The initial list of topics was arranged through particular lenses, or categories that illustrate the primary origin or use of the technology.

pathways of development that are or may be relevant to learning and creative inquiry. New technologies are added to this list in almost every research cycle; others are merged or updated. Collectively, the categories serve as lenses for thinking about innovation; each is defined below.

- > **Consumer technologies** are tools created for recreational and professional purposes and were not designed, at least initially, for educational use — though they may serve well as learning aids and be quite adaptable for use on campuses. These technologies find their ways onto campuses because people are using them, rather than the other way around.
- > **Digital strategies** are not so much technologies as they are ways of using devices and software to enrich teaching and learning, whether inside or outside of the classroom. Effective digital strategies can be used in both formal and informal learning; what makes them interesting is that they transcend conventional ideas and learning activities to create something that is new, meaningful, and 21st century.
- > **Internet technologies** include techniques and essential infrastructure that help to make the technologies underlying how we interact with the network more transparent, less obtrusive, and easier to use.

- > **Learning technologies** include both tools and resources developed expressly for the education sector, as well as pathways of development that may include tools adapted from other purposes that are matched with strategies to make them useful for learning. These include technologies that are changing the landscape of learning, whether formal or informal, by making it more accessible and personalized.
- > **Social media technologies** could have been subsumed under the consumer technology category, but they have become so ever-present and so widely used in every part of society that they have been elevated to their own category. As well established as social media is, it continues to evolve at a rapid pace, with new ideas, tools, and developments coming online constantly.
- > **Visualization technologies** run the gamut from simple infographics to complex forms of visual data analysis. What they have in common is that they tap the brain's inherent ability to rapidly process visual information, identify patterns, and sense order in complex situations. These technologies are a growing

cluster of tools and processes for mining large data sets, exploring dynamic processes, and generally making the complex simple.

- > **Enabling technologies** are those technologies that, like location awareness, have the potential to transform what we expect of our devices and tools. The link to learning in this category is less easy to make, but this group of technologies is where substantive technological innovation begins to be visible. Enabling technologies expand the reach of our tools, make them more capable and useful, and often easier to use as well.

The following pages provide a discussion of the six technologies highlighted by this year's expert panel. Each includes an overview of the technology; a discussion of its relevance to teaching, learning, or creative inquiry; and curated project examples and recommendations for further reading.

2014 NMC Master List of Tracked Technologies

Consumer Technologies

- > 3D Video
- > Electronic Publishing
- > Mobile Apps
- > Quantified Self
- > Tablet Computing
- > Telepresence
- > Wearable Technology

Digital Strategies

- > BYOD
- > Flipped Classroom
- > Games and Gamification
- > Location Intelligence
- > Makerspaces
- > Preservation/Conservation Technologies

Internet Technologies

- > Cloud Computing
- > The Internet of Things
- > Real-Time Translation
- > Semantic Applications
- > Single Sign-On
- > Syndication Tools

Learning Technologies

- > Badges/Microcredit
- > Learning Analytics
- > Massive Open Online Courses
- > Mobile Learning
- > Online Learning
- > Open Content
- > Open Licensing
- > Personal Learning Environments
- > Virtual and Remote Laboratories

Key Emerging Technologies

Social Media Technologies

- > Collaborative Environments
- > Collective Intelligence
- > Crowdfunding
- > Crowdsourcing
- > Digital Identity
- > Social Networks
- > Tacit Intelligence

Visualization Technologies

- > 3D Printing/Rapid Prototyping
- > Augmented Reality
- > Information Visualization
- > Visual Data Analysis
- > Volumetric and Holographic Displays

Enabling Technologies

- > Affective Computing
- > Cellular Networks
- > Electrovibration
- > Flexible Displays
- > Geolocation
- > Location-Based Services
- > Machine Learning
- > Mobile Broadband
- > Natural User Interfaces
- > Near Field Communication
- > Next-Generation Batteries
- > Open Hardware
- > Speech-to-Speech Translation
- > Statistical Machine Translation
- > Virtual Assistants
- > Wireless Power



Flipped Classroom

Time-to-Adoption Horizon: One Year or Less

The flipped classroom refers to a model of learning that rearranges how time is spent both in and out of class to shift the ownership of learning from the educators to the students. In the flipped classroom model, valuable class time is devoted to more active, project-based learning where students work together to solve local or global challenges — or other real-world applications — to gain a deeper understanding of the subject. Rather than the teacher using class time to dispense information, that work is done by each student after class, and could take the form of watching video lectures, listening to podcasts, perusing enhanced e-book content, and collaborating with peers in online communities. Students can access this wide variety of resources any time they need them. Teachers can devote more time to interacting with each individual. After class, students manage the content they use, the pace and style of learning, and the ways in which they demonstrate their knowledge; the teacher adapts instructional and collaborative approaches to suit their learning needs and personal learning journeys. The goal is for students to learn more authentically by doing.

Overview

The flipped classroom model is part of a larger pedagogical movement that overlaps with blended learning, inquiry-based learning, and other instructional approaches and tools that are meant to be flexible, active, and more engaging for students. The first well-documented example of the flipped classroom was in 2007 when two chemistry teachers at Woodland Park High School in Colorado wanted to address the issue of students missing class when they were traveling to and from school activities. Students were struggling to keep up with their work. The teachers, Jonathan Bergmann and Aaron Sams, experimented with using screen capture software and PowerPoint to record live lessons and post them on YouTube. They immediately observed a dramatic change in the classroom: the focus shifted to increasing interactions and fostering deeper connections between them and their students, as well as between students. Their roles transitioned from lecturers to coaches, guiding the learning of students individually. They observed students as they worked on assignments in small groups, made more accurate assessments about who needed extra attention, and

then created mini-lecture videos that catered to those learners.

Around the same time of this implementation, Salman Khan founded the not-for-profit Khan Academy with the mission of providing a free world-class education to anyone, anywhere. The website and apps house an extensive library of professional video lectures, ranging from science to economics to finance to humanities. While millions of students often visit the Khan Academy to supplement their formal education, educators are also using the videos as resources for their flipped classrooms. The Khan Academy has inspired a host of similar endeavors, including the Code Academy and LearnersTV. With a vast array of free resources readily accessible, faculty that are flipping their courses often do not have to create any materials from scratch, but instead focus on curating the best content for the subject matter.

Seven years after the first iteration of flipped learning and the launch of the Khan Academy, educators all over the world have successfully adopted the model, substantiating the topic's near-term position on the horizon. Whereas many learning technology trends first take off in higher education before seeing applications in schools, the flipped classroom reflects an opposite trajectory. Today, many universities and colleges have embraced this approach, enabling students to spend valuable class-time immersed in hands-on activities that often demonstrate the real world applications of the subject they are learning.

Relevance for Teaching, Learning, or Creative Inquiry

The flipped classroom model is becoming increasingly popular in higher education institutions because of how it rearranges face-to-face instruction for professors and students, creating a more efficient and enriching use of class time. For faculty, this often requires carefully creating or selecting the homework materials that are most relevant for a particular lesson. These can take the form of self-recorded video lectures and screencasts, a curated set of guiding links, or a variety of open educational resources (OER). Jorum, based out of the University of Manchester, for example, is a free online

educational repository for thousands of resources searchable by subject, author, or keywords.

Beyond watching recorded video lectures, other technologies such as digital readings with collaborative annotation and discussion software enable instructors to be more in tune with their students' learning patterns and needs. By reviewing the comments and questions

The learning environment transforms into a dynamic and more social space where students can participate in critiques or work through problems in teams.

that students pose online, instructors can better prepare for class and address particularly challenging ideas during face-to-face time. The learning environment transforms into a dynamic and more social space where students can participate in critiques or work through problems in teams. An instructor at Marshall University noted that he no longer needed to spend precious class time with an individual student if they missed a class; he could instead hand him a tablet loaded with content and continue working on hands-on projects among the whole class.

An added benefit of the flipped classroom is that it helps students develop the skills needed to be successful in the workforce. Healthcare is moving towards teams of collaborating practitioners; the Duke Institute for Brain Science has used the flipped classroom as a way to develop stronger collaboration and creative thinking skills in emerging practitioners. Studies are currently examining how flipping the classroom impacts learning, and preliminary results are very encouraging. A study conducted on foundational pharmaceuticals courses at the University of North Carolina shows that the flipped environment increased test scores by 5.1%. Harvey Mudd College is also engaged in a study of the impact of this learning strategy on STEM courses, and researchers are evaluating learning gains, retention, and transfer to downstream courses.

Flipped Classroom in Practice

The following links provide examples of the flipped classroom in use in higher education settings:

Flipped Business Courses in India

go.nmc.org/bsch

The Indian School of Business in Mumbai is using Creatist software to manage content, security, and delivery, as well as to track learners' responses and activities to help facilitate their flipped learning model.

Flipped Classroom for Literary Texts

go.nmc.org/lit

The University of Queensland School of English in Australia is using the flipped classroom to encourage effective reading of literary texts. Students use online quizzes and online marking to ensure that they are prepared to dive into group discussions and debates in the classroom.

Security and Forensics at UAlbany

go.nmc.org/digfor

With support from the National Science Foundation, digital forensics students at the University of Albany are reviewing lectures and working in virtual laboratories outside of class while they work with instructors on solving cyber security problems during class.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about the flipped classroom:

6 Expert Tips for Flipping the Classroom

go.nmc.org/fliptips

(Jennifer Demski, *Campus Technology*, 23 January 2013.)

A Harvard University professor, assistant director of Education Technology Services at Penn State University, and a math professor at Grand Valley State University provide strategies for flipping a university course.

Flipping Med Ed

go.nmc.org/flip

(Carl Straumsheim, *Inside Higher Ed*, 9 September 2013.) A senior associate dean of medical education at Stanford University and the founder of the Khan Academy believe the flipped classroom model can give medical students more hands-on learning time.

A Review of Flipped Learning

go.nmc.org/fln

(The Flipped Learning Network, accessed 6 November 2013.) The Flipped Learning Network released a comprehensive review of the flipped learning model, concluding that existing research demonstrates that the flipped learning approach fosters a classroom environment that is more learner-centered.



Learning Analytics

Time-to-Adoption Horizon: One Year or Less

Learning analytics is an educational application of “big data,” a branch of statistical analysis that was originally developed as a way for businesses to analyze commercial activities, identify spending trends, and predict consumer behavior. As web-tracking tools became more sophisticated, many companies built vast reserves of information to individualize the consumer experience. Education is embarking on a similar pursuit into new ways of applying to improve student engagement and provide a high-quality, personalized experience for learners.

Overview

Learning analytics research uses data analysis to inform decisions made on every tier of the education system, leveraging student data to deliver personalized learning, enable adaptive pedagogies and practices, and identify learning issues in time for them to be solved. Other hopes are that the analysis of education-related data on a much larger scale than ever before can provide policymakers and administrators with indicators of local, regional, and national education progress that can allow programs and ideas to be measured and improved. Adaptive learning data is already providing insights about student interactions with online texts and courseware. One pathway to creating the level of data needed for effective learning analytics is seen in creating student devices that will capture data on how, when, and in what context they are used, and thus begin to build school-level, national, and even international datasets that can be used to deeply analyze student learning, ideally as it happens.

Since the topic first appeared three years ago in the far-term horizon of the *NMC Horizon Report: 2011 Higher Education Edition*, learning analytics has steadily captured the interest of education policymakers, leaders, and practitioners. Big data are now being used to personalize every experience users have on commercial websites, and education systems, companies, and publishers see tremendous potential in the use of similar data mining techniques to improve learning outcomes. The idea is to use data to adapt instruction to individual learner needs in real-time in the same way that Amazon, Netflix, and Google use

metrics to tailor recommendations to consumers. Analytics can potentially help transform education from a standard one-size-fits-all delivery system into a responsive and flexible framework, crafted to meet the students’ academic needs and interests. For many years, these ideas have been a central component of adaptive software, programs that make carefully calculated adjustments to keep learners motivated as they master concepts or encounter stumbling blocks.

New kinds of visualizations and analytical reports are being developed to guide administrative and governing bodies with empirical evidence as they target areas for improvement, allocate resources, and assess the effectiveness of programs, schools, and entire school systems. As online learning environments increasingly accommodate thousands of students, researchers and companies are looking at very granular data around student interactions, building on the tools of web analytics. Pearson Learning Studio, for example, provides an LMS infrastructure that is aggregating data from the millions of learners using their systems, with the aim of enabling school leaders and national policy makers to more effectively design personalized learning paths.

Similarly, a group at Stanford University is examining vast datasets generated by online learning environments. These efforts are taking place through the Stanford Lytic Lab, where researchers, educators, and visiting experts are currently building an analytics dashboard that will help online instructors track student engagement in addition to conducting a study of peer assessment in a MOOC on human-computer interaction, based on 63,000 peer-graded assignments. In April 2013, the Bill & Melinda Gates Foundation awarded Stanford more than \$200,000 in funding to support the Learning Analytics Summer Institute, which provided professional training to researchers in the field.

Relevance for Teaching, Learning, or Creative Inquiry

Learning analytics is developing rapidly in higher education, where learning is happening more within online and hybrid environments. It has moved closer to mainstream use in higher education in each of the past three years. Sophisticated web-tracking tools are

already being used by leading institutions to capture precise student behaviors in online courses, recording not only simple variables such as time spent on a topic, but also much more nuanced information that can provide evidence of critical thinking, synthesis, and the depth of retention of concepts over time. As behavior-specific data is added to an ever-growing repository of student-related information, the analysis of educational data is increasingly complex, and many statisticians and researchers are working to develop new kinds of analytical tools to manage that complexity.

The most visible current example of a wide-scale analytics project in higher education is the Predictive Analytics Reporting Framework, which is overseen by the Western Interstate Commission for Higher Education (WICHE), and largely funded by the Bill & Melinda Gates Foundation. The 16 participating institutions represent the public, private, traditional, and progressive spheres of education. According to the WICHE website, they have compiled over 1,700,000 student records and 8,100,000 course level records in efforts to better understand student loss and student momentum.

Companies such as X-Ray Research are conducting research in online discussion groups to determine which behavioral variables are the best predictors of student performance. The tools reflect the potential of analytics to develop early warning systems based on metrics that make predictions using linguistic, social, and behavioral data. Similarly, studies at universities are proving that pedagogies informed by analytics can improve the quality of interaction taking place online. At Simon Fraser University in British Columbia researchers applied analytics to solve an issue that past experiments revealed — discussion forums used for online courses were not supporting productive engagement or discussion. They developed a Visual Discussion Forum in which students could visualize the structure and depth of the discussion, based on the number of threads extending from their posts. Learners in this study were also able to easily detect which topics needed more of their attention.

Learning Analytics in Practice

The following links provide examples of learning analytics in use in higher education settings:

Big Data in Education

go.nmc.org/bigda

Columbia University professors offer an online course for educators through Coursera to learn about the strengths and weaknesses of the various methods professors are currently using to mine and model the increasing amounts of learner data.

Competency Map

go.nmc.org/capel

The competency map at Capella University helps students own their learning by constantly showing them where they are in each course, how much is ahead of them, and where they need to concentrate their efforts to be successful.

Gradecraft

go.nmc.org/grade

The University of Michigan uses Gradecraft, which encourages risk-taking and multiple pathways towards mastery as learners progress through course material. The analytics employed guide students throughout the process and inform instructors of their progress.

For Further Reading

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

Data Science: The Numbers of Our Lives

go.nmc.org/datasci

(Claire Cain Miller, *The New York Times*, 11 April 2013.) According to a report by McKinsey Global Institute, there will be almost a half million jobs in data science in five years. Institutions are creating programs to train hybrid computer scientist/software engineer statisticians.

Learning to Adapt: A Case for Accelerating Adaptive Learning in Higher Education

go.nmc.org/case

(Adam Newman, Peter Stokes, Gates Bryant, Education Growth Advisors, 13 March 2013). A white paper funded by the Bill & Melinda Gates Foundation illustrates the current adoption of adaptive learning technologies in higher education, relevant obstacles, and the solutions being explored.

The Role of Learning Analytics in Improving Teaching and Learning (Video)

go.nmc.org/lerana

(George Siemens, Teaching and Learning with Technology Symposium, 16 March 2013.) Siemens reviews a number of case studies to show that when analytics are applied to education in a similar manner as companies use them, they can improve teaching and learning.



3D Printing

Time-to-Adoption Horizon: Two to Three Years

Known in industrial circles as rapid prototyping, 3D printing refers to technologies that construct physical objects from three-dimensional (3D) digital content such as 3D modeling software, computer-aided design (CAD) tools, computer-aided tomography (CAT), and X-ray crystallography. A 3D printer builds a tangible model or prototype from the electronic file, one layer at a time, through an extrusion-like process using plastics and other flexible materials, or an inkjet-like process to spray a bonding agent onto a very thin layer of fixable powder. The deposits created by the machine can be applied very accurately to build an object from the bottom up, layer by layer, with resolutions that, even in the least expensive machines, are more than sufficient to express a large amount of detail. The process even accommodates moving parts within the object. Using different materials and bonding agents, color can be applied, and parts can be rendered in plastic, resin, metal, tissue, and even food. This technology is commonly used in manufacturing to build prototypes of almost any object (scaled to fit the printer, of course) that can be conveyed in three dimensions.

Overview

The earliest known examples of 3D printing were seen in the mid-1980s at the University of Texas at Austin, where selective laser sintering was developed, though the equipment was cumbersome and expensive. The term 3D printing itself was coined a decade later at MIT, when graduate students were experimenting with unconventional substances in inkjet printers. Since 3D printing appeared in the very first *NMC Horizon Report* in 2004, the technology has helped the U.S. Department of Defense to inexpensively create aerospace parts, architects create models of buildings, medical professionals develop body parts for transplants, and much more. In the past several years, there has been a lot of experimentation in the consumer space — especially within the maker culture, a technologically-savvy, do-it-yourself community dedicated to advancing science, engineering, and other disciplines through the exploration of 3D printing and robotics.

During the process of 3D printing, the user will start by designing a model of the desired object using

specialized software such as CAD. While a variety of companies produce CAD software, AutoDesk is the acknowledged leader in the development of such tools. Once the design is sent to the printer, the materials — either plastics, metals, or a variety of other materials — are dispensed through a nozzle, and gradually deposited to eventually form the entire object. Additive manufacturing technologies change the way the layers are deposited as some objects call for the material to be softened or melted. Selective heat and laser sintering, for example require thermoplastics, while electron beam melting calls for titanium alloys. In the case of laminated object manufacturing, thin layers must be cut to shape and then joined together; the technology had previously only been found in specialized labs.

The adoption of 3D printing is also being fueled by online applications such as Thingiverse and MeshLab, repositories of free, digital designs for physical objects where users can download the digital design information and create that object themselves. The MakerBot is one of several brands of 3D desktop printers that allow users to build everything from toys to robots, to household furniture and accessories, to models of dinosaur skeletons. Relatively affordable at under \$2,500, the MakerBot was the first 3D printer designed for consumer use. Because of the inherent ability for users to create something, whether original or replicated, 3D printing is an especially appealing technology as applied to active and project-based learning in higher education.

Relevance for Teaching, Learning, or Creative Inquiry

One of the most significant aspects of 3D printing for education is that it enables more authentic exploration of objects that may not be readily available to universities. For example, anthropology students at Miami University can handle and study replicas of fragile artifacts, like ancient Egyptian vases, that have been scanned and printed at the university's 3D printing lab. Similarly, at the GeoFabLab at Iowa State University, geology students and amateur enthusiasts can examine 3D printed specimens of rare fossils, crystals, and minerals without risk of damaging these precious objects.

Some of the most compelling progress of 3D printing in higher education comes from institutions that are inventing new objects. A team at Harvard University and University of Illinois at Urbana-Champaign recently printed lithium-ion microbatteries that are the size of a grain of sand and can supply power to very small devices such as medical implants and miniature cameras. In the field of medical research, innovation at the microscopic level is seeing increasing growth. Researchers at the University of Texas at Austin are caging bacteria in 3D-printed enclosures in order to closely approximate actual biological environments for the study of bacterial infections. Scientists at the University of Liverpool are developing 3D-printable synthetic skin that will closely resemble an individual's age, gender, and ethnicity.

As 3D printing gains traction in higher education, universities are beginning to create dedicated spaces to nurture creativity and stimulate intellectual inquiry around this emerging technology. Examples include North Carolina State University's Hunt Library Makerspace, the 3DLab at the University of Michigan's Art, Architecture, and Engineering Library, and the Maker Lab in the Humanities at the University of Victoria in British Columbia, Canada. These spaces, equipped with the latest 3D scanners, 3D printers, 3D motion sensors, and laser cutters, not only enable access to tools, but they also encourage collaboration within a community of makers and hackers.

3D Printing in Practice

The following links provide examples of 3D printing in use that have direct implications for higher education settings:

3D Art

go.nmc.org/3dart

Art students are learning the history and applications of 3D printed art at Aalto University in Finland. They recently collaborated with a local artist collective to create sculptural works for an exhibition in the city of Hyrynsalmi.

3D Design Studio

go.nmc.org/ude

University of Delaware's Department of Mechanical Engineering opened a design studio with a 3D printer, materials repository, machine shop, and a collaboration laboratory so students can take design ideas from concept to prototype.

Fab Lab

go.nmc.org/fab

Fab Labs began as an outreach project from MIT's

Center for Bits and Atoms to research and experiment with digital fabrication. They have now materialized into centers across the globe, housing technology such as 3D printers, laser cutters, and programming tools that students can use in exploratory environments.

Organ Creation at the University of Wollongong

go.nmc.org/uw3d

Using a 3D bio-plotter, researchers at the University of Wollongong in Australia created technology for printing living human cells, such as muscles, along with a special ink that carries the cells. The hope is that the printer materials can eventually be used for patient-specific implants and even organ transplants.

For Further Reading

The following resources are recommended for those who wish to learn more about 3D printing:

4D Printing: The New Frontier

go.nmc.org/4dp

(Oliver Marks, *ZDNet*, 14 March 2013.) Advances in nano biotechnology are leading to new materials that can be programmed to change their form over time. This could spark new innovations including self-repairing pants made from biological materials and objects that assemble and disassemble depending on temperature.

10 Ways 3D Printers are Advancing Science

go.nmc.org/10ways

(Megan Treacy, *Treehugger*, 16 April 2013.) 3D printers are advancing science, from helping NASA researchers studying moon rocks to medical researchers working with 3D printed prosthetics for ears and other body parts. Specialized 3D printers are being used in labs to produce a variety of skin and other tissues that are literally "printed" onto an organic lattice.

Lab Equipment Made with 3-D Printers Could Cut Costs by 97%

go.nmc.org/reduc

(Paul Basken, *The Chronicle of Higher Education*, 29 March 2013.) A new study from Michigan Technological University shows how 3D printers can allow a sharp improvement in the efficiency and capabilities of research laboratories, cutting costs by as much as 97%. Additionally, 3D-printed parts enable more customization to suit individual needs.



Games and Gamification

Time-to-Adoption Horizon: Two to Three Years

The games culture has grown to include a substantial proportion of the world's population, with the age of the average gamer increasing with each passing year. As tablets and smartphones have proliferated, desktop and laptop computers, television sets, and gaming consoles are no longer the only way to connect with other players online, making game-play a portable activity that can happen in a diverse array of settings. Gameplay has long since moved on from solely being recreational and has found considerable traction in the military, business and industry, and increasingly, education as a useful training and motivation tool. While a growing number of educational institutions and programs are experimenting with game-play, there has also been increased attention surrounding gamification — the integration of gaming elements, mechanics, and frameworks into non-game situations and scenarios. Businesses have embraced gamification as a way to design incentive programs that engage employees through rewards, leader boards, and badges, often with a mobile component. Although more nascent than in military or industry settings, the gamification of education is gaining support among educators who recognize that effectively designed games can stimulate large gains in productivity and creativity among learners.

Overview

According to the Entertainment Software Association, the average age of today's gamers is 30, with 68% of gamers over 18 years old — university age. The popularity of digital games has led to rapid development in the video game industry over the past decade, with considerable advances that have broadened the definition of games and how they are played. When the gaming industry began to incorporate network connectivity into game design, they revolutionized game-play by creating a vast virtual arena where users from all over the world could connect, interact, and compete. The Internet offers gamers the opportunity to join massively multiplayer online (MMO) role-player games, such as "Minecraft," and to build online reputations based on the skills, accomplishments, and abilities of their virtual avatars. In the last few years, games have converged with natural user interfaces to create an experience for players that more closely

mimics real life. Using consoles such as Microsoft Kinect or Nintendo Wii, for example, players interact through body movements and hand gestures.

Gamification, or the notion that gaming mechanics can be applied to routine activities, has been employed successfully by a number of mobile apps and social media companies. One of the most popular incarnations over the years has been FourSquare, with a reward system that encourages people to check into locations to accumulate rewards — a notion that has paved the way for a host of resources that similarly gamify everyday life. Untappd and Tipsi, for example, are apps that allow users to document and receive badges for each different type of beer and wine they have tried, while Simple.com is a gamified banking service that helps users master their finances. It is not uncommon now for major corporations and organizations, including the World Bank and IBM, to consult with gaming experts to inform the development and design of large-scale programs that motivate workers through systems that incorporate challenges, level-ups, and rewards.

While some thought leaders argue that the increasing use of game design in the workplace is a short-lived trend that yields short-term bursts of productivity, companies of all sizes in all sectors are finding that workers respond positively to gamified processes. For higher education, these game-like environments transform assignments into exciting challenges, reward students for dedication and efficiency, and offer a space for leaders to naturally emerge. Badges, for example, are being increasingly used as a rewards system for learners, allowing them, in many cases, to publicly display their progress and skill mastery in online profiles.

Relevance for Teaching, Learning, or Creative Inquiry

Educational gameplay has proven to foster engagement in critical thinking, creative problem-solving, and teamwork — skills that lead to solutions for complex social and environmental dilemmas. This idea is the foundation of Jane McGonigal's work, a recognized game designer and researcher who is raising awareness about the power of games to change the world. McGonigal and other researchers at the Institute for the Future are

designing online games that foster participation and new ways of thinking about systems and sustainability in education, health, and urban contexts. The goal is to develop engaging platforms that spark curiosity, instill a sense of urgency and gravitas, while rewarding users in meaningful ways.

Digital simulations are another method being used widely to reinforce conceptual applications in mock real world scenarios. This is especially evident in business schools. At Montclair University School of Business in New Jersey, students play an online business simulation called GLO-BUS where they run a digital camera company and play with actual competitors in the global marketplace. The simulated environment challenges learners to develop and execute an effective, business savvy strategy, and provides the tools to address product line breadth, operations, outsourcing, pricing, and corporate social responsibility among other considerations. Scenarios like this one demonstrate the power of games to simulate real world scenes of productivity, requiring students to exercise executive thinking on weighty situations where their decisions make a serious impact.

Gamification is also appearing more in online learning environments. Kaplan University, for example, gamified their IT degree program after running a successful pilot in their Fundamentals of Programming course. Students' grades improved 9% and the number of students who failed the course decreased by 16%. Kaplan is using gamification software that can be embedded into LMS and other web applications. Gamification can also incentivize professional development. Deloitte developed the Deloitte Leadership Academy, a training program that leverages gamification to create curriculum-based missions. Learners earn badges for completing missions, which they can display on their LinkedIn profiles. As gaming continues to dominate discussions among educators, some believe it could disenchant students if executed poorly. To negate this challenge, more universities are partnering with companies to conduct research that is relevant to both the curriculum and students' lives.

Gaming and Gamification in Practice

The following links provide examples of gaming and gamification in use in higher education settings:

The Denius-Sams Gaming Academy

go.nmc.org/utgame

The University of Texas at Austin will be offering the first video game program in the nation by Fall 2014. The Denius-Sams Gaming Academy will be taught by

leaders in the video game industry and the program promises to be competitive and industry-driven.

Mentira

go.nmc.org/ment

Mentira, a mobile GPS and augmented reality-based game developed at the University of New Mexico, develops Spanish language skills as learners interact with characters in the Albuquerque, New Mexico setting and work through various obstacles to solve a murder mystery.

SICKO

go.nmc.org/sick

The Stanford University School of Medicine's SICKO is a web-based simulation game in which students manage three virtual patients simultaneously and must make critical decisions in the operating room.

For Further Reading

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

The Awesome Power of Gamification in Higher Education

go.nmc.org/awesome

(Tara E. Buck, *EdTech Magazine*, 18 October 2013.) At her keynote speech at EDUCAUSE 2013, game developer Jane McGonigal presented a vision of the future in which people's work and daily lives are transformed into gamified scenarios or "extreme learning environments."

Gamification Done Right

go.nmc.org/doneright

(Andre Behrens, *The New York Times*, 11 June 2013.) The author explores the various implications that the term gamification carries, and discusses the components that make it successful. He points to Simple.com as an effective and creative example.

Video Game Courses Score Big on College Campuses

go.nmc.org/scorebig

(Yannick Lejacq, *NBC News*, 12 September 2013.) U.S. colleges and universities are now offering more coursework and degrees dedicated to the study of video games than ever before, with 385 institutions now providing either individual courses or full degrees in game design.



Quantified Self

Time-to-Adoption Horizon: Four to Five Years

Quantified self describes the phenomenon of consumers being able to closely track data that is relevant to their daily activities through the use of technology. The emergence of wearable devices on the market such as watches, wristbands, and necklaces that are designed to automatically collect data are helping people manage their fitness, sleep cycles, and eating habits. Mobile apps also share a central role in this idea by providing easy-to-read dashboards for consumers to view and analyze their personal metrics. Empowered by these insights, many individuals now rely on these technologies to improve their lifestyle and health. Today's apps not only track where a person goes, what they do, and how much time they spend doing it, but now what their aspirations are and when those can be accomplished. Novel devices, such as the Memoto, a camera worn around the neck that is designed to capture an image every half minute are enabling people to track their lives automatically. As more people rely on their mobile devices to monitor their daily activities, personal data is becoming a larger part of everyday life.

Overview

People have always demonstrated interest in learning about themselves by tracking and measuring their behaviors and activities. Students already spend time in formal classroom settings gathering data about themselves or research topics. Quantified self technologies tap into this interest in the form of mobile apps, wearable devices, and cloud-based services that make the data collection process much easier.

Popular incarnations of the quantified self movement have materialized in the form of health, fitness, and life streaming tools. The Fitbit, for example, is a small wristband that tracks wearers' daily activities, including sleep patterns, steps taken, and calories burned. Through wireless and automatic syncing between the Fitbit and smartphones, tablets, and laptops, users can see real-time progress across their devices. The Jawbone Up wristband employs similar functionalities, allowing wearers to track sleep, movement, and dietary information that is automatically populated in the accompanying mobile UP app. The experience can easily turn into a social one as people can share their

accomplishments with other users and team up to track and achieve specific goals. Other wearables that have garnered worldwide attention have deeply integrated self-tracking tools, including Google Glass and iWatch, but the high prices — and in some cases, the low availability — of these devices have some pundits concerned that quantified self technologies are a luxury for the upper class. More affordable versions developed in the next four to five years could accelerate this technology trend in educational settings.

These technologies provide individuals greater self-awareness of their behaviors through self-tracking, as well as new ways to think about how to use the data collected. Since the introduction of this concept in

Popular incarnations of the quantified self movement have materialized in the form of health, fitness, and life streaming tools.

2007, communities have formed around the idea of using technology to aid in self-improvement. Through meet-ups and online communities, artists, self-help seekers, and even university researchers share their experiences with the hope to transform themselves and the rest of society through an analysis of the data they produce and collect. The Quantified Self Institute, for example, is an initiative by the Hanze University of Applied Sciences in the Netherlands that brings international and regional partners together to conduct research on different methods of self-tracking. This organization is well positioned to lead the quantified self movement into higher education institutions with recommendations on effective applications.

Relevance for Teaching, Learning, or Creative Inquiry

With the growing use of mobile apps and wearable technology, individuals are creating an exponentially increasing amount of data. The quantified self movement is breaking ground by integrating these data

streams in interesting ways. Self quantifiers, for example, can create healthier living plans after monitoring their sleep, exercise, diet, and other important patterns. The new mobile app Whistle even enables people to do the same for their dogs. It is imaginable that if test scores and reading habits gleaned from learning analytics could be combined with other lifestyle tracking information, these large data sets could reveal how environmental changes improve learning outcomes.

Quantified self technology also has the potential to shape the future of some industries. In the medical field, for instance, doctors are using not only traditional medicine but also data that individuals self-collect, such as heart rate, blood pressure, and sugar levels. Advancements in the field could enable computers to search for patterns and help physicians more accurately diagnose or anticipate health problems before patients step foot into the building. Educators at the moment can only hypothesize about a new era of the academic quantified self, but interest is strong and growing.

One of the current barriers for the mainstream adoption of this technology revolves around privacy concerns. The quantified self movement is about people sharing what they learn about themselves for the greater good, but there is a vulnerability to exposing personal information that will need to be addressed over the next four to five years. This could include a cost/benefit analysis about what data should be collected, what data should be shared, who should be responsible for making those decisions, and how to build the most effective and safe online communities of practice.

Quantified Self in Practice

The following links provide examples of quantified self in use that have direct implications for higher education settings:

Fitbit at the University of Tokyo

go.nmc.org/tokyo

Researchers from the University of Tokyo have used data from the Fitbit pedometer to detect and measure the strength of workplace relationships. The initial results reveal that the data generated by this quantified self technology can foster the creation of an accurate company profile.

Health Data Exploration Project

go.nmc.org/hdexplore

The California Institute for Telecommunications and Information Technology, with support from the Robert Wood Johnson Foundation, launched a research study that is seeking individuals who self-track their health

and fitness in an effort to determine how their data can be used to inform better public health.

The Russ-ome Project at The University of Texas

go.nmc.org/brainstu

A neuroscientist and director of the Imaging Research Center at The University of Texas at Austin is using a headband monitor, a heart monitor, and a survey app to track and report his sleep and exercise patterns for a year-long study. The information is being stored in a database that he will ultimately use for self-improvement.

For Further Reading

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

Gaming the Quantified Self

go.nmc.org/gthet

(Jennifer R. Whitson, Queens University, 2013.) This paper explores how digital games inherently facilitate surveillance of user activities, fostering the compilation of statistics that can be used to monitor individuals and surface overall behavioral patterns in gamified environments.

Quantified Self: The Tech-Based Route to a Better Life?

go.nmc.org/bbcquant

(Karen Weintraub, *BBC Future*, 3 January 2013.) The Quantified Self Movement is rooted in the need to record the details of daily life, and new technologies such as wearable trackers and apps have made it effortless for people to regularly document their activities.

Trackers, Measuring the Quantified Self

go.nmc.org/track

(Gopal Sathe, *Live Mint*, 7 September 2013.) Wearable trackers including Fitbit, Nike Fuel, and Jawbone Up are helping people monitor their personal data such as sleep cycle and step count, and are encouraging people to consider personal data as an integral part of their routines.



Virtual Assistants

Time-to-Adoption Horizon: Four to Five Years

As voice recognition and gesture-based technologies advance and more recently, converge, we are quickly moving away from the notion of interacting with our devices via a pointer and keyboard. Virtual assistants are a credible extension of work being done with natural user interfaces (NUIs), and the first examples are already in the marketplace. The concept builds on developments in interfaces across the spectrum of engineering, computer science, and biometrics. The Apple iPhone's Siri and Android's Jelly Bean are recent mobile-based examples, and allow users to control all the functions of the phone, participate in lifelike conversations with the virtual assistant, and more. A new class of smart televisions are among the first devices to make comprehensive use of the idea. While crude versions of virtual assistants have been around for some time, we have yet to achieve the level of interactivity seen in Apple's classic video, Knowledge Navigator. Virtual assistants of that caliber and their applications for learning are clearly in the long-term horizon, but the potential of the technology to add substance to informal modes of learning is compelling.

Overview

Virtual assistants employ artificial intelligence and natural language processing to provide people with support for a wide range of daily activities, such as discerning the best driving routes, arranging trip itineraries, and organizing email inboxes. The latest tablets and smartphones now include virtual assistants — perhaps the most recognized of which are Apple's Siri, Android's Jelly Bean, and Google Now. These virtual assistants are integrated into the mobile platforms, enabling users to interact more authentically with their devices by leveraging a conversational interface. Users can simply speak a request to the device, and the virtual assistant will respond instantly. The most advanced versions of this software actually track user preferences and patterns so they can adapt over time to be more helpful to the individual. In this sense, virtual assistants encourage convenience and productivity, making them particularly compelling for their potential applications in academic settings, though they are four to five years away from being widely used in higher education.

The functionality of many contemporary virtual assistants is triggered by a combination of three technologies: a conversational interface, personal context awareness, and service delegation. Conversational interfaces rely on voice recognition tools that have been enhanced by special algorithms and machine learning to decipher meaning. Because every person has their own way of speaking, personal context awareness helps virtual assistants understand specific nuances based on keywords and patterns in language. Conversational interfaces and personal context awareness enable virtual assistants to engage in human-like conversations with users. Finally, service delegation allows mobile virtual assistants to access and communicate with users' collections of mobile apps. Thanks to this concept, one of the most appealing features of virtual assistants is that they are often designed to integrate seamlessly with other programs, including mapping and recreational services.

The latest iteration of virtual assistants can be found in smart televisions linked with data processing systems that allow users to connect to the web. Apple, Samsung, and LG have been among the first to market with their versions. Users stream video directly from the Internet through voice-controlled web widgets and software applications. Smart TVs also track users' viewing patterns and program preferences to make tailored recommendations. While there are currently few concrete applications of smart TVs or virtual assistants being used in higher education, the prospect of tools that adapt to students' learning needs and preferences makes the technology one worth following closely over the next five years.

Relevance for Teaching, Learning, or Creative Inquiry

The technologies that enable virtual assistants are advancing at a rapid pace, presenting consumers with interfaces that recognize and interpret human speech and emotions with impressive accuracy. Students are already using virtual assistants in their personal lives, yet most institutions have yet to explore this technology's potential outside research settings. The University of Cambridge, for example, in partnership with the Toshiba Cambridge Research, presented a

prototype of a digital talking head named Zoe, which is one of the first attempts to put a human-like face on a virtual assistant. The research team enlisted the help of a British actress to record 7,000 sentences and emotive facial expressions, which composed the data set used to “train” Zoe’s face. The software is data-light with the potential to be personalized with various faces and voices.

Virtual assistants are already making an appearance in the health sector. In late 2014, intelligent solutions company Nuance Communications will launch an intelligent virtual assistant named Florence that understands clinical language and can take directives from doctors as they order medications, labs, and other diagnostic procedures. The technology is expected to reduce the amount of time a physician spends on administrative work, which accounts for 30% of their workday according to a survey by Nuance. It also offers a glimpse into a future where doctors will be able to retrieve and make additions to medical records in real-time using natural speech with the help of intelligent technologies.

Further development in technologies associated with virtual assistants such as those that teach computers to see, listen, and think like humans do, are progressing rapidly and bringing greater accuracy to pattern recognition, a capability that is also driving real-time translation technologies. Recently, Microsoft’s top scientist Richard F. Rashid demonstrated a computer program that displayed his words as he spoke. In the pauses between each sentence, the software translated his speech into written and then spoken Mandarin, which was heard in his own voice — a language he has never uttered. These scenarios point to a future in which virtual assistants will be equipped with more advanced capabilities that will help people navigate a world where collaboration across borders and overseas is increasingly the norm.

Virtual Assistants in Practice

The following links provide examples of virtual assistants in use that have direct implications for higher education settings:

BlabDroid

go.nmc.org/blab

MIT Media Lab plans to commercialize BlabDroid, a robot that offers similar functionality to other virtual assistants by connecting to a smartphone or the cloud so it can communicate pertinent information to users, including the weather, and post to a social network based on voice commands.

M*Modal

go.nmc.org/mmodal

The University of Virginia Health System is using M*Modal, a cloud-based speech recognition engine, to facilitate the creation, management, and sharing of electronic medical records. The goal is for medical staff and informatics professionals to quickly and accurately capture clinical narratives for improved billing, productivity, and patient care.

VAGUE

go.nmc.org/sphinx

Carnegie Mellon University created an open source toolkit for speech recognition on Kindle devices called VAGUE, which allows users to navigate the reader, launch various tools, and prompt more actions by writing a new script.

For Further Reading

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

Beyond the GUI: It’s Time for a Conversational User Interface

go.nmc.org/cuiwi

(Ron Kaplan, *WIRED*, 21 March 2013.) Ron Kaplan — a linguist, mathematician, and technologist — predicts the imminent emergence of the conversational user interface, which is based on voice-recognition and machine learning technologies.

New Virtual Assistant Anticipates Needs During Conversation

go.nmc.org/needs

(Tyler Falk, *Smart Planet*, 18 January 2013.) The author of this post describes the new iPad app called MindMeld, which, instead of responding to questions, analyzes and understands the content of online conversations in order to provide useful information.

Talk to the Phone: Google’s Moto X Virtual Assistant Raises Smartphone Bar

go.nmc.org/talkto

(Peter Nowak, *CBS News*, 13 August 2013.) The author provides a personal account of how the virtual assistant Google Now aided he and his wife on a trip across the northeastern United States.



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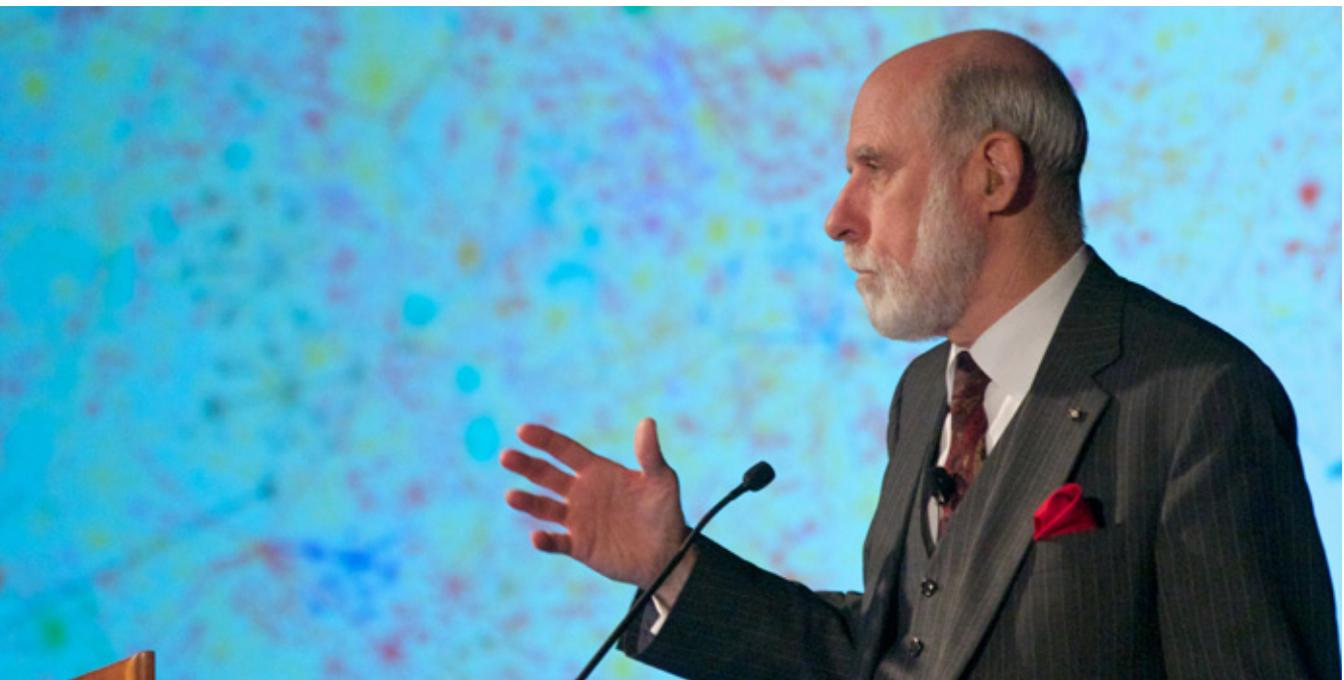
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Google VP Vint Cerf shares his vision for the future of the Internet of Things. *Photo by Dan LaValley.*



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