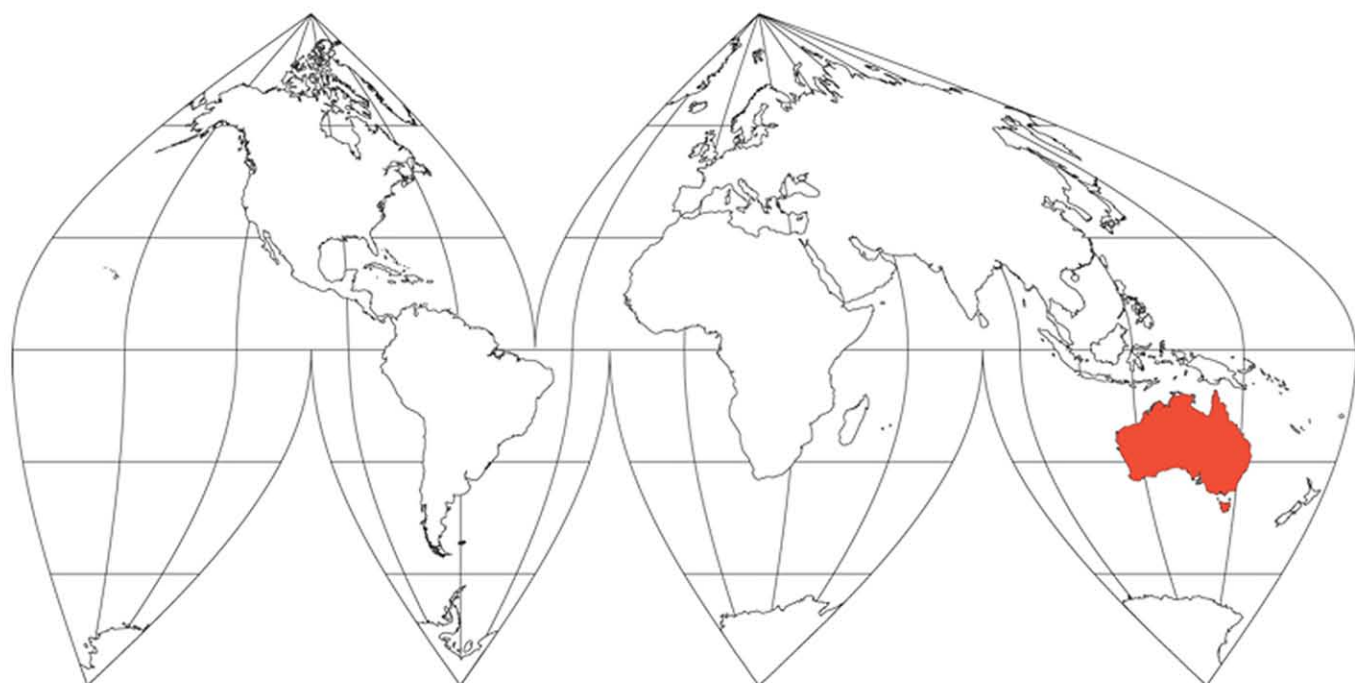




Horizon Project

Technology Outlook

Australian Tertiary Education 2012-2017



An NMC Horizon Report Regional Analysis

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The Technology Outlook for Australian Tertiary Education 2012-2017
is a collaboration between

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and

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Technology Outlook: Australian Tertiary Education 2012-2017

An NMC Horizon Report Regional Analysis

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Executive Summary

The *Technology Outlook for Australian Tertiary Education 2012-2017* reflects a multi-year collaborative effort between the New Media Consortium (NMC) and Griffith University to help inform Australian educational leaders about significant developments in technologies supporting teaching, learning, and research in tertiary education. The research underpinning the report makes use of the NMC's Delphi-based process for bringing groups of experts to a consensus viewpoint, in this case around the impact of emerging technologies on teaching, learning, research, or information management in Australian tertiary education over the next five years. The same process underlies the well-known *NMC Horizon Report* series, which is the most visible product of an on-going research effort begun a decade ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *Technology Outlook for Australian Tertiary Education 2012-2017* was produced to explore emerging technologies and forecast their potential impact expressly in an Australian context. In the effort that ran from February through April 2012, a carefully selected group of 41 experts behind this report considered hundreds of relevant articles, news, blog posts, research, and project examples as part of the preparation that ultimately pinpointed the most notable emerging technology topics, trends, and challenges for tertiary education in Australia over the next five years.

That group of experts, known as the 2012 Horizon.au Advisory Board, is comprised of a body of knowledgeable individuals, all highly regarded in their fields; collectively the advisory board represents a range of diverse perspectives across the learning sector. The project has been conducted under an open data philosophy, and all the interim projects, secondary research, discussions, and ranking instrumentation can be viewed at aus.wiki.nmc.org. The precise research methodology employed in producing the report is detailed in a special section found at the end of this report.

The 12 “technologies to watch” presented in the body of this report uniquely reflect the state of tertiary education in Australia. As the table below illustrates, however, they also overlap in interesting ways with the globally focused *NMC Horizon Report > 2012 Higher Education Edition* as well as the national perspective found in the *Technology Outlook for New Zealand Tertiary Education 2011-2016*. All three of these project's advisory boards — a group of 126 acknowledged experts — agree that mobile apps will likely tip into mainstream use in educational settings in the coming year. For the first time, all three advisory boards also placed cloud computing in the near-term, and agreed that game-based learning would see mainstream adoption within two to three years, reflecting a worldwide consensus among experts regarding the utility of all three of these potentially disruptive technologies.

Experts all over the globe see learning analytics as important, but the Horizon.au advisory board see this technology in 2012 as more imminent than both the New Zealand experts and the global higher education group, who saw it further away from mainstream and placed it in the far-term horizon. In fact, this report marks the first time learning analytics has been voted into the near-term horizon, indicating that Australia is well-positioned for leadership in this area. Secondary research supported the conclusion that Australian institutions are particularly interested in finding new ways to measure student performance, ideally in real-time.

There are some other interesting overlaps between Australia and the other two reports, including the position of natural user interfaces in the far-term horizon. The 79 experts from both the Australia and New Zealand advisory boards also collectively saw digital identity and personal learning environments as technologies still two to three years away. Open content, digital

preservation, and telepresence are topics of unique interest in Australia that did not appear in either of the other two recent reports. These three areas would seem to also present clear opportunities for Australian leadership, not only in the refinement of the technologies themselves, but also in the exploration and use of them on campuses.

“Short List” Topics Across Three NMC Horizon Research Projects

Technology Outlook for AU Tertiary Education 2012-2017	NMC Horizon Report 2012 Higher Education Edition	Technology Outlook for NZ Tertiary Education 2011-2016
Time-to-Adoption Horizon: One Year or Less		
Cloud Computing Learning Analytics Mobile Apps Tablet Computing	Cloud Computing Mobile Apps Social Reading Tablet Computing	Cloud Computing Collaborative Environments Mobile Apps Tablet Computing
Time-to-Adoption Horizon: Two to Three Years		
Digital Identity Game-Based Learning Open Content Personal Learning Environments	Adaptive Learning Environments Augmented Reality Game-Based Learning Learning Analytics	Digital Identity Electronic Publishing Game-Based Learning Personal Learning Environments
Time-to-Adoption Horizon: Four to Five Years		
Digital Preservation Massively Open Online Courses Natural User Interfaces Telepresence	Digital Identity Natural User Interfaces Haptic Interfaces Internet of Things	Augmented Reality Gesture-Based Computing Next-Generation Batteries Smart Objects

Massively open online courses (MOOCs) is a new topic this year; while prominent in the press over the last year, it was first voted into a *Horizon Report* by the 2012 Horizon.au Advisory Board. The choice would seem to fit logically with the advisory board’s placement of open content on the mid-term horizon, as open content is a key supporting technology for MOOCs. The courses are built around curated collections of open, subject-specific resources. Many learners in Australia are looking to open — often free — online universities to supplement the current courses at brick-and-mortar institutions. Outside of a few notable experiments, it remains unclear for the moment exactly how credit might be granted for MOOCs to students outside the offering institution.

Just as the nuances of the technologies and their associated adoption horizons featured in this report are unique to Australia, the trends and challenges selected by the 2012 Horizon.au Advisory Board distinctly reflect the current attitude, innovation, and obstacles of Australia as a whole. For example, the advisory board agreed upon the growing need for people to be able to work, learn, and study wherever they want, which is a trend that many Australian universities are responding to with innovative cloud computing and mobile solutions. As such, the experts spent a fair amount of time researching and discussing relevant trends and challenges in the context of Australian tertiary education. A full discussion of trends and challenges begins on page 17; the top three from those longer lists are included in the two tables presented here.

Two of the top three trends voted in by the 2012 Horizon.au Advisory Board do not overlap with the other two boards. While the New Zealand and global advisory boards focused on the network and bandwidth, Australia placed more of an emphasis on the learner’s control over the technology. These experts are finding a need for learning experiences with more freedom and flexibility — students should be able to use whatever devices they want to access the online content that corresponds best with their learning styles. This desire is again supported by the emerging technologies they agreed would have the biggest impact on education over the next five years: mobile apps, tablets, open content, personal learning environments, and MOOCs. The trends the Australian experts deem most prominent are pushing universities to invest in tools that enable more individualised, informal learning and foster entrepreneurship.

Top Trends Across Three NMC Horizon Research Projects

Technology Outlook for AU Tertiary Education 2012-2017	NMC Horizon Report 2012 Higher Education Edition	Technology Outlook for NZ Tertiary Education 2011-2016
People expect to be able to work, learn, and study whenever and wherever they want.	People expect to be able to work, learn, and study whenever and wherever they want.	The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators.
Increasingly, students want to use their own technology for learning.	The technologies we use are increasingly cloud-based, and our notions of IT support are decentralized.	The growing availability of bandwidth will dramatically change user behaviours in teaching, learning and research over the next five years.
Education paradigms are shifting to include online learning, hybrid learning and collaborative models.	The world of work is increasingly collaborative, driving changes in the way student projects are structured.	People expect to be able to work, learn, and study whenever and wherever they want.

Horizon Project Advisory Boards in general agree that trends such as these — even those not currently grounded in educational practice — are clear drivers of technology adoption. Likewise, the panels of experts also agree that technology adoption is hindered by challenges both local and systemic. Many challenges are grounded in everyday realities that often make it difficult to learn about, much less adopt, new technologies. Economic pressures, for example, continue to dominate conversations about the acceptance of technology in tertiary education worldwide, and Australia is no different.

Top Challenges Across Three NMC Horizon Research Projects

Technology Outlook for AU Tertiary Education 2012-2017	NMC Horizon Report 2012 Higher Education Edition	Technology Outlook for NZ Tertiary Education 2011-2016
Economic pressures and new models of education are bringing unprecedented competition to the traditional models of tertiary education.	Economic pressures and new models of education are bringing unprecedented competition to the traditional models of tertiary education.	Digital media literacy continues its rise in importance as a key skill in every discipline and profession.
Appropriate metrics of evaluation lag behind the emergence of new scholarly forms of authoring, publishing, and researching.	Appropriate metrics of evaluation lag behind the emergence of new scholarly forms of authoring, publishing, and researching.	Economic pressures and new models of education are bringing unprecedented competition to the traditional models of tertiary education.
Most academics are not using new and compelling technologies for learning and teaching, nor for organising their own research.	Digital media literacy continues its rise in importance as a key skill in every discipline and profession.	Most academics are not using new and compelling technologies for learning and teaching, nor for organising their own research.

Both the 2012 Horizon.au Advisory Board and the global higher education advisory board noted that evaluation metrics are not keeping up with the pace at which new scholarly forms of authoring, publishing, and researching continue to evolve. There is a consensus that there is not enough consideration placed on quantifying and qualifying the learning outcomes of the technology that is being adopted. This notion supports the 2012 Horizon.au Advisory Board's

emphasis on learning analytics as a technology with potential impacts in Australia in the very near-term.

The Australian and the New Zealand panels both agreed the pervasive resistance of academics to the personal adoption and use of new technologies or techniques themselves is a continuing barrier to institutional leadership with any technology. Both felt strongly that for students to learn how to effectively use technology, their teachers and mentors must find ways to embrace and creatively integrate it into their own work.

These insights and comparisons are intended as useful context for the body of the report that follows. Twelve key technologies are profiled, each on a single page that describes and defines the technology, outlines its educational relevance, points to several examples of the technology being applied in practice, and ends with a short list of additional readings for those who wish to learn more.

While these discussions are the core of this report, two additional sections are worthy of note. The Horizon.au experts were also asked to detail the key trends and the significant challenges they saw as influential factors in the adoption of any new technologies over the coming five years.

Those key sections, and this report in general, are intended as references and guides for educators, researchers, administrators, policymakers, and technologists to more easily make choices about technology that can improve, support, or extend teaching, learning, research, or information management. Educators and administrators worldwide look to the NMC Horizon Project and both its global and regional reports as key strategic technology planning references, and it is for that purpose that the report is presented.

The results of the research detailed in the *Technology Outlook for Australian Tertiary Education 2012-2017* will be officially released at a high-level workshop and public lecture in Brisbane, Australia, hosted by Griffith University. The workshop welcomes a diverse range of national thought leaders, policy makers, educators and information professionals to explore the emerging technologies identified in this report, and aims to develop a communiqué in response.

Time-to-Adoption: One Year or Less**Cloud Computing**

When cloud computing first appeared in the *NMC Horizon Report* in 2009, a number of concerns were voiced by Australian writers and policy makers related to privacy and security of important data that led to a dramatic growth in Australian cloud services. Since that time, the usage rates of the cloud in Australia for supporting collaboration, file storage, and access to computing cycles, as well as the number of applications that rely on cloud technologies have all grown tremendously. Cloud computing has become the unifying factor among content and applications on the many devices people use in everyday life. Whether connecting at home, work, school, on the road, or in social spaces, nearly everyone who uses a computer relies on cloud computing to access their information and applications. This ability to access services and files from any location and on any device is driving development of cloud computing applications in the consumer space. In the academic sector, this technology makes educational resources and communication and collaboration tools more resilient and ubiquitous. As cloud computing garners widespread adoption, Australian providers are establishing standards for privacy and security while staying ahead of evolving institutional needs.

Relevance for Teaching, Learning, Research, or Information Management

- Dynamic provisioning services offered by cloud providers like Amazon's S3 have transformed how we add storage and processing power, and scale resources.
- Cloud computing is being used in computer science programs to simulate virtually any computer, from historical machines to super computers.
- Cloud-based services include a wide range of increasingly powerful tools for almost any platform a user might choose, or any task a user might need to do.

Cloud Computing in Practice

- Bond University is one of the first in tertiary education in Australia to offer specialization in cloud computing: go.nmc.org/bond.
- XENON helped the University of Melbourne build a cloud specifically designed for researchers spanning all disciplines: go.nmc.org/cloud.
- Swinburne University is exploring how cloud computing can be an effective vehicle for scientific workflows and data storage: go.nmc.org/swinb.

For Further Reading**Cloud Computing and Creativity: Learning on a Massive Open Online Course**

go.nmc.org/clomoo

(Rita Kop and Fiona Carroll, *European Journal of Open, Distance and E-Learning*, 20 December 2011.) This paper discusses how cloud computing can be leveraged to support collaborative learning, specifically in massive open online courses.

Cloud Computing Strategic Direction Paper (PDF)

go.nmc.org/final

(Australian Government Department of Finance and Deregulation, April 2011.) After consulting with government agencies and cloud service providers, the Department of Finance and Deregulation analyzed the opportunities and impact of cloud computing.

Time-to-Adoption: One Year or Less**Learning Analytics**

Learning analytics refers to the interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues. Data are collected from explicit student actions, such as completing assignments and taking exams, and from tacit actions, including online social interactions, extracurricular activities, posts on discussion forums, and other activities that are not directly assessed as part of the student's educational progress. The goal of learning analytics is to enable teachers and schools to tailor educational opportunities to each student's level of need and ability in close-to-real time. Learning analytics promises to harness the power of advances in data mining, interpretation, and modeling to improve understandings of teaching and learning, and to tailor education to individual students more effectively. Learning analytics responds to calls for accountability on campuses and leverages the vast amount of data produced by students in academic activities.

Relevance for Teaching, Learning, Research, or Information Management

- Learning analytics can help surface early signals that indicate a student is struggling, allowing teachers and schools to address issues quickly.
- When correctly applied and interpreted, learning analytics will enable teachers to more precisely identify students' learning needs and tailor instruction appropriately.

Learning Analytics in Practice

- Amrita University is reaching more students in rural India via a multilingual collaborative platform that can be used remotely to teach language, promote adaptive learning, and run virtual experiments: go.nmc.org/amrit.
- The Graduate School of Medicine at the University of Wollongong used learning analytics to help design a new curriculum with a strong clinical focus. The approach provided evidence of appropriate curriculum coverage and student engagement: go.nmc.org/wollo.
- The University of New England's "Automated Wellness Engine" uses learning analytics to receive early alerts that identify at-risk students: go.nmc.org/autom.

For Further Reading**Exploring the Khan Academy's use of Learning Data and Learning Analytics**

go.nmc.org/khana

(K. Walsh, *Emerging EdTech*, 22 April 2012.) Khan Academy is now expanding its services with the "Teacher Toolkit," a new set of tools to help teachers learn about and navigate the Khan Academy. One of the major new components makes graphic reports available to help teachers personalise the learning process.

How Data and Analytics Can Improve Education

go.nmc.org/data

(Audrey Watters, *O'Reilly Radar*, 25 July 2011.) This interview with George Siemens addresses the importance and consequences of privacy issues within learning analytics.

Social Learning Analytics: Technical Report

go.nmc.org/social

(Simon Buckingham Shum and Rebecca Ferguson, Knowledge Media Institute, the Open University, UK, June 2011.) This paper studies the technological needs of implementing accurate learning analytics in an online academic setting.

Time-to-Adoption: One Year or Less**Mobile Apps**

There is a revolution that is taking place in software development that parallels the changes in recent years in the music, publishing, and retail industries. Mass market is giving way to niche market, and with it, the era of highly priced large suites of integrated software is giving way to a new view of what software should be. Smartphones including the iPhone and Android have redefined what we mean by mobile computing, and in the past three to four years, the small, often simple, low cost software extensions to these devices — apps — have led to a hotbed of development. New tools are free or sell for as little as 99 cents, and anyone can be a developer. A popular app can see millions of downloads in a short time, and that potential market has spawned a flood of creativity that is instantly apparent in the extensive collections available in the app stores — themselves a new way of delivering software that reduces distribution and marketing costs significantly. Apple's app store opened in July 2008; Google's followed in October of that year. Since then, the Apple store has sold more than 25 billion apps; Google's store has booked more than 10 billion sales. These simple but useful apps have found their way into almost every form of human endeavour.

Relevance for Teaching, Learning, Research, or Information Management

- As interactive and social features become more integrated into mobile apps, learners can share their findings on topics, making the app an ever-growing repository of information.
- Many disciplines now have mobile apps dedicated to deeper exploration of specific subjects, from the periodic table to art movements.
- Mobile apps facilitate content creation, through the use of cameras, microphones, and other sensors and tools that are inherent in many smartphones.

Mobile Apps in Practice

- Bond University's album on iTunes U explores mobile applications and provides tips for using them to produce video and audio content:
go.nmc.org/bondi.
- Engineering students at the University of New South Wales used the school's "Rubrik" app to help them collect real-time data in a marketing design project competition:
go.nmc.org/rubrik.
- Monash University's new app informs students about news and events across all of their campuses, as well as providing helpful maps, directories, and resources:
go.nmc.org/monash.

For Further Reading**Best iPhone Apps for Uni Students**

go.nmc.org/besti

(Michelle Starr, *CNET Australia*, 15 February 2012.) This article outlines the top apps that students should be using for productivity, learning, and recreation, including "Notability" and "iTunes U."

How to Build a University Mobile Application: Best Practice and Insight

go.nmc.org/builda

(Karen Eustice, *The Guardian*, 8 December 2011.) This article compares the different avenues universities are taking in creating and updating their mobile apps, showing the efficiency and reasoning behind each option from the developer's perspective.

Time-to-Adoption: One Year or Less**Tablet Computing**

In the past year, advances in tablet computers have captured the imagination of educators around the world. Led by the incredible success of the iPad, which in 2011 was selling at the rate of more than 3 million units a month, other similar devices such as the Samsung Galaxy and Sony's Tablet S have also begun to enter this rapidly growing new market. In the process, tablets (a form that is distinct from tablet PCs) have come to be viewed as not just a new category of mobile devices, but indeed a new technology in its own right, one that blends features of laptops, smartphones, and earlier tablet computers with always-connected Internet, and thousands of apps with which to personalise the experience. With significantly larger screens and richer gestured-based interfaces than their smartphone predecessors, they are ideal tools for sharing content, videos, images and presentations because they are easy for anyone to use, visually compelling, and highly portable.

Relevance for Teaching, Learning, Research, or Information Management

- Tablets are easily adaptable to almost any learning environment, with tens of thousands of educational applications emerging as part of a new software distribution model.
- As a one-to-one solution, tablets present an economic, flexible alternative to laptops and desktops due to their lower cost, greater portability, and access to apps.
- Tablets are conducive to engaging in learning outside the classroom, with a suite of tools for capturing data in real-time and collaborating on projects, while offering a large, user-friendly interface.

Tablet Computing in Practice

- Designed by the University of Queensland, UQMarkup is an iPad app developed to facilitate the integration of contextualised audio and written feedback in student writing assessments: go.nmc.org/uqmark.
- Swinburne University of Technology, University of Limerick, and Loughborough University collaborated to develop "MathsCasts," which are videos of mathematical explanations recorded by writing on a tablet: go.nmc.org/maths.
- First-year science students at the University of Adelaide are using iPads in place of the standard set of textbooks: go.nmc.org/adela.

For Further Reading**The B-School Case Study Gets a Digital Makeover**

go.nmc.org/bschool

(Erin Zlomek, *Bloomberg Business Week*, 25 July 2011.) This article demonstrates how tablets allow students a convenient way to access and interact with the many business case studies that are a core part of business school curriculum.

Here Come Tablets. Here Come Problems.

go.nmc.org/tablets

(Shara Tibken, *The Wall Street Journal*, 2 April 2012.) This article addresses the biggest mistakes that organizations make in adopting tablets and what can be learned from them.

How the iPad is Changing Education

go.nmc.org/ipadis

(John Paul Titlow, *Read Write Web*, 22 April 2012.) Two years after the launch of the iPad, more institutions are sharing their implementation outcomes. The results of using the iPad for learning are particularly promising for self-education and student enjoyment.

Time-to-Adoption: Two to Three Years**Digital Identity**

Digital identity management focuses on enabling users to create a single digital identity that can be used in any place where a login is required to access a website or service. It is not a single technology, but a group of related technologies and ideas. In the simplest terms, one's digital identity is a method that allows recognition any place where a login is needed. A variety of different systems are being developed, and though they have the same broad purpose of creating a sign-on system that is convenient and secure for an individual rather than a company or organisation, ideas about what precisely defines a user-centric identity system and how that would be implemented are still widely varied. Both Google and Facebook are positioning their systems to be the "home" of one's digital identity. Digital identity benefits academia because learners can quickly switch back and forth from various secure web resources and contribute posts under the same ID, though this raises security issues. Educators can view the work students are doing and the content they are creating across the Internet because it is associated with each user.

Relevance for Teaching, Learning, Research, or Information Management

- Digital identity allows for broader control beyond information systems; there is one path to trace when profiling an individual's digital footprint, i.e. content delivery.
- Digital identity has the potential to personalise curriculum through profiling learners' interests based on their historic content consumption.
- A single ID and password helps educators and students seamlessly connect to resources across multiple devices and websites.

Digital Identity in Practice

- The ARCS Data Fabric allows student and staff members of any Australian university to access a federated resource using their institutional username and password: go.nmc.org/arcsd.
- The Australian Access Federation organises different universities' identities to support collaboration between institutions that do not use the same identity systems: go.nmc.org/austra.
- The Future of Identity in the Information Society is an organisation dedicated to studying and documenting the forensic applications, privacy, mobility, and evolving definition of digital identity: go.nmc.org/fidis.

For Further Reading**The Challenge of Creating Web Based Identity Standards**

go.nmc.org/goog

(John Fontana, *Mashable*, 14 November 2011.) The author discusses the battle between corporations, including Google, Facebook, and Yahoo, to own users' digital identities, as well as the security implications.

Digital Identity Development in Higher Education

go.nmc.org/digita

(Ed Cabellon, *On the Go*, 29 August 2011.) This article addresses the importance of students carefully crafting their digital identities — online profiles are becoming critical in helping them build their reputations.

Govt. Agencies, Colleges Demand Applicants' Facebook Passwords

go.nmc.org/govt

(Bob Sullivan, *MSNBC*, 6 March 2012.) This article brings to light some of the issues of digital identity, and the implications of institutions monitoring students' online activity.

Time-to-Adoption: Two to Three Years**Game-Based Learning**

Game-based learning refers to the integration of games or game mechanics into educational experiences. This topic has gained considerable traction over the past decade as games have proven to be effective learning tools, and beneficial in cognitive development and the fostering of soft skills among students, such as collaboration, communication, problem solving, and critical thinking. The forms of games grow increasingly diverse and some of the most commonly used for educational purposes include alternate reality games (ARG), massively multiplayer online games (MMO), and global social awareness games. Most games that are currently used for learning across a wide range of disciplines share similar qualities in that they are goal-oriented, have strong social components, and simulate some sort of real world experience that students find relevant to their lives. As game-based learning garners more attention in academia, commercial providers like Serious Games are developing new games to support immersive, experiential learning.

Relevance for Teaching, Learning, Research, or Information Management

- Educational games offer opportunities for both discovery-based and goal-oriented learning, and can be very effective ways to develop teambuilding skills.
- Simulations and role-playing games allow students to re-enact difficult situations to try new responses or pose creative solutions.
- Educational games can be used to teach cross-curricular concepts that touch on many subjects in an engaging way.

Gamed-Based Learning in Practice

- In McGill University's "Open Orchestra" simulation game, a workstation uses high definition panoramic video and surround sound to provide musicians with the experience of playing in an orchestra or singing in an opera:
go.nmc.org/canar.
- MicroExplorer3D provides an avenue for students who do not have access to a microscopy lab to learn the parts of a compound microscope:
go.nmc.org/micro.
- Victoria University's Games Development program equips students with the skills to design games in 3D and develop them for multiple platforms including mobile devices:
go.nmc.org/victo.

For Further Reading**Games and Learning: Teaching as Designing**

go.nmc.org/design

(James Gee, *The Huffington Post*, 21 April 2011.) James Gee, renowned proponent for gaming in education, builds a case for games as catalysts for more interaction, creativity, and critical thinking in learning. He likens gamers to designers as they both must understand the "rule system" to be successful.

What Does Game-Based Learning Offer Higher Education?

go.nmc.org/gameb

(Justin Marquis, *OnlineUniversities.com*, 14 October 2011.) This article explores the benefits of gaming at the university level by breaking down a hypothesis by game designer, Jane McGonigal, which recognises specific positive attributes of gamers that can translate to productivity in the classroom and beyond.

Time-to-Adoption: Two to Three Years**Open Content**

The movement toward open content reflects a growing shift in the way academics in many parts of the world are shifting to a view that education is (or should be) more about the process of learning than the information conveyed in their courses. Information is everywhere; the challenge is to recognise when it is credible and to make effective use of it. Open content embraces not only the sharing of information, but the sharing of pedagogies and experiences as well. Part of the appeal of open content is that it also presents a response to both the rising costs of traditionally published resources and the lack of educational resources in some regions. Open content offers a cost-effective alternative to textbooks and other materials. As customizable educational content — and insights about how to teach and learn with it — is increasingly made available for free over the Internet, students are learning not only the material, but also skills related to finding, evaluating, interpreting, and repurposing the resources they are studying in partnership with their teachers.

Relevance for Teaching, Learning, Research, or Information Management

- The use of open content promotes a set of skills that are critical in maintaining currency in any area of study — the ability to find, evaluate, and put new information to use.
- The same set of materials, once placed online and made sharable via the appropriate licensing, can inform a wide variety of learning modalities, not the least of which is learning for the sheer joy of discovery.
- Sharable materials reduce teacher workloads as they do not need to be recreated from scratch.

Open Content in Practice

- Australia's Knowledge Gateway was launched by a group of 8 universities to provide a portal where researchers can search and find relevant people, projects, and publications: go.nmc.org/gatew.
- Carnegie Mellon University Australia's Open Technology Foundation helps governments make cost effective and innovative use of open technologies: go.nmc.org/carne.
- An international partnership of accredited universities, colleges, and polytechnics are providing free learning opportunities for students worldwide through Creative Commons licenses: go.nmc.org/ccweb.

For Further Reading**Exemplary Collection of Open eLearning Content Repositories**

go.nmc.org/opencon

(WikiEducator, accessed 30 April 2012.) WikiEducator lists the best resources for the open content, organised by subjects (including science and humanities), institutions, and standalone digital media resources.

Open Resources: Transforming the Way Knowledge Is Spread

go.nmc.org/openre

(D. D. Guttenplan, *The New York Times*, 18 March 2012.) This article examines the state of open content in education. Open Education Resources are vital to extend literacy and opportunity while cutting costs for schools, families, and students worldwide.

Time-to-Adoption: Two to Three Years**Personal Learning Environments**

Personal learning environments (PLEs) support self-directed and group-based learning, designed around each user's goals, with great capacity for flexibility and customization. The term has been evolving for some time, but has crystallised around the personal collections of tools and resources a person assembles to support their own learning — both formal and informal. The conceptual basis for PLEs has shifted significantly in the last year, as smartphones, tablets, and apps have begun to emerge as a compelling alternative to browser-based PLEs and e-portfolios. Along with that, there has been a corresponding move away from centralised, server-based solutions to distributed and portable ones. Using a growing set of free and simple tools and applications, such as a collection of apps on a tablet, it is already easy to support one's ongoing social, professional, learning and other activities with a handy collection of resources and tools that are always with you. While the concept of PLEs is still fairly fluid, it is clear that a PLE is not simply a technology but an approach or process that is individualised by design, and thus different from person to person.

Relevance for Teaching, Learning, Research, or Information Management

- PLEs may cater to students with differing learning styles; for instance, visual learners might be able to obtain material from a different source than auditory learners.
- Students using PLEs may benefit from the practice of keeping track of, and curating, their own resource collections.
- PLEs can empower students to take greater control of their learning networks and connections with peers, experts, and others.

Personal Learning Environments in Practice

- Innovative Technologies for an Engaging Classroom is a pan-European project dedicated to designing the future classroom by bringing together policy-makers, researchers, technology suppliers, and teachers to develop scalable learning environments for students: go.nmc.org/itec.
- Scitable is a free science library and personal learning tool that allows students to explore subjects including genetics, science communication, and career planning: go.nmc.org/natur.
- The Shared Learning Collaborative is developing a common data layer and encouraging independent software vendors to build personalised learning applications. The project is establishing common ways to exchange education data among systems and feed information to students, teachers, and administrators: go.nmc.org/slcedu.

For Further Reading**Preparing Students to Learn Without Us**

go.nmc.org/prepar

(Will Richardson, *ASCD Educational Leadership*, February 2012.) As our culture moves toward customization of gadgets, playlists, and search results that reflect each individual's taste, many education models are becoming more individually focused.

This Time It's Personal

go.nmc.org/person

(Jennifer Demski, *The Journal*, 4 January 2012.) This article emphasises the crucial role of changing the current classroom infrastructure to make it more student-centered in order to incorporate technology in a transformative way. The author states that incorporating new technological tools into outdated teacher-centered structures will not be effective.

Time-to-Adoption: Four to Five Years**Digital Preservation**

At the most basic level, digital preservation refers to the conservation of important objects, artifacts, and documents that exist in digital form. As technology continues to rapidly evolve and new software is propelled into mainstream use nearly every day, continued innovation leads to planned obsolescence for hardware and software, all too often rendering content created with older versions unusable. Universities have vast amounts of electronic media in their collections, and each item of digital content represents a unique challenge from a conservation standpoint. Museums have long employed art historians with specialties in artifact preservation, but to university libraries, it is often a challenge to find professionals who understand preservation from a computer science perspective. Just like ancient objects, digital objects can be fragile and require special care, and the growing dependence on changing technologies puts these digital items at great risk. As universities, libraries, and other organisations start to support and develop processes and resources for digital preservation, a new science and toolset is emerging to support and inform the work.

Relevance for Teaching, Learning, Research, or Information Management

- Advances in digital preservation can be shared between institutions and create opportunities for large-scale collaboration.
- As technology continues to rapidly evolve, institutions must develop new tools and workflows for preserving digital content and making the transition between technologies more seamless.
- Digital objects are also objects of cultural heritage, and the danger of losing the contributions of contemporary digital creators is great.

Digital Preservation in Practice

- The Digital Preservation Coalition is raising awareness on the importance of digital preservation and the accompanying cultural and technological issues: go.nmc.org/digitpres.
- After investigating the formats, standards, and workflows associated with digital video preservation, the National Film & Sound Archive of Australia updated their video encoding equipment and infrastructure using a Media Asset Management System, Mediaflex: go.nmc.org/natfilm.
- The National Library of Australia is using a tool called PANDORA to archive its publications. They are dedicated to continuously monitoring and assessing risks for its digital collections as technology evolves: go.nmc.org/libofau.

For Further Reading**Race to Save Digital Art from the Rapid Pace of Technological Change**

go.nmc.org/raceto

(Vanessa Thorpe, *The Observer*, 7 May 2011.) This article follows scientists' searches for methods to preserve today's digital artwork and issues a serious warning about the future state of digital objects if conservationists cannot effectively archive them.

When Data Disappears

go.nmc.org/datadis

(Kari Kraus, *The New York Times*, 6 August 2011.) When the University of Texas, Austin, received papers from science fiction writer Bruce Sterling with no digital back-ups, they faced a major challenge. With that case in mind, the article explores different possibilities for digital preservation, including emulation.

Time-to-Adoption: Four to Five Years**Massively Open Online Courses**

Coined in 2008 by Stephen Downes and George Siemens, the term massively open online courses refers to web courses that people can take from anywhere across the world, with potentially thousands of participants. The basis of each MOOC is an expansive and diverse set of content, contributed by a variety of experts, educators, and instructors in a specific field, and then aggregated into a central repository, such as website. What makes this content set especially unique is that it is “remixed” — the materials are not necessarily designed to go together but become associated with each other through the MOOC. A key component of the original vision is that all course materials and the course itself are open source and free — with the door left open for a fee if a participant taking the course wishes university credit to be transcribed for the work. A second key element is that the structure of MOOCs be minimalist, so as to allow participants to design their own learning path based upon whatever specific knowledge or skill they want to gain. The point is that participants can control how, where, and when they learn.

Relevance for Teaching, Learning, Research, or Information Management

- MOOCs fill a large gap for many who simply want to participate in quality learning opportunities without having to go through the process of applying to a particular institution.
- MOOCs focus on learning rather than institutional requirements; they offer the potential for building a network of learners who come together to explore topics of mutual interest.
- When more learners and institutions participate in MOOCs by sharing content, it leads to sustainability of the MOOC ecosystem over time.

Massively Open Online Courses in Practice

- Coursera, a start-up by two Stanford University professors, is offering over 30 free online classes, including science fiction and healthy policy. A "calibrated peer-review" system is currently in the works: go.nmc.org/course.
- MIT's new learning initiative, "MITx," offers a wide variety of MIT courses for free to a global, virtual community of students. MITx courses can be taken on their own or used to supplement existing classes and labs on the physical campus: go.nmc.org/mitx.
- The Open University of Australia is an online university with a collection of courses and units provided by reputable universities around the continent, including Griffith University and Macquarie University: go.nmc.org/openu.

For Further Reading**Disruptive Innovation — in Education**

go.nmc.org/disrup

(Larry Hardesty, *MIT News Office*, 20 April 2012.) This article discusses MITx, and how the student interaction in community forums has created an unpredictably advantageous learning experience.

Is Peer Input as Important as Content for Online Learning?

go.nmc.org/peer

(Nathan Maton, *Mindshift*, 24 April 2012.) This article discusses how important community and social aspects of MOOCs are in free online universities such as P2PU, which is proving to be an effective distance learning model.

Time-to-Adoption: Four to Five Years

Natural User Interfaces

It is already common to interact with a new class of devices entirely by using natural movements and gestures. The iPad, iPhone and iPod Touch, Xbox Kinect, Nintendo Wii, the new class of “smart TVs” and a growing list of other devices built with natural user interfaces accept input in the form of taps, swipes, and other ways of touching; hand and arm motions; body movement; and increasingly, natural language. These are the first in a growing array of alternative input devices that allow computers to recognise and interpret natural physical gestures as a means of control. Natural user interfaces allow users to engage in virtual activities with movements similar to what they would use in the real world, manipulating content intuitively. The idea of being able to have a completely natural interaction with your device is not new, but neither has its full potential been realised. What makes natural user interfaces especially interesting this year is the burgeoning high fidelity of systems that understand gestures, facial expressions, and their nuances, as well as the convergence of gesture-sensing technology with voice recognition, which allows users to interact in an almost natural fashion, with gesture, expression, and voice communicating their intentions to devices.

Relevance for Teaching, Learning, Research, or Information Management

- Natural user interfaces allow users to easily perform precise manipulations that can be difficult to manage with a mouse or controller.
- Natural user interfaces facilitate the convergence of a user’s thoughts with their movements and voice, which appeals to kinetic learners who learn by acting.
- Natural user interfaces help blind, dyslexic, or otherwise disabled students, reducing their dependence on keyboards.

Natural User Interfaces in Practice

- The EyeMusic project uses eye-tracking sensors to compose multimedia productions based on the user’s eye movements: go.nmc.org/eyemu.
- The Norrköping Visualization Center and Center for Medical Image Science and Visualization in Sweden created a virtual autopsy table. Detailed CT scans are transferred to the table where they are manipulated with gestures, allowing forensic scientists to examine a body, make virtual cross-sections, and more: go.nmc.org/autop.
- Researchers at RWTH Aachen University in the Netherlands are developing a localised haptic feedback interface called MudPad for fluid touch interfaces in order to offer more nuanced ways to interact with screens through touch: go.nmc.org/mudp.

For Further Reading

The Human Voice, as Game Changer

go.nmc.org/voice

(Natasha Singer, *The New York Times*, 31 March 2012.) This article paints a picture of how the voice-enabled future will materialise in which human speech garners responses from everyday objects, such as refrigerators, thermostats, alarm systems, and other devices.

Kinect for Windows Hits the Classroom

go.nmc.org/kinect

(Esther Shein, *EdTech Magazine*, 19 April 2012.) This article discusses how Kinect for Windows is being used in a variety of academic settings, including an Immersive Game Design course at the University of Southern California, where students use Kinect to create rich, dynamic gaming and learning experiences.

Time-to-Adoption: Four to Five Years**Telepresence**

Telepresence is a form of remote conferencing in which the participants appear to be physically present in the conference space. Body language cues like eye contact are easily transmitted and interpreted because of the fidelity, size, and position of the images. Several high-profile demonstrations of the technology have taken place; for instance, CNN made extensive use of the 3-dimensional version of the technology three years ago during coverage of the 2008 US presidential election. Typically, 3D telepresence requires a specially configured space in which to capture a 360-degree image that can then be inserted into a virtual set, and viewed from any angle, but high-definition displays, seamless integration with software and data presentation, and full-surround audio make even 2D telepresence a very immersive experience.

Relevance for Teaching, Learning, Research, or Information Management

- 2D Telepresence is often a consideration for distance learning, collaborative courses with students in other geographical areas, and guest lectures.
- The ability for physically disabled students to connect with educators and courses remotely allows them to receive equal learning opportunities as their peers from the comfort of their homes.
- New high definition forms of telepresence are easily adapted to researching locations that human beings cannot physically reach or safely explore.

Telepresence in Practice

- Australia's "Pathways to Space" is a program at the Powerhouse Museum where secondary students are developing space robotics, and searching for life on Mars through video conferencing: go.nmc.org/pathw.
- iRobot's Ava mobile robot will be released later this year to help hospitals remotely diagnose patients through videoconferencing: go.nmc.org/irobo.
- Monash University is using the Cisco TelePresence system to provide a communication platform between medical school students who are training in rural areas and teachers who are located at the central campuses: go.nmc.org/cisco.

For Further Reading**AARNet & Huawei Pioneer Telepresence Interoperability in Australia**

go.nmc.org/aarne

(Australia's Academic and Research Network, 22 September 2011.) This article describes how Australia's Academic and Research Network (AARNet) linked Huawei's latest TP suite with Polycom and Cisco TelePresence equipment to conduct a videoconference demo.

Leukaemia Sufferer Stepan Supin Stays Home, Sends Robot to School

go.nmc.org/leuka

(*Herald Sun*, 24 January 2011.) A telepresence robot allows a student with leukaemia to participate in the classroom and interact with teachers and other students while at home.

Telepresence in Education

go.nmc.org/nextbl

(*Next Blitz*, 20 February 2011.) This post discusses how telepresence supplements face-to-face learning at institutions but does not replace it. It increases the opportunity for peer-to-peer and student-to-teacher interactions that were previously hindered by distance.

Top Ten Trends

The technologies featured in the NMC Horizon Project are embedded within a contemporary context that reflects the realities of the time, both in the sphere of education and in the world at large. To assure this perspective, each advisory board researches, identifies, and ranks key trends that are currently affecting the practice of teaching, learning, research, and information management, and uses these as a lens for its later work. These trends are surfaced through an extensive review of current articles, interviews, papers, and new research. Once identified, the list of trends is ranked according to how significant an impact they are likely to have on education in the next five years. The following trends have been identified as key drivers of technology adoptions in Australia for the period of 2012 through 2017; they are listed here in the order each was ranked by the advisory board.

1) People expect to be able to work, learn, and study whenever and wherever they want. This trend is certainly true for most adults, and many well-paying jobs literally can be done from anywhere that has a mobile Internet connection. It is also true for many of today's school-age children, who live their lives in a state of constant connection to their peers, social groups, and family. While some decry the constant flow of information as a distraction or worse (with some justification), others see the opportunity to “flip” expectations about what is homework and what is schoolwork by taking advantage of those connections as learning opportunities. The implications for formal learning are profound, as flipping uses the resources on the Internet to free up valuable teacher classroom time, and fundamentally changes the teacher-student relationship. When students know how to use their network connections for more than texting, learning becomes much more serendipitous, opening the door to “just-in-time” learning, and “discovered” learning.

2) Increasingly, students want to use their own technology for learning. As new technologies are developed at a more rapid pace and at a higher quality, there is a wide variety of different devices, gadgets, and tools from which to choose. Utilizing a specific device has become something very personal — an extension of someone's personality and learning style — for example, the iPhone vs. the Android. There is comfort in giving a presentation or performing research with tools that are more familiar and productive at the individual level. And, with handheld technology becoming mass produced and more affordable, students are more likely to have access to more advanced equipment in their personal lives than at school.

3) Education paradigms are shifting to include online learning, hybrid learning and collaborative models. Budget cuts have forced institutions to re-evaluate their education platforms and find alternatives to the exclusive face-to-face learning models. As such, what may have begun as a challenge has now become an increasingly interesting trend. Students already spend much of their free time on the Internet, learning and exchanging new information through various resources, including social networks. Institutions that embrace face-to-face/online hybrid learning models have the potential to leverage the online skills learners have already developed independent of academia. We are beginning to see developments in online learning that offer similar — if not better — environments 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 learn at their own pace and style, whenever they want from wherever they are.

4) The growing availability of bandwidth will dramatically change user behaviours in teaching, learning and research over the next five years. The advent of cloud computing has alleviated the burden of storing software, email services, and other applications locally. Major resources are now accessible via web browser in just one click, no longer bogging down computer speed. Students and educators can now connect and collaborate with more ease, transfer files and information quicker, and store more new content.

5) The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators. Institutions must consider the unique value that each adds to a world in which information is everywhere. In such a world, sense-making and the ability to assess the credibility of information are paramount. Mentoring and preparing students for the world in which they will live is again at the forefront. Tertiary institutions have always been seen as critical paths to educational credentialing, but challenges from competing sources are redefining what these paths can look like.

6) There is a new emphasis in the classroom on more challenge-based and active learning. Challenge-based learning and similar methods foster more active learning experiences, both inside and outside the classroom. As technologies such as tablets and smartphones now have proven applications in schools, educators are leveraging these tools, which students already use, to connect the curriculum with real life issues. The active learning approaches are decidedly more student-centered, allowing them to take control of how they engage with a subject and to brainstorm and implement solutions to pressing local and global problems. The hope is that if learners can connect the course material with their own lives and their surrounding communities, then they will become more excited to learn and immerse themselves in the subject matter. Studies of challenge-based learning in practice, including two authored by the NMC, depict an increase in the uptake of 21st Century Skills among learners, including leadership and creativity.

7) The technologies we use are increasingly cloud-based, and our notions of IT support are decentralised. The continuing acceptance and adoption of cloud-based applications and services is changing not only the ways we configure and use software and file storage, but even how we conceptualise those functions. It does not matter where our work is stored; what matters is that our information is accessible no matter where we are or what device we choose to use. Globally, in huge numbers, we are growing used to a model of browser-based software that is device-independent. While some challenges still remain, specifically with notions of privacy and control, the promise of significant cost savings is an important driver in the search for solutions.

8) What were previously thought of as new and disruptive forms of scholarship are now becoming the norm for scholarly communication. Blogs, open textbooks, electronic journals, and forms of expression embodied in new media formats have challenged notions of scholarly writing and communication for several years. Yet these techniques are increasingly common and are readily accepted as informal outlets for scholarly work. A more gradual trend toward official acceptance is moving slowly, but its stirrings are visible in the adoption of electronic content, experiments with crowdsourcing, and open, online peer review of scholarly work.

9) Lecture capture, podcasting, and cheap personal video recorders increasingly make it much easier to prepare lecture-style content for students to see/hear before coming to class. There is an ever-growing cadre of professors posting lectures, pre-lectures, and other video-based reflections online. Similar to how students would prepare for class by reading a book, they can now watch or listen to educators exploring the course material beforehand. This frees up time during class to engage in responsive activities and collaborative problem-solving. The driving forces behind this trend are popular models such as Khan Academy, which contains thousands of brief video tutorials that convey material.

10) There is an increasing interest in using data for personalising the experience and for performance measures. As learners participate in online activities, they leave a vast trace of data that can be mined for a range of purposes. In some instances, the data is used for intervention, enrichment, or extension of the learning experience. This can be made available to instructors and learners as dashboards so that student progress can be monitored. In other cases, the data is made available to appropriate audiences for measuring students' academic performance. As this field matures, the hope is that this information will be used to continually improve learning outcomes. The government's aim is for Australia to be among the world's leading digital economies based on key indicators such as broadband penetration and usage rankings by the year 2020.

Top Ten Challenges

Along with the key current trends, the advisory board notes important challenges faced by the tertiary sector, especially those that are likely to continue to affect education over the five-year time period covered by this report. Like the trends, these are drawn from a careful analysis of current events, papers, articles, and similar sources, as well as from the personal experience of the advisory board members in their roles as leaders in education and technology. Those challenges ranked as most significant in terms of their impact on teaching, learning, research or information management in Australia in the coming five years are listed here, in the order of importance assigned them by the advisory board.

1) Economic pressures and new models of education are bringing unprecedented competition to the traditional models of tertiary education. Across the board, institutions are looking for ways to control costs while still providing a high quality of service. Institutions are challenged by the need to support a steady — or growing — number of students with fewer resources and staff than before. As a result, creative institutions are developing new models to serve students, such as streaming introductory courses over the network. As these pressures continue, other models may emerge that diverge from traditional ones. Simply capitalizing on new technology, however, is not enough; the new models must use these tools and services to engage students on a deeper level.

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

3) Most academics are not using new and compelling technologies for learning and teaching, nor for organising their own research. Many researchers have not undergone training on basic digitally supported teaching techniques, and most do not participate in professional development opportunities. This issue is due to several factors, including a lack of time, a lack of expectations that they should, and the lack of infrastructure to support the training. Academic research facilities rarely have the proper processes set up to accommodate this sort of professional development; many think a cultural shift will be required before we see widespread use of more innovative organisational technology. Many caution that as this unfolds, the focus should not be on the technologies themselves, but on the pedagogies that make them useful.

4) Institutional barriers present formidable challenges to moving forward in a constructive way with emerging technologies. Too often it is the educational system's own processes and practices that limit broader uptake of new technologies. Much resistance to change is simply comfort with the status quo, but in other cases, such as in promotion and tenure reviews, experimentation or innovative applications of technologies are often seen as outside the role of researcher or scientist.

5) Commercial providers are delivering ever more credible educational content, providing a wide range of customizable offerings at quality levels that may dampen interest in traditional sources of scholarly work, such as university presses, and even open educational resources (OERs). Increasingly, publishers are either buying learning resource websites or creating their own virtual warehouses of digital textbooks and other educational content. iTunes University is a prime example of this, offering thousands of course materials for free from distinguished institutions and professors. This trend creates a related challenge for university

presses that have traditionally been the publishers of much of the work of their faculties; there is a growing fear that they will become obsolete. Both OERs and university presses are at a critical juncture for different reasons, yet each is aggressively confronted with the need to adapt, evolve, or even reconstruct their roles in education over the next five years.

6) Digital media literacy continues its rise in importance as a key skill in every discipline and profession. This challenge appears at the top of the list because despite the widespread agreement on the importance of digital media literacy, training in the supporting skills and techniques is still very rare in teacher education. As classroom professionals begin to realise 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.

7) The demand for personalised learning is not adequately supported by current technology or practices. The increasing demand for education that is customised to each student's unique needs is driving the development of new technologies that provide more learner choice and control and allow for differentiated instruction. It has become clear that one-size-fits-all teaching methods are neither effective nor acceptable for today's diverse students. Technology can and should support individual choices about access to materials and expertise, amount and type of educational content, and methods of teaching.

8) The role of the tertiary educator is changing. As the focus in tertiary education shifts from teacher-centred, lecture-based classrooms to open educational resources (OERs), educators must adapt to the role of online facilitator. Because these OERs are loaded with pre-developed materials, teachers must sift through the resources and identify what is credible and revise the materials often as new information arises. In this sense, they will be online resource managers, but they also must develop creative ways to digitally interact with students in regards to those resources — otherwise they risk becoming dispensers of course materials rather than scholarly guides and instructional designers.

9) Critical campus infrastructures are under-resourced. As educators seek to leverage various technologies, develop software for personalising learning, and visualisations for making that learning possible, campus information technology groups are struggling to deploy bandwidth and access. Rather than encouraging researchers to build on and extend core resources, leverage shared file systems, and open accessible service APIs, institutions are narrowing their focus to what they perceive as the minimal subset of enterprise services they can afford to sustain. As a result, educators are often trying to design new, innovative learning models that must be integrated with out-dated, pre-existing technology and learning management systems.

10) The global drive to increase the number of students participating in undergraduate education is placing pressure across the system. The often 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 many countries 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.

Methodology

The process used to research and create the *Technology Outlook for Australian Tertiary Education 2012-2017: An NMC Horizon Report Regional Analysis* is very much rooted in the methods used throughout the NMC Horizon Project. All editions of the *Horizon Report* are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned advisory board that first considers a broad set of important emerging technologies, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected.

Much of the process takes place online, where it is captured and placed in the NMC Horizon Project wiki. This wiki is intended to be a completely transparent window onto the work of the project, and contains the entire record of the research for each of the various editions. The section of the wiki used for the *Technology Outlook for Australian Tertiary Education 2012-2017* can be found at aus.wiki.nmc.org.

The procedure for selecting the topics that will be in the report includes a modified Delphi process now refined over years of producing the *NMC Horizon Report* series, and it begins with the assembly of the advisory board. The board as a whole is intended to represent a wide range of backgrounds, nationalities, and interests, yet each member brings a particularly relevant expertise. To date, hundreds of internationally recognised practitioners and experts have participated in the NMC Horizon Project Advisory Boards; in any given year, a third of advisory board members are new, ensuring a flow of fresh perspectives each year.

Once the advisory board for a particular edition is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertains to emerging technology. Advisory board 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 is the potential relevance of the topic to teaching, learning, research, or information management. A carefully selected set of RSS feeds from dozens of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants throughout the process.

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

1. Which of the key technologies catalogued in the Horizon Listing will be most important to teaching, learning, research, or information management within the next five years?
2. What key technologies are missing from our list? Consider these related questions:
 - a. 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, research or information management?
 - b. What technologies that have a solid user base in consumer, entertainment, or other industries should educational institutions be actively looking for ways to apply?
 - c. 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 educational institutions approach our core missions of teaching, research, and service?
4. What do you see as the key challenges related to teaching, learning, research or information management that educational institutions will face during the next five years?

One of the advisory board's most important tasks is to answer these questions as systematically and broadly as possible, so as to ensure that the range of relevant topics is considered. Once this work is done, a process that moves quickly over just a few days, the advisory board moves to a unique consensus-building process based on an iterative Delphi-based methodology.

In the first step of this approach, the responses to the research questions are systematically ranked and placed into adoption horizons by each advisory board 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 technology 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.

For additional detail on the project methodology or to review the instrumentation, the ranking, and the interim products behind the report, please visit the project wiki at aus.wiki.nmc.org.



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