NMC Horizon Project

2014 NMC Technology Outlook

Australian Tertiary Education

A Horizon Project Regional Report

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A Horizon Project Regional Report

is a collaboration between

The New Media Consortium

and

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An NMC Horizon Project Regional Report

Executive Summary

The *2014 NMC Technology Outlook for Australian Tertiary Education: A Horizon Project Regional Report* reflects a collaborative research effort between the New Media Consortium (NMC) and Open Universities Australia to help inform Australian education leaders about significant developments in technologies supporting teaching, learning, and creative inquiry in tertiary education.

All of 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, or creative inquiry 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 more than 12 years ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *2014 NMC Technology Outlook for Australian Tertiary Education* was produced to explore emerging technologies and forecast their potential impact expressly in a tertiary education context. In the effort that took place from January through March 2014, a carefully selected panel of experts was asked to consider 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 Australian tertiary education over the next five years.

Known as the 2014 Horizon Project Australia Expert Panel, that group of thought leaders consists of notably knowledgeable individuals, all highly regarded in their fields. Collectively the panel represents a range of diverse perspectives across the education 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.

Table 1: Comparison of "Final 12" Topics Across Three NMC Horizon Research Projects

NMC Horizon Report 2014 Higher Education Edition	2014 Technology Outlook for Australian Tertiary Education	2013 Technology Outlook for Australian Tertiary Education
Time-to-Adoption Horizon: One Year or Less		
Bring Your Own Device Flipped Classroom Learning Analytics Massive Open Online Courses	Bring Your Own Device Flipped Classroom Mobile Learning Online Learning	Learning Analytics Massive Open Online Courses Mobile Learning Social Media
Time-to-Adoption Horizon: Two to Three Years		
3D Printing Games and Gamification The Internet of Things Wearable Technology	Badges/Microcredits Games and Gamification Learning Analytics Open Content	3D Printing Badges Information Visualisation Location-Based Services
Time-to-Adoption Horizon: Four to Five Years		
Affective Computing Flexible Displays Quantified Self Virtual Assistants	The Internet of Things Machine Learning Natural User Interfaces Wearable Technology	Flexible Displays The Internet of Things Virtual and Remote Laboratories Wearable Technology

The 12 "technologies to watch" presented in the body of this report reflect our experts' opinions as to which of the nearly 60 technologies considered will be most important to Australian tertiary education over the five years following the publication of the report. As Table 1 above illustrates, the choices of our experts overlap in interesting ways with those who contributed to the *NMC*

Horizon Report > 2014 Higher Education Edition, which looked at technology uptake from a global perspective, and the *2013 NMC Technology Outlook for Australian Tertiary Education*, which provides perspective on how the technology discussions in Australia have shifted in the past year.

All three of these projects' expert panels — a group of 145 acknowledged experts — strongly agree that mobile learning and online learning, in some form, will likely tip into mainstream use within the next year — a trend that spans education across much of the world. While there are several other overlaps between two of the panels, there are some differences between perceived time-to-adoption horizons. For example, the 2013 Australian panel and the 2014 Higher Education panel felt that learning analytics and the mining of student data would enter the mainstream within a year, while the 2014 Australian panel placed the topic further out, at two to three years away. That is not to say that learning analytics has slowed in Australian tertiary education, but different facets of it have emerged in the past year, such as adaptive learning, adding more complexity to the topic that will require more time to explore and implement at scale.

Both the 2014 Australian panel and global Higher Education panel agree that games and gamification are gaining traction in teaching and learning, but expect it will take two to three years to fully come to fruition. While games and game elements have proven to make learning more engaging for students, some panel members discussed concerns about educational games matching the high quality of games that are produced for entertainment. Individual institutions, such as Griffith University and their "World Trade Game," have developed successful models to emulate.

Table 2: Top-Ranked Trends Across Three NMC Horizon Research Projects

NMC Horizon Report 2014 Higher Education Edition	2014 Technology Outlook for Australian Tertiary Education	2013 Technology Outlook for Australian Tertiary Education
Integration of Hybrid Learning Designs	Digital Delivery is Increasingly the Norm	Increasing Preference for Personal Technology
Rise in Data-Driven Learning And Assessment	Increasing Focus on Open Content	Integration of Hybrid Learning Designs
Evolution of Online Learning	Massive Reinvention of the Personal Computer	Increasing Focus on Open Content

Wearable technology made the list of technologies for all three panels, though it is worth pointing out that the global Higher Education panel perceives it as garnering widespread adoption several years sooner, most likely due to the initial popularity of health-centric devices such as Jawbone UP and Fitbit in the United States. At Melbourne's Bionic Institute, researchers are focused on more advanced wearables related to health specifically, developing implantable bionic devices including electrodes that can be inserted into the brain to detect abnormal activity and even deliver treatment to patients.

There were several distinct choices that distinguished the viewpoints expressed by the 2014 Australian panel from their counterparts in other regions of the world; open content, natural user interfaces, badges, and machine learning, although considered by other recent panels, were seen as likely developments for Australia in the mid- and far-term horizons; each has also appeared in previous global editions of the *NMC Horizon Report*. For example, open content is considered to be an extremely important topic in Australia, where the government has published numerous guidelines on the effective development and use of open educational resources, and individual

institutions such as Open Universities Australia, La Trobe University, and Adelaide University have launched significant open content initiatives.

The nuances of the technologies and their associated adoption horizons featured in this report are specific to Australian tertiary education, even if there are commonalities with other reports. Likewise, the key trends (Table 2 and pages 17-18) and significant challenges (Table 3 and pages 19-20) selected by the 2014 Australian panel distinctly reflect the current drivers and obstacles facing tertiary education in Australia over the coming five years. The top three trends and challenges from those longer lists are included in the related tables in this summary, and are organised by time-based categories described in the corresponding sections of this report.

The panel agreed that the use of digital content has become commonplace and the growing awareness of its importance is an important driver of decisions across the continent. The growing interest in online and hybrid learning is fuelling the rise of related approaches in Australia, such as the flipped classroom, badges, and open content. In fact, both Australian panels emphasised the growth of open content, making it a top-ranked trend in back-to-back years. This consensus conveys the immense value of open educational resources and open-source educational platforms in the continent — a movement that is expanding access to high-quality learning materials for all Australians.

Table 3: Top-Ranked Challenges Across Three NMC Horizon Research Projects

NMC Horizon Report 2014 Higher Education Edition	2014 Technology Outlook for Australian Tertiary Education	2013 Technology Outlook for Australian Tertiary Education
Low Digital Fluency of Faculty	Low Digital Fluency of Faculty	Low Digital Fluency of Faculty
Scaling Teaching Innovations	Scaling Teaching Innovations	Faculty Use of Technology to Organise their Own Work
Expanding Access to Education	Keeping Education Relevant	Integration of Personalised Learning

Horizon Project panels in general have agreed that trends like these are clear drivers of technology adoption; the 2014 Australian panel especially saw such a linkage. At the same time, these panels of experts also agree that technology adoption is often hindered by both local and systemic challenges, which are grounded in everyday realities that make it difficult to learn about, much less adopt, new tools and approaches.

All three panels agreed that the digital fluency of lecturers and professors is a great challenge, although the solutions are clear. Digital media literacy is not nearly pervasive enough in initial education programmes or continuing professional development for faculty. In order for emerging technologies to be creatively leveraged by students in classrooms across Australia, professors and instructors need to be confident and effective in applying them. Adequate professional development is one key component, but more important is that academia set expectations for the basic skills of the professoriate. Without changes in expectations for modern university teachers, even when faculty do innovate, it will continue to be rare for those new ideas and pedagogies to move into mainstream practice.

New this year to the list of top challenges facing Australian tertiary education is the concern over keeping formal education relevant. Because this challenge is defined as wicked — one that is difficult if not impossible to define, let alone address — articulating it is a complicated endeavour.

As the workforce has evolved, calling for a mix of highly technical and communication-centric skill sets, student expectations of the traditional university degree are changing. There is less perceived value in large lecture hall courses and a greater emphasis on campus experiences that invoke more hands-on, immersive learning that either simulate the real world or are part of it.

These points and comparisons provide an important context for the main body of the report that follows this summary. There, 12 key technologies are profiled, each on a single page that describes and defines a technology ranked as very important for Australian tertiary education over the next year, two to three years, and four to five years. Each page opens with a carefully crafted definition of the highlighted technology, outlines its educational relevance, points to several real life examples of its current use, and ends with a short list of additional readings for those who wish to learn more. Following those discussions are sections that detail the expert panel's top ranked trends and challenges, and frame them into categories that illuminate why they are seen as highly influential factors in the adoption or proliferation of any of these technologies over the coming five years.

Those key sections, and this report in general, constitute a reference and straightforward technology-planning guide for educators, researchers, administrators, policy makers, and technologists. It is our hope that this research will help to inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry in Australian tertiary education. 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 *2014 NMC Technology Outlook for Australian Tertiary Education* is presented.

Time-to-Adoption: One Year or Less

Bring Your Own Device

Bring Your Own Device (BYOD) refers to the practice of students bringing their own laptops, tablets, smartphones, or other mobile devices with them to class. Intel coined the term in 2009, when the company observed that an increasing number of its employees were using their own devices and connecting them to the corporate network. Since then, this type of activity has become commonplace in workplaces all over the globe. The BYOD movement in Australian universities is being driven by a major challenge that many institutions face — a lack of funds to support one-to-one learning, which is a systemic solution in which every student is provided a laptop or mobile device that can be used to support learning in and outside of the classroom. BYOD makes one-to-one easier by simply leveraging the devices that students already have. In practice, it has proven important to provide funds to support students in financial need, and to standardise on a small set of devices and software packages. In early studies, the act of a student using his or her own device for learning has proven to increase productivity and engagement. Tablet computing has accelerated the pace of BYOD, especially in tertiary education, where these smaller, less-expensive devices are seen as a better option than traditional laptops. With their ever-growing capabilities, tablets (which now include an expanding set of choices, such as the iPad, Galaxy, Nexus, and Surface) are well positioned for BYOD environments.

Relevance for Teaching, Learning, or Creative Inquiry

- BYOD can extend faculty and staff contributions and learning opportunities to times and places outside of the institution.
- BYOD policies allow students to work with technology with which they are already comfortable and familiar.
- BYOD programmes eliminate some of the support and other burdens from universities and colleges that go along with paying for and maintaining institution-provided devices.

BYOD in Practice

- The Deakin School of Law has implemented a pilot programme that permits students to complete their exams using their own computing devices rather than requiring tests be done with pen and paper: go.nmc.org/deakin.
- Faculty at Curtin University leverage students' personal devices to check their understanding during class using polls conducted via web-based or mobile apps: go.nmc.org/curtin.
- Working with the University of Tasmania, the University of Queensland secured a grant to develop the processes and a platform for e-exams in supervised BYOD environments: go.nmc.org/eexams.

For Further Reading

The ABCs of BYOD on Campus
go.nmc.org/abcs

(Melissa Delaney, *EdTech Magazine*, 12 August 2013.) When Jeremy Campbell became the CIO of North Carolina's Rowan-Cabarrus Community College, he built an infrastructure to support BYOD, focusing IT resources on providing wireless access, security, and virtual applications.

Bring Everything: BYOD's Evolution in Higher Education
go.nmc.org/helman

(Brian Helman, *Information Week*, 28 February 2014.) Having worked on networks for over 25 years, this university technologist describes how campus wireless infrastructure has been challenged to meet the needs of students that are connecting more than just laptops and smartphones to their campus' network.

Time-to-Adoption: One Year or Less

Flipped Classroom

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 instructor 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, or collaborating with peers in online communities. Students access the online tools and resources any time they need them. Faculty can then 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 instructor 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. 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.

Relevance for Teaching, Learning, or Creative Inquiry

- Flipped classroom concepts and providing students with a more diverse set of learning resources can support self-directed learning.
- More active learning is an important component of the flipped classroom: lectures can be watched with ensuing online discussions unfolding at home, while professors can use class time for hands-on activities or trips outside of the building.

Flipped Classroom in Practice

- The School of Nursing and Midwifery at the University of Western Sydney employs a blended learning model that provides students access to online resources outside of class, while face-to-face sessions are reserved for clinical practice: go.nmc.org/nurse.
- Second and third-year archaeology students at the University of Queensland receive lectures online while class time is intended for building on key concepts through problem-solving and guidance from the instructor: go.nmc.org/archae.
- Students taking Science, Technology, and Society courses at Griffith University are engaged with a form of the flipped classroom known as “interteaching,” a blended, video-based approach: go.nmc.org/Griffith.
- Undergraduates studying Life Sciences at the University of Sydney are using an ePortfolio system, PebblePad, to complete tutorials outside of class: go.nmc.org/theta.

For Further Reading

First Inversion: A Rationale for Implementing the 'Flipped Approach' in Tertiary Music Courses
go.nmc.org/grant

(Catherine Grant, *Australian Journal of Music Education*, 2013.) A music educator makes a case for a collaborative, constructivist approach to learning that allows students to watch lectures on their own while time spent in class is focused on problem-solving and developing skills.

Using Technology to Enable Flipped Classroom Whilst Sustaining Sound Pedagogy
go.nmc.org/usqflipped

(Michael D. Sankey and Lynne Hunt, 30th ascilite Conference, 2013.) Researchers from the University of Southern Queensland present a series of case studies that show how the flipped classroom approach can be applied to university settings with the goal of highlighting the underlying constructivist pedagogy.

Time-to-Adoption: One Year or Less

Mobile Learning

We are in the midst of a complete shift in the devices we use. As smartphones and tablets become more capable and user interfaces increasingly natural, old methods of computing seem place-bound and much less intuitive. People increasingly expect to be connected to the Internet and the rich tapestry of knowledge it contains wherever they go, and the majority of them use a mobile device to do so. According to the 2013 ICT "Facts and Figures" report from the ITU Telecommunication Development Bureau, the mobile market consists of over 6.8 billion subscribers. *Business Insider* reports that Australia is a top market, with a penetration rate of 84% last year and 71% of those smartphone owners also owning a tablet. The unprecedented evolution of these devices and the apps that run on them has opened the door to myriad uses for education. Learning institutions all over the world are adopting apps into their curricula and modifying websites, educational materials, and tools so they are optimised for mobile devices. The significance for teaching and learning is that these devices have the potential to facilitate almost any educational experience, allowing learners to organise video meetings with peers all over the world, use specialised software and tools, and collaborate on shared documents or projects in the cloud. Although there are still likely many uses that have not been realised yet, over the past several years mobile learning has moved quickly from concept to reality.

Relevance for Teaching, Learning, or Creative Inquiry

- As a one-to-one solution, mobiles present an economic, flexible alternative to laptops and desktops due to the devices' lower cost, greater portability, and access to apps.
- Mobile apps with built-in social features enable learners to share their questions or findings with each other in real-time. For example, productivity apps such as Evernote and Dropbox make it possible to exchange notes, assignments, drawings, videos, and more.
- Students can leverage the cameras, microphones, and other tools inherent in mobiles to do field work or create rich media. This is especially convenient for work done outside of the classroom as students can record interviews, collect data for experiments, and more.

Mobile Learning in Practice

- Dr. Peter Teasdale at Griffith University uses the app "H2GU," which allows his students to work in the field when learning to collect and test water samples: go.nmc.org/HGU.
- In the Accounting for Business Decisions course at The University of Technology Sydney, students use their mobiles to access mInteract, a system developed by the university to help the professor gauge how well students understand a topic: go.nmc.org/phone.
- Medical students at the University of Melbourne use the app "mdTimetable" to access personal timetables, as well as "mdPatients," to create and manage patient records at the bedside during or immediately after patient encounters: go.nmc.org/melb.

For Further Reading

CSU Gives Students More Control Over Study Experience with New Mobile Services
go.nmc.org/csu

(Marianne Stenger, *informED*, 4 October 2013.) This article shares how students at Charles Sturt University use a dynamic, personalised mobile assessment calendar and electronic portfolio that can be accessed from any personal device.

From Web-Based Learning To Mobile Learning: Electronic Textbooks, Mobile Devices and Sanskrit
go.nmc.org/sans

(McComas Taylor, *The Australian National University*, Accessed 10 April 2014.) Shifting content from a LMS to an e-textbook (pre-loaded into mobile devices) enabled the Australian National University to solve five long-term problems, including improved accessibility and increased learner engagement.

Time-to-Adoption: One Year or Less

Online Learning

Online learning is not new; the category encompasses any learning that takes place through web-based platforms, whether formal or informal. The learning can be structured into traditional course formats, entirely self-paced, or anything in between. What has made the topic new is the recent and unprecedented focus on providing learning via the Internet that has been stimulated by the tremendous interest in massive open online courses (MOOCs). According to *The Sydney Morning Herald*, Open Universities Australia alone accounts for 140,000 MOOC enrolments. Online learning has "come of age;" more and more, the design of online learning is specifically intended to encompass the latest research, the most promising developments, and the newest business models. At many institutions across Australia, online learning is an area newly ripe for experimentation — some would argue it is undergoing a sea change, with every dimension of the process open for reconceptualisation. On campuses around the continent, virtually every aspect of how students connect with institutions and each other to learn online is being reworked, rethought, and redone.

Relevance for Teaching, Learning, or Creative Inquiry

- As new pedagogies emphasise personalised learning, there is a growing demand for learner-centred online opportunities. Online learning environments, when designed effectively, have the potential to scale globally.
- Online learning environments can make creative use of several educational technologies and emerging instructional approaches, including blended learning, video lectures, and badges.
- When placed online, a diverse set of learning resources is easily accessible to students and can support self-directed learning.

Online Learning in Practice

- CQ University Australia offers its Bachelor of Laws programme, which is accredited with the Legal Practitioners Admissions Board of Queensland, in an online format where students access materials using iPads, iTunesU, Moodle, and Collaborate: go.nmc.org/cqu.
- Monash University offers two courses through FutureLearn's MOOC platform — "Creative Coding" and "The Science of Medicines:" go.nmc.org/monashu.
- The University Of Applied Sciences Potsdam created an interdisciplinary MOOC to study storytelling that includes project presentations by game designers, writers, trans-media producers, executives, and theorists from different fields of study: go.nmc.org/potsd.

For Further Reading

4 Lessons We Can Learn from the "Failure" of MOOCs
go.nmc.org/lessons

(Andrew Miller, *Edutopia*, 30 January 2014.) This article explores ways to improve the practice and quality of online education for all, through the lens of massive open online courses.

Medical Schools' Hi-Tech Future
go.nmc.org/biomed

(Peter Smith and Dror Ben-Naim, *The Australian*, 16 October 2013.) The Biomedical Education Skills and Training (BEST) Network was launched by a team of Australian universities to provide a suite of cloud-based online tools, including an ever-growing medical image bank, interactive virtual laboratories, and simulation training modules.

Time-to-Adoption: Two to Three Years

Badges/Microcredits

Badges are a mechanism to award incentives, progress indicators, and micro-credits. Badging draws on longstanding ways learning has been documented in other settings, such as the personal skills and achievement when a Boy or Girl Scout earns a merit badge. The approach is being used in learning environments like the Khan Academy, with promising results — people watch videos on specific subjects and earn new badges by doing so. Mozilla has published an open specification for badging — the Open Badge Initiative (OBI) — that enables providers and users alike to easily display their achievements on the web. Badges can be used as a way to incorporate some of the advantages of game mechanics as participants work through various levels or stages to achieve credentials. While badges are not by any means pervasive in education systems, they appeal to many educators because they are considered to be a credible alternative for measuring knowledge comprehension and skill acquisition in a very granular way, as compared to standard tests, grades, or the venerable credit hour.

Relevance for Teaching, Learning, or Creative Inquiry

- Badges can be used to gamify the learning process, incentivizing learners to participate in projects and activities that publicly demonstrate their knowledge, and achieve recognition.
- Badges are very flexible, and can provide institutional as well as peer- and self-documentation, and if OBI-compliant, even external validation.
- For faculty, the awarding of badges can demonstrate continuing professional development that is achieved through online training academies or informal methods.

Badges/Microcredits in Practice

- At Swinburne University, Open Mozilla badges are used to reward students in Swinburne's "Carpe Diem" MOOC upon completion of the assigned online activities: go.nmc.org/carpe.
- Deakin University's "Deakin Digital" will provide a more robust way of providing credit for prior learning, combining digital badging with micro-badging to describe a student's existing knowledge detail: go.nmc.org/deak.
- Insignia is a project led by the Director of Research Training at the Australian National University, dedicated to exploring open badging in research education: go.nmc.org/adven.

For Further Reading

Digital Badges Need Mass to Matter
go.nmc.org/digbag

(Frank Catalano, *EdSurge*, 25 February 2014.) The author believes that the increased and effective use of online badges still requires a critical eye on the part of both education industry leaders and educators.

Not Just for MOOCs Anymore: Integrating Badges on Campus
go.nmc.org/notjust

(Courtney Bell, *Edcetera*, 27 March 2013.) Some universities are using badges to recognise accomplishments that their traditional credit system does not cover, such as extracurricular activities, including attending career fairs and speakers series.

Out With the Degree, In With the Badge: How Badges Motivate Learning And 7 Tips To Use It Right
go.nmc.org/outwith

(Saga Briggs, *informED*, 13 August 2013.) This article discusses how organisations across the globe are adopting the OpenStudy digital badge system, creating a new exchange of badges that recognise educational achievement both inside and outside the classroom.

Time-to-Adoption: Two to Three Years

Games and Gamification

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, computers, television sets, and gaming consoles are no longer the only way to connect with other players online. Gameplay is now a portable activity that can happen in a diverse array of settings, and has long since moved on from solely being recreational. Games have 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 programmes 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 programmes 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 recognise that effectively designed games can stimulate gains in productivity and creativity among learners.

Relevance for Teaching, Learning, or Creative Inquiry

- Discovery-based and goal-oriented learning are often inherent in educational games and gamified experiences, fostering opportunities for collaboration and the development of teambuilding skills.
- Educational games can be used to teach cross-curricular concepts that touch on many subjects, and often are more engaging than traditional approaches.
- Simulations and role-playing games allow students to re-enact difficult situations to try new responses or pose creative solutions.

Games and Gamification in Practice

- Developed by Griffith University, the "World Trade Game" is an online multi-player experience that engages students in simulated, real-time global trading with a focus on economic and environmental impacts: go.nmc.org/wtgame.
- SimSchool from Curtin University is an open digital game and assessment platform that allows teachers in training to practice in a virtual environment and interact with simulated students: go.nmc.org/simschool.
- The Swinburne University of Technology is developing a mobile game to educate Australians and motivate them to work collaboratively toward the goal of decreasing their reliance on carbon products and services: go.nmc.org/crcarbon.

For Further Reading

Gamification of Tertiary Courses: An Exploratory Study of Learning and Engagement
go.nmc.org/varina

(Varina Paisley, 30th ascilite Conference, December 2013.) A researcher from Macquarie University conducted a trial on 21 study abroad students and discovered that incorporating game elements, such as a leaderboard and experience points, increased learners' motivation to participate in extracurricular cross-cultural activities.

The Role of Gamification and Game-based Learning in Authentic Assessment
go.nmc.org/herdsa

(Lincoln C. Wood et al., 36th HERDSA Annual International Conference, July 2013.) Researchers from Australia and New Zealand outline how game elements, such as rewind, ghost images, save points, and multiple lives can support authentic learning.

Time-to-Adoption: Two to Three Years

Learning Analytics

Learning analytics is an educational application of "big data," a developing science with origins in data mining and the analysis of online commercial activities, spending trends, and consumer behaviour. Education aims to use similar techniques to improve student retention and provide a high quality, personalised experience for learners. The goal of learning analytics is to make use of sophisticated data analysis to inform decisions made at every tier of the educational system. Whereas analysts in business use consumer data to target potential customers with highly personalised advertising, learning analytics leverages student data to improve the efficacy of learning overall, identify and meet the needs of at-risk students, and adapt delivery approaches as needed to maximize learning for every student — outcomes of profound interest to legislators and policymakers. For educators and researchers, learning analytics is seen as crucial to gaining insights about student interaction with online texts and courseware. Students are beginning to experience the benefits of learning analytics as they engage with mobile and online platforms that track data to create responsive, personalised learning experiences.

Relevance for Teaching, Learning, or Creative Inquiry

- If used effectively, learning analytics can generate early signals of learning issues, allowing teachers and schools to address the needs of struggling students quickly.
- The goal of learning analytics is to enable teachers to understand and address students' individual learning needs and tailor instruction appropriately.

Learning Analytics in Practice

- The Queensland University of Technology plans to mine data from multiple systems including MOOCs to detect student progress and discover when students are having the kind of cognitive problems that put them at risk: go.nmc.org/queensl.
- Researchers from Murdoch University, Western Australia, and The University of Newcastle, New South Wales, are combining learning analytics tools, grades, interview transcripts, and behaviours to describe how each student is engaging with the unit: go.nmc.org/explo.
- A symposium supported by Australia's Office for Learning and Teaching engaged researchers and practitioners with opportunities to explore the learning analytics frameworks of state, provincial, and institutional strategy and policy: go.nmc.org/symp.

For Further Reading

How Can Educational Data Mining and Learning Analytics Improve and Personalise Education?
go.nmc.org/datamin

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

Policy and Strategy for Systems-Level Deployment of Learning Analytics
go.nmc.org/improving

(George Siemens et al., Society for Learning Analytics Research, December 2013.) The authors call for a national learning analytics policy and strategy for Australia that evaluates current international practice and guides decision-making.

University Data Can Be a Force for Good
go.nmc.org/forc

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

Time-to-Adoption: Two to Three Years

Open Content

The movement toward open content reflects a growing shift in the way scholars in many parts of the world are conceptualising education toward a view that is more about the process of learning than the information conveyed. Information is everywhere; the challenge is to make effective use of it. Open content uses open licensing schemes, like those of Creative Commons, to encourage 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 is a response to both the rising costs of traditionally published resources and the lack of localised educational resources in some regions. As this open, customisable content — and insights about how to teach and learn with it — is increasingly made available for free over the Internet, people are learning not only the material, but also the skills related to finding, evaluating, interpreting, and repurposing the resources. The OECD reports that Australia is making increasing use of open educational resources; AEShareNet alone offers approximately 20,000 open items for educational use. The Macquarie E-Learning Centre of Excellence is developing open-source software tools and open standards for e-learning. The increasing focus on open content will continue to impact how we think about content production, sharing, and learning for some time.

Relevance for Teaching, Learning, or Creative Inquiry

- In many cases, open materials can be easily updated and reposted to reflect the latest knowledge and discoveries.
- Most of Australia's top institutions are providers of open content and have created a wealth of materials now available on demand to anyone.
- 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.

Open Content in Practice

- At La Trobe University, the Faculty of Health Sciences have successfully piloted a programme to develop and distribute OER and research practices using Wikiversity and the Wikimedia Foundation Projects: go.nmc.org/latrobe.
- The Faculty of Sciences at Adelaide University is transitioning from printed textbooks to open-source textbooks, which are accessed by students primarily via iPads: go.nmc.org/adelaide.
- Librarians and academics from Australia and New Zealand worked together over a weekend to create or 'hack' an open textbook for undergraduate students in Communication and Media Studies: go.nmc.org/texthack.

For Further Reading

Some Examples of Best Practice in Open Educational Resources
go.nmc.org/somex

(Frances Gray and Carina Bossu, DEHub, February 2013.) Researchers from the University of New England examined four open courseware initiatives with the goal of providing a diverse range of insights about the successful adoption of OER.

Supporting OER Engagement at Australian Universities
go.nmc.org/oltaus

(Berenice Scott, Australian Government Office for Learning and Teaching, February 2013.) This document contains background on the use of open educational resources in Australian universities and identifies key intellectual property rights and licensing considerations for decision-makers as they develop policy and processes to support the uptake of OER in tertiary education.

Time-to-Adoption: Four to Five Years

The Internet of Things

The Internet of Things conveys information communicated by network aware objects that connect the physical world with the world of information through the web. The advent of TCP/IP v6, launched in 2006, added enormous new addressing capabilities to the Internet, and enabled objects and the information they might carry in attached sensors or devices to be addressable and searchable across the web. This expanded address space is particularly useful for tracking objects that monitor sensitive equipment or materials, point-of-sale purchases, passport tracking, inventory management, identification, and similar applications. Embedded chips, sensors, or tiny processors attached to an object allow helpful information about the object, such as cost, age, temperature, colour, pressure, or humidity to be transmitted over the Internet. This simple connection allows remote management, status monitoring, tracking, and alerts if the objects they are attached to are in danger of being damaged or spoiled. Traditional web tools allow objects to be annotated with descriptions, photographs, and connections to other objects, and any other contextual information. The Internet of Things makes access to these data as easy as it is to use the web.

Relevance for Teaching, Learning, or Creative Inquiry

- Informal learning institutions, such as museums, are already leveraging the Internet of Things to track and monitor the conditions of ancient artefacts, such as individual dinosaur bones.
- The Internet of Things can be particularly useful in fieldwork, facilitating opportunities for students to collect scientific data through mobile devices and instantly add them to large databases.
- Internet of Things-enabled innovations such as the Nest Learning Thermostat allow owners to control the conditions of physical spaces through their smartphones in addition to self-programming.

The Internet of Things in Practice

- Students from the University of Sydney won Telstra's machine-to-machine challenge by designing a small device that can be connected to cars to track mileage for student drivers: go.nmc.org/ingear.
- Archaeologists from the University of Bristol are embedding historical objects from the transatlantic slave trade for "Reflector," a project that aims to share stories through authentic pieces of history: go.nmc.org/reflector.
- Electric car maker Innova and non-profit consortium Internet2 are bringing networked vehicles to four universities in order to spark discussion about real-world applications of the Internet of Things: go.nmc.org/innova.

For Further Reading

10 Things You Should Know About the Internet of Things
go.nmc.org/10things

(Patrick Gray, *TechRepublic,* 10 January 2013.) This article provides a helpful list of relevant ideas related to the Internet of Things, including a description of its uses and the value it holds for businesses.

Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions
go.nmc.org/iotvision

(Jayavardhana Gubbi et al., Future Generation Computer Systems, 2013) Researchers from the University of Melbourne lay out a vision of the future in which Wireless Sensor Network technologies, the Internet, and cloud computing converge to create the Future Internet.

Time-to-Adoption: Four to Five Years

Machine Learning

Machine learning refers to computers that are able to act and react without being explicitly programmed to do so. Practical speech recognition, semantic applications, and even self-driving cars all leverage machine learning via data systems that not only intake, retrieve, and interpret data, but also learn from it. To do this, the machine must make a generalisation, using algorithms to respond to new inputs after being "trained" on a different learning data set — much like a human learns from experiences and uses that knowledge to respond appropriately in a different encounter. In this sense, machine learning is widely considered by many researchers and thought leaders as a step towards human-like artificial intelligence. Recent incarnations of machine learning include a university-developed telescope that can automatically detect significant changes pointing to supernova occurrences. The software Xapagy improvises dialogue and plot moves in stories fed to it by users. The potential of machine learning for education is still some years away, but the potential of learning systems that can adapt and learn on their own is driving research around the continent.

Relevance for Teaching, Learning, or Creative Inquiry

- Machine learning models can potentially sort through learner-contributed observations about the world around them and create visualisations that identify crucial patterns.
- Ultimately, machine learning promises to enable scientists and researchers to communicate more authentically with their devices — even in improvised ways, just as a colleague would. It is foreseeable that students will collaborate with machines on projects.
- Software that employs machine learning to detect patterns in written work, speech, and other actions could better adapt to students' learning styles and needs.

Machine Learning in Practice

- Collaborative research conducted by the University of Sydney and two other institutions has produced a system designed to automatically generate specific trigger questions from citations for academic writing: go.nmc.org/critical.
- Developers from the University of Tasmania created a computer programme with artificial intelligence that can help forecast bushfire hotspots in Australia: go.nmc.org/bushfire.
- Researchers from Queensland University of Technology developed the PHP Intelligent Tutoring System, which leverages machine learning to teach web programming, and noted improved test scores among students during evaluation: go.nmc.org/phptutor.

For Further Reading

Adaptive Technology: Machine Learning
go.nmc.org/machine

(Seth Fletcher, *Scientific American*, 17 July 2013.) This article describes the science of adaptivity and intelligent computerized-learning interfaces.

Deep Learning Comes of Age
go.nmc.org/dee

(Gary Anthes, Communications of the ACM, June 2013.) The author discusses the developments in machine learning systems that have led to improvements in the accuracy of computer vision and speech recognition.

True Artificial Intelligence Not So Far Away
go.nmc.org/trueai

(Kesha West, *Australia Network News*, 8 February 2013.) Interviews with Australian computer scientists illuminate how the rapid progression of machine learning technologies has led to increasingly intuitive user interfaces and intelligent machines.

Time-to-Adoption: Four to Five Years

Natural User Interfaces

A growing list of devices built with natural user interfaces (NUIs) accept input in the form of taps, swipes, and other ways of touching; hand and arm motions; body movement; and increasingly, natural language. Tablets and smartphones are the first in a growing array of devices that allow computers to recognise and interpret natural physical gestures as a means of control. These 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 increasing high fidelity of systems that understand gestures, facial expressions, and their nuances, as well as the convergence of gesture-sensing technology with voice recognition. Users interact with their devices in an almost natural fashion, with gesture, expression, and voice communicating their intentions. The next wave of NUIs will likely be electrovibration, while involves the use of an electrostatic force to produce detailed tactile sensations that users can feel. Seen as the next evolution of touchscreen technology, it will allow users to not only provide touch-based input, but also tactile output via a wide variety of textures, topography, and other features as they interact with the screen.

Relevance for Teaching, Learning, or Creative Inquiry

- As the ability of NUIs to read subtle changes in facial expressions and user reactions improves, software will be able to "sense" when a student is struggling with material.
- NUIs make devices seem easier to use and more accessible; interactions are far more intuitive, which promotes exploration and engagement.
- Science students increasingly rely on simulators employing natural user interfaces to practice precise manipulations that would be far less productive if they had to try to simulate sensitive movements with a mouse and keyboard.

Natural User Interfaces in Practice

- The University of Melbourne partnered with Microsoft to launch the Microsoft Research Centre For Social Natural User Interfaces, where researchers are exploring how touchless interfaces and brain signal sensors can be used for social interactions: go.nmc.org/socnui.
- The MIT Media Lab created a mechanism that allows users to remotely manipulate objects from a distance and physically interact with data: go.nmc.org/dynamic.
- Researchers at Purdue University created the design tool "Shape-It-Up," which uses computer algorithms and a depth-sensing camera to interpret hand gestures, enabling designers and artists to create and modify 3D shapes via gestures: go.nmc.org/shapes.

For Further Reading

How Helsinki-Based Startup Senseg Creates Touchscreens You Can Feel
go.nmc.org/helsin

(Stephen Kelly, *Wired*, 11 April 13.) Senseg has produced a thin, durable material that uses an ultra-low electrical current to create an attractive force that allows users to feel textures, edges, and vibrations.

With A Voice Interface API For Any App, Wit.ai Wants To Be The Twilio For Natural Language
go.nmc.org/voicein

(Ingrid Lunden, *TechCrunch*, 17 March 2014.) This article describes Wit.ai, a platform and API that enables developers to incorporate speech recognition and a natural language interface into any app or piece of hardware.

Time-to-Adoption: Four to Five Years

Wearable Technology

Wearable technology refers to devices that can be worn by users, taking the form of an accessory such as jewellery, sunglasses, a backpack, or even actual items of clothing such as shoes or a jacket. The benefit of wearable technology is that it can conveniently integrate tools that track sleep, movement, location, social media, and even new classes of devices that are seamlessly integrated with a user's everyday life and movements. Google's "Project Glass" was one of the earliest examples, and enables a user to see information about their surroundings displayed in front of them. Smart watches have also become commonplace, allowing users to check emails and perform other productive tasks through a tiny interface. Additionally, a rapidly growing category of wearable technology takes advantage of the burgeoning interest in the "quantified self." The Jawbone UP and Fitbit bracelets are two examples that track how you eat, sleep, and move. Empowered by these insights, many individuals now rely on these technologies to improve their lifestyle and health. Today's wearables 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.

Relevance for Teaching, Learning, or Creative Inquiry

- The next wave of wearable technology, implantable devices, can be embedded under a person's skin to detect and even dispense treatment for health issues.
- Students already spend time in formal classroom settings gathering data about themselves or research topics. Quantified self-enabled wearables tap into this interest to make the data collection process much easier.
- Wearable devices such as the Memoto, a camera worn around the neck that can capture an image every half minute, are enabling people to track their surroundings automatically — a particularly interesting dimension for student fieldwork.

Wearable Technology in Practice

- Researchers at Melbourne's Bionic Institute are creating implantable bionic devices, including electrodes that can be inserted into the brain to detect abnormal activity and deliver treatment: go.nmc.org/brain.
- University of Tokyo researchers have used data from the Fitbit pedometer to detect and measure the strength of workplace relationships: go.nmc.org/tokyo.
- The Wearable Computer Lab at the University of South Australia develops augmented reality-enabled wearable devices and specialises in human-computer interaction techniques: go.nmc.org/unisa.

For Further Reading

Australians are Quick to Embrace Wearable Technology
go.nmc.org/embrace

(Nadia Cameron, *CMO*, 19 September 2013.) A survey cited in a report from *The Human Cloud: Wearable Technology from Novelty to Productivity* found 35% of Australians have used some form of wearable technology to date such as health and fitness monitors, smart glasses, watches, clothing or cameras, which is nearly double the percentage of consumers in the UK and US.

What Does Wearable Computing Mean for Education?
go.nmc.org/wearab

(Ben Stern, *EduMusings*, 7 January 2014.) Wearables can provide real-world contexts and enable learning to occur anywhere and anytime. Companies are developing apps for wearable devices that allow students to demonstrate their learning.

Key Trends Accelerating Technology Adoption

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 panel member researches, identifies, and ranks key trends that are currently affecting teaching, learning, and creative inquiry in Australian tertiary education, and uses these as a lens for its work in predicting the uptake of emerging technologies.

These nine trends, which 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 realise their impact in the next one to two years, and two categories of slower trends that will realise their impact within three to five (or more) years.

Fast Trends

Driving Ed Tech adoption in Australian tertiary education over the next one to two years

Digital Delivery is Increasingly the Norm. Though face-to-face interaction is still very much the norm for tertiary learning, the delivery of instructional content and materials via the Internet is increasing. Australia.edu reports that 87% of universities across the continent provide Internet access for all students on campus, making online resources convenient for teaching and learning. More and more, teachers are interacting with students through online discussion forums and by sharing video and audio recordings.

Growing Ubiquity of Social Media. 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 November 2013 report by *Social Media News* reported that 38.3 million residents of Australia used some form of social media regularly. Examples of effective use of social media are easily found in almost every education sector. In response, many Australian institutions, including the University of Wollongong, have established clear social media policies.

Rising Preference for Personal Technology. Driven by the breadth of Australia's burgeoning mobile market, which now reaches 84% of the population, both faculty and students increasingly want to use their own technology for learning. This mirrors a trend that has been present in the workplace for some time. Students and educators alike appreciate being able to do their work with tools they have configured to their own preferences, which are familiar and productive for them personally. As devices continue to be ever more capable, affordable, and mobile, students often have access to more advanced equipment in their personal lives than they do in class.

Mid-Range Trends

Driving Ed Tech adoption in Australian tertiary education over the next three to five years

Evolution of Online Learning. Over the past several years, there has been a shift in the perception of online learning to the point where its value is now well understood, with flexibility, ease of access, and the integration of sophisticated multimedia and technologies chief among the list of appeals. While online continues to grow steadily in Australia, the tools and technology itself continue to evolve, and as such, this trend will continue to drive decisions for a number of years. Over that time, 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.

Increasing Focus on Open Content. Openness — concepts like open content, open data, and open resources, along with notions of transparency and easy access to data and information — is increasingly important across all of education globally, and this is equally important in the Australian context. As traditional sources of authority are augmented by downloadable content, however, there is need for more curation and other forms of validation that can communicate the credibility of a resource. The Australian government has published numerous guides on developing and using open content, including *A Guide to Open Educational Resources*, that encourage the creation and use of educational materials that are freely copiable, freely remixable, and free of barriers to access, sharing, and educational use.

Increasing Use of Hybrid Learning Designs. Students are prolific users of the Internet, finding, using, and exchanging tools, information, and content constantly. Hybrid learning environments offer different affordances than physical campuses, including a wide range of ways to encourage collaboration, critical thinking, and communication 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. Like many other Australian institutions, the University of Adelaide is moving to more use of hybrid learning to update their pedagogical models — while taking care to ensure that the online experiences are high-quality and serve to deepen learning.

Long-Range Trends

Driving Ed Tech adoption in Australian tertiary education over the next five or more years

Agile Approaches to Change. There is a growing consensus among many higher education thought leaders that institutional leadership and curricula could benefit from agile start-up models. Programmes based on these models can stimulate top-down change across a broad range of institutional settings. The Lean Start-up movement uses technology as a catalyst for promoting a culture of innovation in a more widespread, cost-effective manner. Pilots and other experimental programmes are being developed for teaching and improving organisational structure to more effectively nurture entrepreneurship among both students and faculty in Australia.

Massive Reinvention of the Personal Computer. Computers as we know them are in the process of a massive reinvention. The computer is smaller, lighter, and better connected to the Internet and its applications than ever before; smartphones and other mobile devices are sufficient for basic computing needs, and only specialised tasks require a keyboard, large monitor, and a mouse. As the capabilities and interfaces of small computing devices improve, ideas about when — or whether — a traditional computer is necessary are changing as well. Today's mobiles are infinitely flexible devices that can add instant new functionality by simply downloading new apps, with most either free or nearly free.

Rise of Data-Driven Learning and Assessment. There is a growing interest in using new sources of data for personalising the learning experience and for performance measurement, led by Australian institutions like the Learning Analytics Research Group at the University of Melbourne. Smart Sparrow, an Australian-based eLearning platform invented at the University of New South Wales and used in institutions across Australia and in the US, combines adaptive feedback and adaptive pathways to create an intelligent tutoring system that aligns online learning with a student's level of knowledge. As the field of learning analytics matures, the hope is that this information will enable continual improvement of learning outcomes.

Significant Challenges Impeding Technology Adoption

Along with the trends discussed in the preceding section, the expert panel noted a number of significant challenges faced in Australian tertiary education that are impeding the uptake of emerging technologies. Because not all challenges are of the same scope, the discussions here are sorted into three categories defined by the nature of the challenge. The NMC Horizon Project defines solvable challenges as those that we both understand and know how to solve; difficult challenges are ones that are more or less well understood, but for which solutions remain elusive. Wicked challenges, the most difficult, are categorised as complex to even define, and thus require additional data and insights before solutions will even be possible.

Solvable Challenges

Those which we both understand and know how to solve

Blending Formal and Non-Formal Learning. As the Internet has brought the ability to learn something about almost anything to the palm of one's hand, there is an increasing interest in the kinds of self-directed, curiosity-based learning that have long been common in museums and science centres. These and other serendipitous forms of learning fall under the banner of Informal learning, and serve to enhance student engagement by encouraging them to follow their own learning pathways and interests. Many experts believe that a blending of formal and informal methods of teaching and learning can create an environment that fosters experimentation, curiosity, and creativity. The need for methods for capturing and assessing informal learning is at the centre of this challenge, but these methods exist, and institutions like Victoria University are already including them in teacher preparation programs.

Creating Opportunities for Authentic Learning. Many educators feel that learning that incorporates real life experiences is not occurring enough in tertiary education, and is undervalued when it does take place. Fortunately, there are many options available to institutions that want to incorporate more authentic learning experiences in their programs. Project-based learning is a widely used set of practices that incorporate real life experiences, technologies, and tools. The University of the Western Cape, an acknowledged leader in authentic learning, recently hosted an Authentic Learning Colloquium to showcase successful applications research. The challenge that remains with authentic learning is to put it to use at scale.

Low Digital Fluency of Faculty. Digital media literacy continues its rise in importance as a key skill in every discipline and profession. In education as well, lecturers and professors across Australia are beginning to realise that they are limiting their students by not helping them to develop and use digital media literacy skills across the curriculum. This challenge is exacerbated by the fact that skills and standards based on tools or platforms have proven to be somewhat ephemeral. These same challenges exist in the workplace, but expectations for work-related digital competencies are clear, and people are driven to seek solutions to their own shortcomings or skill needs. In education, there remains a role for professional development, but the larger need is to use policy to change the expectations of the basic skills that every modern lecturer or professor should have to be part of a modern university.

Difficult Challenges

Those we understand but for which solutions are elusive

Competition from New Models of Education. New models of education are bringing unprecedented competition to academia's hallowed halls. 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, but concerns have arisen related

to the low completion rates of some MOOCs. As these new platforms emerge, there is a growing need to frankly evaluate outcomes and processes, determine how to best support collaboration, interaction, and assessment at scale, and engage students on a deeper level.

Expanding Access. 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.

Scaling Teaching Innovations. Current organisational 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. While this challenge is deemed as difficult, institutions across Australia are already working to solve it. At the University of Tasmania, for example, teaching development grants encourage more strategic institutional practices by supporting faculty as they engage in scholarly activities to enhance their pedagogies.

Wicked Challenges

Those that are complex to even define, much less address

Complex Thinking and Communication. It is increasingly essential for students to understand the difference between human and artificial intelligence, to learn how to use abstraction and decomposition when tackling complex tasks, and to deploy heuristic reasoning to complex problems — but none of these skills are well understood. Communication skills must also be mastered for complex thinking to be applied in profound ways. Indeed, the most effective leaders are outstanding communicators with a high level of social intelligence; their capacity to connect people with other people, using technologies to collaborate and leveraging data to support their ideas, requires an ability to understand the bigger picture and to make appeals that are based on logic, data, and instinct.

Keeping Education Relevant. Many pundits worry that if education does not adapt to the times, other models of learning (especially other business models) will take its place. As online learning and free educational content become more pervasive, institutional stakeholders must address the question of what school can provide that other approaches cannot, and rethink the value of education from a student's perspective. In 2011, the Australian government launched "Future Unlimited," an initiative to reconceptualise the global relevance and practicality of the continent's learning institutions and promote more innovation and a better return on investment for students..

Managing Knowledge Obsolescence. Simply staying organised and current presents a challenge in a world where information, software tools, and devices proliferate at the rate they do today. New developments in technology are exciting and their potential for improving quality of life is enticing, but it can be overwhelming to attempt to keep up with even a few of the many new tools that are released. User-created content is exploding, giving rise to information, ideas, and opinions on all sorts of interesting topics. There is a greater need than ever for effective tools and filters for finding, interpreting, organising, and retrieving the data that is important to us.

Methodology

The process used to research and create the *2014 NMC Technology Outlook for Australian Tertiary Education: A Horizon Project Regional Analysis* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC Horizon Project 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 panel of experts 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, which has grown into a resource of hundreds of pages, 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 *2014 NMC Technology Outlook for Australian Tertiary Education* can be found at aus.wiki.nmc.org.

The procedures for selecting the topics that are in this report include a modified Delphi process now refined over years of producing the *NMC Horizon Report* series, and it began with the assembly of the expert panel. The board as a whole was intended to represent a wide range of backgrounds and interests, yet with each member bringing a particularly relevant expertise. To date, hundreds of internationally recognised practitioners and thought leaders have participated in the NMC Horizon Project Expert Panel; 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. Panel 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, or creative inquiry. 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 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 are designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the panel:

1. *Which of these key technologies will be most important to Australian tertiary education 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 Australian tertiary education institutions and programmes are using today that arguably ALL institutions and programmes should be using broadly to support or enhance teaching, learning, or creative inquiry?*
    b. *What technologies that have a solid user base in consumer, entertainment, or other industries should Australian tertiary education institutions and programmes be actively looking for ways to apply?*

   c. *What are the key emerging technologies you see developing to the point that Australian tertiary education institutions and programmes 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 Australian tertiary education institutions and programmes approach our core missions of teaching, learning, and creative inquiry?*
4. *What do you see as the key challenges related to teaching, learning, and creative inquiry that Australian tertiary education institutions and programmes will face during the next five years?*

One of the expert panel'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.

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, which can be found at aus.wiki.nmc.org.

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