



HORIZON REPORT

2009 Australia–New Zealand Edition

a publication of
The NEW MEDIA CONSORTIUM

**The *Horizon Report: 2009 Australia–New Zealand Edition*
is a publication of
The NEW MEDIA CONSORTIUM**

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EXECUTIVE SUMMARY

The New Media Consortium's Horizon Project is an ongoing research project that aims to identify and describe emerging technologies likely to have a large impact on teaching, learning, or creative inquiry within education around the globe over a five-year time period. The project's central products are the *Horizon Reports*, an annual series of publications that describe promising emerging technologies and highlight their relevance to education. This edition, the *Horizon Report: 2009 Australia-New Zealand Edition*, is the second in the ANZ series and focuses on emerging technologies as they appear in and affect education in Australia and New Zealand particularly.

The report follows a specific format to describe six areas of emerging technology that will impact education in Australia and New Zealand within three adoption horizons over the next five years. Each topic opens with an overview describing the technology at hand, followed by a discussion of its relevance to teaching, learning, or creative inquiry. Examples of how the technology is currently employed, or how it could be applied to education, illustrate its potential. Finally, an annotated list of materials for further reading is provided for those who wish to explore a topic in greater depth.

In selecting the six topics, the project draws on an ongoing conversation among leaders in the fields of business, industry, and education, informed by a review of published resources, by current research and practice, and by the expertise of educational technology communities in Australia, New Zealand, and around the world. The report is guided by the Horizon Project's Australia-New Zealand Advisory Board, a body of experts representing a range of perspectives in Australia and New Zealand. The Advisory Board engages in a discussion framed by a set of research questions that are intended to uncover significant trends and challenges and to identify a broad field of potential technologies for the report. The process by which the Advisory Board arrives at consensus about the final six topics presented in the *Horizon Report* is detailed in the methodology section.

Key Trends

Each year, the Advisory Board reviews key trends, examining current articles, papers, interviews, and

published research to discover patterns that are affecting the practice of teaching, learning, and creative enquiry. The Advisory Board listed the four trends described here as those most likely to have a significant impact in education in Australia and New Zealand over the next five years. They are presented in priority order as ranked by the Advisory Board.

- *The perceived value of innovation and creativity is increasing.* Innovation is valued at the highest levels of business and must be embraced in schools if students are to succeed beyond their formal education. Many jobs that will be sought and filled by educated young people require the ability to improvise, though this skill is neither taught nor prized in school. The ways we design learning experiences must reflect the growing importance of innovation and creativity as professional skills if students are to succeed beyond the classroom.
- *Technology continues to impact how people work, play, gain information, and participate in communities.* Once seen as an isolating factor for those who use it, the Internet has now become firmly established as a key medium through which people connect with one another. It provides virtual spaces where people who share interests can congregate; it facilitates serendipitous connections between people located in very different parts of the world; it connects colleagues, families, friends, and communities no matter how widely scattered they may be. The Internet is blurring the boundaries between online and real-world, between work and play, and between near and distant, affecting every part of our lives.
- *Technology is increasingly a means for empowering students, a method for communication and socialising, and a ubiquitous, transparent part of their lives.* For many students, technology is a primary means of socialising and managing one's own learning. In a natural extension of the previous trend, it permeates teaching and learning as it does the rest of our activities. It is an integral part of everyday life for students and teachers, and increasingly, an indispensable tool for learning. It places the power to communicate firmly in the hands of students, connecting them to experts,

to information, and to one another in powerful and immediate ways.

- *The way we think about learning environments is changing.* Because technology is so pervasive in our lives, the learning environment is no longer limited to a physical space. Today, the notion of a “classroom” includes experiences, experts, collaborators, peers, and resources located all over the globe and available twenty-four hours a day. To take advantage of this trend, institutions must reflect and support the transformation of the learning environment by embracing the means that make it possible: social networking tools, semantic applications, mobile devices, virtual worlds, and other emerging technologies that facilitate collaboration, communication, and learning.

Critical Challenges

In addition to identifying key trends, the Advisory Board noted many challenges facing educational institutions in Australia and New Zealand. The four listed below are those selected as most likely to impact the practice of teaching, learning, and creative enquiry over the next five years. One challenge not listed below but present as an undercurrent in every dialog has been the effect of recent events in the global financial markets. While these events and their still-emerging ramifications are not elaborated upon here, they remain a backdrop on the stage as the trends and challenges noted by the board play out.

- *Practices for evaluating student work will evolve in response to the changing nature of learning and student preferences for receiving feedback.* As students continue to use new media and technology in research and class work — either because it is assigned or because they prefer it — effective methods of assessing non-traditional work must be developed. Additionally, new ways to conduct and deliver evaluations and grades must be adopted that take advantage of technology for dynamically assessing and reporting progress and for delivering feedback in ways that are meaningful and convenient for students.
- *Ageing learning environments do not easily allow for embracing the use of information and communication technologies (ICTs), or enable the sorts of learning support systems being promoted by modern theorists.* Many classrooms

are not equipped to support the number of students who bring laptops and require power and reliable Internet connectivity. Further, most of these spaces were designed for instructor-led lecture classes and are not conducive to collaborative group work. In a world where learning happens more and more in groups, particularly groups connected to resources via the Internet, traditional classrooms are no longer the best kind of space for every learning experience. Even the online spaces available to students often do not support their preferences or the recommendations of experts; many course and learning management systems that are used in schools are enterprise systems that too often do not reflect students’ desire for flexible, customisable tools.

- *There is a growing need for formal instruction in key new skills, including information literacy, visual literacy, and technological literacy.* To fully participate in the media-rich world around them, students must be able to understand basic content and media design, interpret media and advertising, and create multimedia messages that demonstrate visual fluency. These skills are not routinely taught and it is often wrongly assumed that because they are surrounded by media-rich messages, students simply absorb the ability to interpret and create them. There is an increasing realisation that these skills are as important as written, spoken, and information literacy, and they must be formally taught.
- *There is a growing recognition that new technologies must be adopted and used as an everyday part of classroom activities, but effecting this change is difficult.* The difficulty lies in creating new opportunities for learning in a well-established system. Teachers must be encouraged to master technological tools the same way any professional is expected to master his or her tools. To take advantage of new technologies, teachers, already pressed for time and resources, must be given the opportunity to incorporate professional development, training, and preparation into their own practice.

The trends and challenges noted here frame any discussion of the six technologies described below. They surround and infuse the environment in which these technologies exist and are put to use, and they inform the way we pursue the activities of teaching,

learning, and creative enquiry. The Advisory Board acknowledges that understanding is only the first step toward incorporating any emerging technology into practice and recognises that the factors described here influence our decisions and actions on a daily basis.

Technologies to Watch

The six technologies detailed in the *Horizon Report: 2009 Australia-New Zealand Edition* are placed along three adoption horizons that indicate likely timeframes for their widespread adoption on campuses — defined here as penetration rates of greater than 16-20% both within and among institutions. The first adoption horizon assumes the likelihood of broad adoption within the next year; the second, adoption within two to three years; and the third, adoption within four to five years.

A wide range of *mobile Internet devices* is easily found on campuses today; the second technology in the first horizon, *private clouds*, is less visible, but being widely explored and within the next year is projected to be quite common on (and among) university campuses. Those in the middle horizon, *open content* and *virtual and alternate realities*, are commonly used in business and industry and by leading educational institutions. Not surprisingly, the two technologies located on the furthest horizon are those that have been least adopted and are still in the early stages of development: *location-based learning and smart objects and devices*.

Specific examples of each technology are included in the body of the report, but these become rarer and more experimental as we move out along the horizons toward the far term. The research of the Advisory Board indicates that each of these six featured areas will have significant impact on campuses in Australia and New Zealand within the next five years.

- **Mobile Internet Devices** Similar in name to next-generation mobile, a topic which appeared on the far horizon in the *2008 Australia-New Zealand Edition*, mobile Internet devices are portable, small, and able to access nearly the full range of Internet content. In the last year, these devices — particularly mobile phones — have moved rapidly to the near-term horizon, driven by a variety of factors. Educational uses are increasing, thanks to online tools that blend the portability of mobile Internet devices with the features of web-based applications.
- **Private Clouds** Cloud-based applications and cloud computing practices have seen rapid growth in education, business, and industry since they appeared in this report a year ago. In response to challenges unique to Australia and New Zealand, we are now seeing the emergence of private clouds that offer the benefits of cloud computing while mitigating some of the risks associated with the use of offshore computing resources.
- **Open Content** As the costs associated with education continue to rise, an increasing number of educators are turning to open content as a way to provide less expensive, highly customised learning materials for students. Communities are springing up around open content that support institutionally and non-institutionally educated students, lifelong learners, and teachers. The opportunities for reusing and sharing course materials created by open content are changing our perspectives on educational publishing, textbook selection and distribution, and the types of resources available to students.
- **Virtual, Augmented, and Alternate Realities** With virtual worlds firmly established as valuable learning spaces, educational institutions are exploring additional ways to provide immersive experiences for education. Activities that blur the boundary between the virtual and the real, including simulations, augmented reality experiences, and alternate reality games, are proving to be effective means for attracting students' interest and increasing their engagement.
- **Location-Based Learning** Mobile devices commonly carried by students provide a platform for anytime, anywhere learning that takes advantage of the student's physical location. Since the devices know where they are, information that is relevant to a particular place can easily be delivered to students on location. From self-guided tours to friend finders, location-based learning is already in use in a number of social contexts, and deeper educational applications are not far behind.
- **Smart Objects and Devices** Smart objects and devices are able to connect the physical world with the world of information. This can be done very simply — for instance, by printing out

a quick response (QR) code and attaching it to an object — or by means of more sophisticated technology such as an embedded microchip. Whatever the means for making an object “smart,” the effect is to connect that object to the larger world by linking it with other objects, information, and media. Smart objects are increasingly common in the consumer and entertainment arenas, and educational uses are beginning to emerge as well.

These six key emerging technologies were selected by the Advisory Board from over eighty technologies and practices identified during the process of preparing this report. They are presented here as they appear within the context of educational practice in Australia and New Zealand.

About the Horizon Project

The Horizon Project is a long-running research project that since 2002 has continuously examined new and emerging technologies and the trends and issues accompanying them, and produced an ongoing series of reports, wikis, discussions, papers and other resources related to this work. The annual Horizon Report, the project’s flagship effort, is released each January and is currently published in six languages. That report looks at the applications of key new technologies to teaching, learning, and critical enquiry from a global perspective, and reaches hundreds of thousands of educators worldwide.

Throughout the year, a series of related editions are released that reflect the project’s work in specific economic sectors and geographic regions. This report, the annual Australia-New Zealand Edition, is one of the most visible parts of that effort, which also includes an annual K12 Edition as well as special

reports such as the recent Economic Development Edition and a series of high-level discussions within the museum community.

Like the umbrella efforts from which it sprung, the Australia-New Zealand Edition used qualitative research methods to identify the technologies selected for inclusion in the report. The process began with a survey of the work of other organisations and a review of the literature with an eye to spotting interesting emerging technologies. When the cycle started, little was known, or even could be known, about the appropriateness or efficacy of many of the emerging technologies for these purposes, as the Horizon Project expressly focuses on technologies not currently in widespread use in academe. For the current report, more than eighty of these were initially considered by the members of the project’s Advisory Board.

The 37 members of this year’s Advisory Board were purposely chosen to represent a broad swath of Australian and New Zealand education, as well as key writers and thinkers from business and industry. They engaged in a comprehensive review and analysis of research, articles, papers, and interviews; discussed existing applications, and brainstormed new ones; and ultimately ranked the items on the list of candidate technologies for their potential relevance to teaching, learning, and creative expression. This work took place entirely online in May and June 2009, using a variety of tools specially purposed for the project. All of this work was captured and may be reviewed on the project wiki, at <http://horizon.nmc.org/anz>.

For additional background on the Australia-New Zealand project and specifics about the research methodology, please see the section on Methodology at the end of this report.

MOBILE INTERNET DEVICES

Time-to-Adoption Horizon: One Year or Less

More students than ever are now carrying mobile devices — including phones, netbooks, smartbooks, portable personal wireless hubs, and e-book readers — that cost far less than a computer and can easily access the Internet. It has been common to find students carrying mobile phones for some time now, but recent advances in the technology have wrought a dramatic change in the mobile landscape. Devices like the Apple iPhone 3GS, Kogan Technologies' Agora, the HTC Magic, and other new models are in high demand. Combining innovative interfaces with large, clear screens and a wide array of software applications, mobiles are compact tools that support many tasks typically performed on computers. The swift uptake of new models combined with the emergence of new data plans, wider availability of mobile broadband, and an increasing availability of third-party applications for education has catapulted mobiles into the near horizon for education in Australia and New Zealand.

Overview

From phones to smartbooks, mobile devices with access to the Internet now make it possible to do all kinds of activities — whether working, studying, or socialising — wherever one happens to be. In recent years, mobile phones have evolved to include innovative interfaces, GPS and wifi capability, and third-party applications. Small mobile Internet devices including netbooks and smartbooks offer another way to stay connected and work on the go: smaller than laptops but larger than mobile phones, these devices are compact and powerful.

Placed on the far horizon for Australia and New Zealand last year because of slow adoption rates and low availability of bandwidth, mobile Internet devices are moving toward broad adoption much more quickly than originally anticipated. One key reason for this sudden upswing is the popularity of a new class of smartphones that have emerged in the past year. Along with reduced broadband costs and new plans that offer alternatives to hefty overage charges, the capabilities of these sophisticated devices have heightened the already strong interest in mobiles in Australia and New Zealand.

These new mobiles are capable of running third-party applications that connect to the Internet. They include innovative interface elements — multi-touch screens that can interpret natural gestures, accelerometers that can detect the phone's position and movement, and voice recognition — and they are equipped with GPS devices, so the phones always know where they are. Applications can tap into a phone's location awareness to offer specialised services based on the user's position. Using the mobile's ability to access wifi networks, applications can sync with web-based tools and social networking systems.

Businesses, public agencies, and schools are beginning to explore multimobile services — convenient, flexible tools that enable users to access information in a range of formats using mobile devices — as a way to support customers, staff, and students. With multimobile services, a user can send a query using email, text messaging, a voice call, or a web interface, receiving responses in any of the same formats. The queries can access information, carry out commands (such as registering for classes or placing an order with a merchant), and proactively keep the user informed of changes in status (such as the user's position on a class waiting list, for instance). Multimobile services can be accessed anytime, anywhere, and from nearly any mobile device. One serious drawback, particularly in Australia, is the pricing structure of text messages; students and customers are unlikely to use a service that costs fifteen cents per request or reply.

A new class of mobile Internet devices generally referred to as netbooks — relatively inexpensive personal computers that run basic productivity software and access the Internet — are driven more by institutional recommendations and requirements than by personal choice, but are nonetheless making their way into the hands of students. Smartbooks, styled as smaller, less expensive netbooks, combine the convenience of a keyboard and basic computer functions with the power of mobile access. Where finding wifi coverage is a problem, portable personal network devices such as Novatel's MiFi create instant, multiuser wireless hotspots by tapping into the 3G cellular data network.

In general, access to the Internet outside school or work is still a key concern for many Australian

consumers; finding any kind of wireless Internet service is often difficult outside of urban centres. In many cases, while students may own mobile Internet devices, the high cost of broadband coverage prevents them from taking advantage of the full range of applications available to them. Although a government-sponsored effort is underway to improve Australia's broadband to make it faster and available in more locations, the work progresses slowly and many areas are still without access.

Relevance for Teaching, Learning, and Creative Enquiry

Mobile devices, phones especially, are commonly carried by students, which means many if not most of them bring these devices with them. Services that take advantage of built-in features like the GPS and the ability to access wifi networks increasingly allow students to manage their social and educational networks, take their learning materials with them wherever they go, and access just-in-time information when and where they need it. The variety of learning tools available for mobile Internet devices is broad and growing, encompassing everything from graphing calculators to astronomy applications. Mobile Internet devices work with technologies like cloud computing, location-based media, and open educational resources to deliver applications for communication, organisation, research, study, and fieldwork.

While the capacity to access the Internet is a key capability of these devices, their utility is not necessarily dependent on a persistent connection. Many applications for the popular iPhone and Android platforms work with or without Internet access. Some are self-contained and, once downloaded, can be used anytime; others can connect intermittently. Examples include study sets for the GMAT and other exams by Watermelon Express; *Google Sky Map* for Android platforms, which serves as a mobile planetarium; *History: Maps of the World*, containing full-colour, historical maps; *iSeismometer*, capable of measuring vibrations and tremors; and a variety of references, including the *Australian Oxford Dictionary* and the *Aussie Slang Dictionary*, featuring more than 700 common Australian phrases.

It is increasingly common for universities to provide admissions, registration, event, and other information for students via mobile Internet devices. Colleges publish sports and lecture event schedules, campus

news, maps, course listings, campus directories, and multimedia content. Teachers converse with students via text-messaging or Twitter, and post class notes, lectures, and syllabi in forms that can be read by mobiles. The mobile serves as an effective emergency alert tool; campus authorities can quickly and efficiently reach both resident and commuter students with news of school closings due to weather or security-related issues.

A sampling of applications of mobile Internet devices across disciplines includes the following:

- **Architectural and Ecological Design.** Lecturers from Unitec New Zealand issued mobile Internet devices, including smart phones and netbooks, to students in two courses who collaborated on the design of a sustainable home for the Sustainable Habitat Challenge. Students used the devices to communicate, capture and share data, and develop design ideas.
- **Medicine.** Researchers at Washington University in St. Louis have developed a mobile ultrasound application. Using a USB cable, a portable ultrasound scanner is connected to a mobile phone and the scanner's data is shown on the mobile display. The system is ideal for locations where a computer is impractical or where a portable ultrasound machine is prohibitively expensive; the scanner costs one-tenth as much as a portable machine.
- **Meteorology.** The *Weather Machine* application for the iPhone offers information from over 58,000 weather stations around the world, allowing the user to select which stations to monitor. The report is updated every half hour, enabling students to access real-time data.

Mobile Internet Devices in Practice

The following links provide examples of mobile Internet devices in educational settings.

iPhone to Replace Register at Japan University
<http://www.reuters.com/article/internetNews/idUSTRE54R1NE20090528>

(Chris Meyer, *Reuters*, 28 May 2009.) Faculty at Aoyama Gakuin University in Japan use college-issued iPhones to take attendance and diminish truancy. Students type an ID and class number into an iPhone app, which uses the device's GPS to verify their presence in class.

knfbReading Technology

<http://www.knfbreader.com>

The knfbReader Mobile is designed to help those with learning disabilities or visual impairment. The user snaps a picture of text using his or her mobile phone and the phone converts the text to speech.

MobilAP: The Mobile Academic Platform

<http://daap.uc.edu/mobilap>

Featured at the University of Cincinnati's College of Design, Architecture, Art, and Planning, MobilAP is a web-based platform with a mobile component that includes polls and quizzes, discussions, scheduling, and link sharing features.

Mobile Phones Increase Campus Security

<http://campustechnology.com/articles/2009/06/12/napa-valley-colleges-lockdown-a-lesson-in-hyper-information.aspx>

Campus security at Napa Valley College used mobile technology to quickly alert students and faculty of a campus lockdown. A survey of students, staff, and faculty indicated that an alert system based on mobiles would be the fastest and most reliable way to reach the community.

MobilEdu

<http://www.medu.com>

MobilEdu provides a suite of tools for mobile devices that are designed specifically for colleges and universities. Applications include maps, directories, financial management tools, course information, athletic scores and schedules, and more.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about mobile Internet devices.

Mobile Learning: An Online Reflective Journal on Mobile Learning Practice

<http://mlearning.edublogs.org>

(Leonard Low, *Mobile Learning*.) This award-winning blog, written by an e-learning designer from the University of Canberra, contains frequent posts on mobile learning technology, as well as relevant publications for further reading.

New Technologies, New Pedagogies: Mobile Learning in Higher Education

<http://ro.uow.edu.au/edupapers/91>

(J. Herrington et. al, University of Wollongong, April 2009.) This faculty-authored e-book explores the use of mobile devices in education and includes a number of examples.

Qualcomm, Freescale Say 'Smartbooks' to Rival Netbooks

http://news.cnet.com/8301-13924_3-10251841-64.html

(Brooke Crothers, *cnet*, 29 May 2009.) This article describes a new breed of laptops called smartbooks. Lighter, cheaper, and more connected than notebooks, smartbooks are the computer versions of smartphones.

The Revolution No One Noticed: Mobile Phones and Multimobile Services in Higher Education

<http://www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolume163866>

The Revolution No One Noticed Mobil/163866

(Alan Livingston, *Educause Quarterly*, Volume 32, Number 1, 2009.) The author lists characteristics of mobile devices and how they can be used in higher education, particularly to provide administrative multimobile services.

Wi-Fi to Go, No Café Needed

http://www.nytimes.com/2009/05/07/technology/personaltech/07pogue.html?_r=3&partner=rss&emc=rss&pagewanted=all

(David Pogue, *The New York Times*, 6 May 2009.) The MiFi is a tiny portable wireless router that delivers wifi to multiple users on any wifi-capable device in a small radius, including an office, a car, an airport terminal, or wherever one happens to be.

Delicious: Mobile Internet Devices

<http://delicious.com/tag/hz09au+mobile>

(*Australia-New Zealand Horizon Advisory Board and Friends*, 2009). Follow this link to find additional resources tagged for this topic and this edition of the *Horizon Report*. To add to this list, simply tag resources with "hz09au" and "mobile" when you save them to *Delicious*.

PRIVATE CLOUDS

Time-to-Adoption Horizon: One Year or Less

Cloud computing refers to storage and processing that occurs in a networked environment rather than relying on the limits of a personal computer. In the cloud, storage and processing resources are allocated “on the fly” among consumers based on their specific needs. The result is shared content that is less expensive to store, easier to manage and access, and often more true to the dynamic nature of knowledge that emerges from university settings. The cloud has been of tremendous interest to Australia and New Zealand for some time, but concerns over the legal jurisdiction and continued availability of data stored on offshore servers is leading to the development of private, Australian clouds that offer the same benefits.

Overview

Cloud computing is the practice of using networked computers to distribute storage, processing power, applications, and large systems among many machines. To the end user, the cloud is invisible; it is simply the back-end platform that supports everyday applications, both web-based and desktop. Resources and storage in the cloud are allocated as needed in response to the level of demand at any given time, allowing applications to scale dynamically to support user loads of different sizes. Cloud-based applications appeared in the 2008 report on the near horizon, and indeed, many of the applications highlighted in that report have been integrated into educational practice already. However, as experience with the technology has grown, it has become clear that cloud computing poses unique challenges for audiences in Australia and New Zealand. The solution to the most vexing of these challenges is increasingly seen as combining the resources of educational institutions into cloud clusters, known informally as “private clouds.”

A key factor in the mix is that, irrespective of how the cloud is configured or where it is located, there are a number of clearly positive capacities inherent in cloud computing. Cloud-based applications are always up to date and there are no demands placed on local support staff to make that happen. The same is true when project and other shared sorts of documents are stored in the cloud; a number of cloud-based applications allow workgroups to collaborate in ways that automatically track changes and present the latest versions to users.

Cloud computing is also valued for the elasticity of resources it affords. Institutions and commercial entities that use the cloud to support complex computing demands, storage, and media streaming need not worry about over- or under-provisioning for necessary services, since the available resources

expand and contract in real time in response to load and demand.

These benefits are naturally very attractive, but in Australia and New Zealand, they are tempered by concerns related to the physical location of cloud resources. Nearly all of the large data farms available for cloud-based applications are currently located in North America, Asia, or Europe, which poses problems for Australians concerned with the sovereignty of their information. Questions about who has legal control of data stored on computers in another country are not easily answered, making it a challenge to use the cloud to store or work with confidential, sensitive, or private information such as student records, health histories, financial data, and so on.

To address the issues around using existing clouds, Australian companies — and international companies that do significant business in Australia — are beginning to establish private clouds located within the country to house their customers’ data. For example, Blackboard, an American company, has established an Australian data centre to serve its customers there. Local providers like Infoplex (<http://www.infoplex.com.au>) offer secure, private cloud services to their clients using servers that are physically located within Australia. Enterprise software solutions such as Microsoft’s web-based Office 2010 can now be set up and configured to run in private cloud environments, combining the flexibility of cloud-based productivity tools with the security of a privately-controlled cluster.

Companies like Cisco Systems are encouraging the Australian and New Zealand governments and major educational organisations to establish private clouds within and among institutions, and to experiment with notions like hybrid clouds, which would use local clouds for processes and data that have

needs tied to physical location, and external clouds for processes where there is less concern around data sovereignty. Advances in the ways networks are locally configured are making such approaches easier all the time; the creation of local cloud clusters, for example, has been spurred by advances in how they are configured and administered. Support for private clouds is on the very near term horizon, via open source cloud platforms such as Eucalyptus or OpenNebula.

Relevance for Teaching, Learning, and Creative Enquiry

Cloud computing in all its forms offers wide ranging benefits for education in the form of software and hardware management, data-driven research, and flexibility of resources. Private clouds offer the promise of truly personalised computing environments, complete with all the tools and resources one needs, accessible via the Internet on a wide range of devices located anywhere.

Access to scalable computing resources on demand means institutions will have a much wider range of choices regarding how they balance the cost of provisioning their networks with the research needs of their departments. University data centres, in particular, are uniquely poised to maximise their resources by creating local clouds on their own networks. For institutions that do not have a large computing infrastructure, the cloud allows researchers to easily and relatively inexpensively scale their computing needs up or down as the demands of their work require. In the not-so-recent past, neither of these scenarios was really possible. Such benefits apply across the range of cloud configurations under discussion.

The move toward private clouds physically located in Australia and New Zealand — and particularly in educational institutions there — is seen as a critical component of a larger effort to establish a national network of research data. Also called the national data fabric, this network would be supported by a series of Australian cloud clusters. Organisations such as the Australian National Data Service (ANDS) are being established to promote and realise the vision of an Australia-wide research data network. Such a data fabric promises secure and locally administered access for Australian scholars and researchers pursuing enquiries in virtually every discipline, and is a major driver of interest in private clouds.

A sampling of applications of cloud computing and private clouds across disciplines includes the following:

- **Biotechnology.** The Medical College of Wisconsin Biotechnology and Bioengineering Centre in Milwaukee produced a set of free tools called ViPDAC (Virtual Proteomics Data Analysis Cluster) to be used with Amazon's cloud computing service to determine the elemental composition as well as chemical structure of a molecule.
- **Computer Science.** Students at the University of California, Berkeley, use cloud computing resources to perform load testing measurements as they learn how to design datacenter-scale applications. Each pair of students is able to access 8-10 virtual servers to make their own observations — nearly 200 servers are used per class. Once the lab is over, the servers are released.
- **Professional Development.** A trial project at Continuing Education Bendigo in Victoria, Australia known as RSSing Organisational Capacity aims to use RSS to collate information and coursework about learners so that teachers and trainers can quickly assess prior learning and current needs. The project is supported by the Australian Flexible Learning Framework.

Private Clouds in Practice

The following links provide examples of cloud computing and private clouds in educational settings.

8 Ways Cloud Computing May Change Schools <http://blog.core-ed.net/derek/2009/06/8-ways-cloud-computing-may-change-schools.html>

(Derek Wenmoth, *Derek's Blog*, 8 June 2009.) Working in the cloud offers benefits to higher education. For example, students, staff, and the institution need no longer be concerned with outdated software. Using cloud computing eliminates the need to update software, or purchase a new program to sync home and school.

AWS in Education Customer Experiences

<http://aws.amazon.com/education/customer-experiences/#6>

Amazon Web Services (AWS) provides grant money to higher education institutions to allow technological advancement to take place. This link provides examples of how grant money has been used in the past, from universities such as Stanford, Oxford, and Carnegie Mellon.

Cloud Riders to be the Envy of Web Surfers

<http://www.swinburne.edu.au/magazine/6/115/cloud-riders-to-be-the-envy-of-web-surfers/>

(Richard Constantine, *Swinburne Magazine*, June 2009.) At the University of Swinburne, cloud computing may solve the issue of student mobility, allowing participation of offshore students and researchers.

Megha: Melbourne Cloud Computing Initiative

<http://www.gridbus.org>

University of Melbourne addresses the issue of underdeveloped cloud computing skills among recent graduates by sponsoring research on the design and development of different cloud platforms for a range of applications.

Technology Enabled Learning and Teaching

<http://telt.unsw.wikispaces.net>

The University of New South Wales is currently implementing a new approach to e-learning, labelled Technology Enabled Learning and Teaching (TELT). This platform encompasses a suite of technologies, including cloud computing, to address the diverse needs of students and staff.

Uni of Melb Cloud to Water Farms

http://www.zdnet.com.au/news/software/soa/Uni-of-Melb-cloud-to-water-farms/0,130061733,339296510,00.htm?feed=pt_cloud_computing

(Chris Duckett, *ZDnet.com.au*, 19 May 2009.) Using cloud computing as part of the irrigation system at an experimental farm increased production by 300 percent. The cloud program, IBM's System S, combines thousands of data streams which allow the farmer to predict variables — like the weather, or supply and demand — months into the future.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about cloud computing and private clouds.

7 Things you Should Know about Cloud Computing

<http://www.educause.edu/node/176856>

(ELI, EDUCAUSE, August 2009.) This article explains cloud computing and its relevance to educational practice.

Be Careful when you Come to put your Trust in the Clouds

<http://www.guardian.co.uk/technology/2009/jun/04/bruce-schneier-cloud-computing>

(Bruce Schneier, *The Guardian*, 4 June 2009.) This article provides a description of potential security and reliability issues that could face users of cloud computing and storage once they give up control of their data.

Cloud Computing Special Part 1: Looking for the Silver Lining

http://www.cio.com.au/article/309984/cloud_computing_special_part_1_looking_silver_lining

(Brad Howarth, *CIO*, 06 July 2009.) Australian companies are becoming increasingly more interested in cloud computing. This article discusses many aspects of cloud computing as it relates to Australian industry.

Cloud Computing's Top Issues for Higher Education

<http://www.universitybusiness.com/viewarticle.aspx?articleid=1342>

(John L. Nicholson, *University Business*, June 2009.) The author describes the different forms cloud computing takes, from storage to computing applications, as well as issues that face would-be cloud computing adopters.

Cloud Computing: What are Private Clouds?

<http://web2.sys-con.com/node/663501>

(Jian Zhen, *web2journal.com*, 9 September 2008.) When considering how to incorporate cloud computing into a university's IT program, should you choose a private or public cloud? This article explains private cloud computing.

Defining Private Clouds, Part One

http://www.cio.com.au/article/304190/defining_private_clouds_part_one?rid=-154

(Bernard Golden, *CIO*, 22 May 2009.) This article, first in a series of four on private clouds, describes private clouds and illustrates some of the considerations that should be taken into account when establishing one.

Harnessing Cloud Computing for Data-intensive Research on Oceans, Galaxies

<http://uwnews.org/article.asp?articleid=48747>

(Hannah Hickey, *University of Washington News*, 14 April 2009.) This press release describes three projects that integrate cloud computing with university meteorological and astronomical research and a grant that provides curriculum and training.

Delicious: Private Clouds

<http://delicious.com/tag/hz09au+cloudcomputing>

(*Australia–New Zealand Horizon Advisory Board and Friends*, 2009.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report*, including the ones listed here. To add to this list, simply tag resources with “hz09au” and “cloudcomputing” when you save them to *Delicious*.

OPEN CONTENT

Time-to-Adoption Horizon: Two to Three Years

The rising costs of education and the chronic shortage of time felt by most teachers are beginning to open the door to a broader acceptance of open content. Open content for education includes any freely available course materials — everything from worksheets to lectures to study aids to entire courses — offered online for teachers or learners to access, download, use, and in many cases, modify. There is a growing trend of community support around open content that is creating interesting opportunities for learning both inside and outside traditional environments; peer teaching, volunteer tutors, and community forums add a richness to the available materials that contributes to the formation of communities of learners from across the globe.

Overview

Open content is a name used to describe a wide range of materials for teaching and learning; the unifying feature is that these materials are licensed in such a way that they may be freely used in support of educational activities. These materials include specific learning content (e.g., textbooks, chapters, lectures and lecture notes, slides, online tutorials, videos, etc.), the scaffolding needed to support such content (teacher and student guides, research questions, source material, syllabi, and so on), teacher training materials, tools for managing learning that range from the complex (content management systems) to the simple (grade books), and many other sorts of materials and resources.

From quite specific materials on a particular concept or topic to full lectures, discussions, and even entire courses, the notion of open content includes materials of any size and depth. A commonly cited benefit of using open content is that it can reduce the growing costs of education by allowing educators to develop, select, distribute, and reuse materials quickly and easily, with less dependence on traditional publishers. Traditional content is envisioned as a commodity of sorts, well-established in the marketplace of ideas. As such, it does not need to be reinvented and should be broadly available via the Internet. The idea is that by using these already prepared materials, educators can then focus on pedagogy, context, and teaching. A key feature of open content is that it is meant to be easy to update as the body of knowledge in a given field advances; changes are entered by the community and are immediately available, analogous to the way Wikipedia is kept current.

Paralleling the growing interest in open content itself, there is also an increased emphasis on supporting the activities that surround the use of open content. Community and collaboration are

seen as key components that enhance collections of open resources for education. The most robust and successful open educational offerings also incorporate support for the community of teachers and learners who make use of the content, such as profile directories, discussion support, peer mentoring, or other means of connecting people with one another.

The increased interest in open content reflects a changing perception of what constitutes a learning environment, and the kinds of experiences and supporting materials that are present in such an environment. As the demand for personalised learning experiences grows, educators are increasingly turning to open content to find ways of engaging their students that extend or even replace traditional course materials. Fuelling interest is the widely held perception that open content resources are more cost effective than textbooks or packaged online courses.

Broad use of open content is seen as two to three years away, partly because there is not yet a sufficient critical mass of content creators to tip the balance toward mainstream use. Further, where content is available, it is not always easy to find; open content does not currently include well-defined features that would enhance findability, so locating resources is often rather hit or miss. The growing social networks are seen as a potential way to fill this gap by creating a sort of virtual word of mouth around good materials.

Credibility and quality are concerns that potential users have around open content. Producers of open content are often worried about how making resources modifiable will impact their own reputations and what might be done with their intellectual property. A related concern is how to honour copyrights of others and how to ensure an

investment of good scholarship will persist once the materials have become “open.”

Relevance for Teaching, Learning, and Creative Enquiry

In a time when teachers and educators are increasingly attuned to student engagement, many see open content as a way to share learning materials in forms other than text. A great deal of rich media content, for example, is available in audio or video form through iTunes U, YouTube, and other media sharing sites. Increasingly, institutions are creating special content expressly to be shared on such sites.

Open content offers the additional promise of reaching people that are not formally enrolled in a program of study — independent, informal, just-in-time, and life-long learners, for example — and these learners often congregate around sites that include social networking components like the ability to comment or annotate materials, or add responses. Educational communities organised around open content offer great potential to connect these individuals learning with and supporting each other. Groups such as the Open CourseWare Consortium (<http://www.ocwconsortium.org>) expressly support the community aspect of open content and model effective practices.

Despite the potential drawbacks, a growing number of institutions are encouraging departments to make course content openly available online, with an eye to reducing repeated effort and to potentially reducing costs for students. Sharable materials offer the promise of reducing teacher workloads, as they do not need to be recreated from scratch for every use. When such materials are properly licensed, faculty are free to create custom teaching packages without the challenges that accompany the creation or use of traditionally published materials.

A clear and positive response to concerns over intellectual property and copyrights are the flexible licensing options, such as those offered by Creative Commons (<http://www.creativecommons.org>), that content creators employ to indicate how their resources can be used. By specifying certain options — such as requiring attribution or requiring that any derivative works be distributed under the same kind of license as the original — creators can maintain ties to their work while still allowing it to be shared and adopted freely.

A sampling of applications of open content across disciplines includes the following:

- **Chemistry.** OpenChemistry is a United Kingdom-based online collection of chemistry resources, all of which are licensed under a Creative Commons attribution license. Materials may be freely used and modified.
- **Education.** At Brigham Young University, students in Professor David Wiley’s *Introduction to Open Education* course learn about open education while practising problem-based learning methods in a semester-long role-playing game where their own actions shape the class itself.
- **Physics.** Senior lecturer Dr. Adam Micolich at the University of New South Wales not only uses clips from YouTube to show rare demonstrations — such as super fluid helium — to his students, he also records and posts his own video tutorials on physics topics.

Open Content in Practice

The following links provide examples of open content in educational settings.

Connectivism and Connective Knowledge

<http://ltc.umanitoba.ca/connectivism>

George Siemens and Stephen Downes run a yearly Massive Open Online Course (MOOC) which is open to anyone in the world; over 2000 people participated in 2008.

Flat World Knowledge

<http://www.flatworldknowledge.com>

Flat World Knowledge offers free online textbooks that teachers can modify for their own courses. Students can access the texts online or order inexpensive print copies. The community can contribute to textbooks or discuss the content.

OER Commons

<http://www.oercommons.org>

OER Commons is a clearinghouse of open educational resources. Each resource is clearly described, indicating its source and the licensing requirements for use (if any).

Open Research Online

<http://oro.open.ac.uk/>

Open Research Online houses research publications from faculty and staff at the Open University, a UK institution dedicated to distance learning. The repository is freely available to the public.

Otago Polytechnic

http://wiki.creativecommons.org/Otago_Polytechnic

Otago Polytechnic in Dunedin, New Zealand shifted their model for the use of educational resources from traditional views of ownership and intellectual property to one in which materials are shared under a Creative Commons Attribution license.

Wiki Educator

<http://wikieducator.org>

Wiki Educator aims to provide open educational resources for teachers around the world, covering all areas of the curriculum.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about open content.

Is Wikipedia Becoming a Respectable Academic Source?

<http://digitalscholarship.wordpress.com/2008/09/01/is-wikipedia-becoming-a-respectable-academic-source/>

(Lisa Spiro, *Digital Scholarship in the Humanities*, 1 September 2008.) Once considered not intellectually rigorous enough for citation in scholarly publications, Wikipedia's open nature often results in articles undergoing more professional scrutiny than some academic journals.

Mobile Devices and the Future of Free Education 2009

http://www.ou.nl/Docs/Campagnes/ICDE2009/Papers/Final_paper_252mcgreal.pdf

(Rory McGreal, Athabasca University, 2009.) This paper describes M-learning, or the delivery of open educational content via mobile devices, and suggests its potential for providing free, universal access to education.

Open Education News

<http://openeducationnews.org/>

(Gurell, et al.) Open Education News is a blog devoted to reporting current events and news related to open education and resource sharing around the world.

Science in the Open

<http://blog.openwetware.org/scienceintheopen/>

(Cameron Neylon.) This blog discusses the academic and social issues around open science — the practice of publishing scientific research openly and freely, while it is happening.

Uni Computer Lecturer Makes YouTube his Classroom

<http://www.theage.com.au/news/home/technology/youtube-his-classroom/2009/03/04/1235842462189.html>

(Asher Moses, *The Age*, 4 March 2009.) At the University of New South Wales, senior lecturer Richard Buckland offers his course free of charge to high school students. The students watch the lectures on YouTube and attend a tutorial once a week.

Universities Opt for iTunes

<http://www.universityworldnews.com/article.php?story=20080605161223823>

(*University World News*, 8 June 2008.) This article describes how a number of universities in Australia and New Zealand are offering free, online lectures to distant students through iTunes U.

Delicious: Open Content

<http://delicious.com/tag/hz09au+opened>

(*Australia–New Zealand Horizon Advisory Board and Friends*, 2009.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report*, including the ones listed here. To add to this list, simply tag resources with “hz09au” and “opened” when you save them to *Delicious*.

VIRTUAL, AUGMENTED, AND ALTERNATE REALITIES

Time-to-Adoption Horizon: Two to Three Years

More and more, educational institutions are seeking ways to embed rich, immersive experiences as part of teaching and learning. One approach — virtual worlds — appeared on the near term horizon last year, and many effective applications for learning in such environments have emerged. Virtual worlds are a subset of the larger category of immersive experiences described here and can be characterised as representing one end of a continuum of activities that blend the virtual and the real in varying proportions. Institutions are beginning to experiment with activities all along that continuum and are overlaying technology onto the real world via augmented reality, alternate reality, and other approaches. Each of these combines aspects of the virtual and the real to create rich experiences that surpass either mode alone.

Overview

As thinking around how humans interact with machines has evolved, it has become clear that there are many ways to create technology-mediated immersive experiences. This category, Virtual, Augmented, and Alternate Realities, views these three approaches (traditionally often thought of as very different from one another) as related in their use of technology to create a hybrid experience that is both engaging and immersive. Each uses technology to immerse the participant in a sea of data not normally available via the five senses of our ordinary lives.

These heightened experiences can be viewed as lying along a continuum, with highly virtual experiences at one end and highly physical experiences at the other. Activities that take place in Second Life, Blue Mars, OpenSim, and other virtual worlds fall nearer the virtual end, as do more contextualised immersive experiences such as the use of flight simulators. On the other side, the pendulum swings toward real-life activities modulated by virtual aspects, such as alternate reality games. Toward the middle we find augmented reality and physical activities enhanced with handheld and other devices. Each of these practices is grounded in different approaches and makes use of different technologies, but they all share the characteristic of blurring the boundaries between the virtual and the real.

Virtual reality is the practice of inserting a user into a simulated environment via an avatar which has movement and sensory features much as a human would. Augmented reality, on the other hand, is the practice of overlaying virtual information onto the real world. The technology has been in use in disciplines such as medicine, engineering, the sciences, and archaeology for some time. Until very

recently, specialised equipment was required, but smaller, cheaper means of creating and perceiving augmented reality are now emerging. For example, there are astronomy applications for mobiles that overlay accurate star charts onto the sky; the user simply holds up the phone, looking at the sky on the screen through the mobile's camera. Stars, constellations, and other bodies are identified by labels overlaid on the screen. The same technology is used to annotate buildings on a street, labelling storefronts and restaurants with reviews and user ratings. The ability to describe real objects with virtual annotations is a powerful tool, and we are now seeing new advances that suggest that more common use is not far away.

Across the spectrum from virtual worlds we find alternate reality games. These are collaborative problem-solving activities that typically take days, weeks, or even months to solve. Clues are hidden in the physical world that lead players to information in different locations — on the web, on a phone message, or even to another physical clue. The clues are blended with real objects so that it is often difficult to notice them for those who are not attuned to the game; for instance, a clue might be found in a message on a billboard, or in a quick response (QR) code stapled to a telephone pole, or on a sign in a shop window. Some alternate reality games can be played with tools as simple as pencil, paper, and occasional Internet access, though mobiles are often used to record or access clues. The experience is immersive in the sense that the world of the game is the same world the players inhabit all the time.

Relevance for Teaching, Learning, and Creative Inquiry

The kinds of experiences enabled by these hybrid realities are engaging by nature. Wherever they are located on the spectrum from virtual to physical, immersive activities draw students deeper into the content and processes as they learn. Once the mechanics of the activity are mastered — moving and communicating in a virtual world, or finding and following clues in an alternate reality game — the activity itself becomes the main focus. There is a tremendous opportunity to make the content come alive for the learner.

Virtual and alternate realities also allow students to have experiences they could not otherwise have. In virtual worlds, medical students can diagnose and treat simulated patients, prescribe drugs and observe their effects, and use complicated or expensive equipment, without the risks of failure inherent in the real world. Students can tour dangerous or inaccessible facilities and observe natural phenomena from impossible viewpoints, such as experiencing a tsunami from the ocean floor. Augmented reality can make hidden things visible; pedestrians on the street can see subway tunnels below them, athletes can watch the inner workings of muscles and tendons overlaid on an arm or leg, and the structural elements of a building can be revealed to architecture students during a tour.

Alternate reality games are an ideal platform for challenge-based learning opportunities in which students must work together to address a real problem or issue facing their community or the larger world. For instance, in *World Without Oil* (<http://worldwithoutoil.org>), an alternate reality game about the first 32 weeks of a global oil crisis, players created stories about how the crisis affected their lives and what they saw happening around them as the world's oil supply collapsed. *World Without Oil* ran for one month in 2007. As a result of participating in the game, players report that they lowered their utility bills, changed their consumption habits, and encouraged their communities to take steps to do the same. A similar example is *Superstruct* (<http://www.superstructgame.org>), in which players collaboratively reinvented the world by describing what it will be like in 2019.

A sampling of applications of virtual, augmented, and alternate realities across disciplines includes the following:

- **Dentistry.** Faculty and students at the Medical College of Georgia School for Dentistry collaborated with game developers at BreakAway, Ltd. to design the Virtual Dental Implant Training Simulation, a program that allows students to work with and treat simulated patients. Students conduct interviews, choose a procedure, select the tools to carry it out, and perform it on their simulated patients.
- **History.** At the University of Leicester, advanced students of history participate in an alternate reality game to engage the students with historical research and teach them key skills. The *Great History Conundrum* was developed to replace a first-year research skills course that the students were previously required to take.
- **Media Studies.** The Laboratory of Advanced Media Production (LAMP) at the Australian Film Television and Radio School offers graduate certificates in multiplatform game development, virtual worlds development, and more.

Virtual, Augmented, and Alternate Realities in Practice

The following links provide examples of educational applications of alternative input devices.

The Island of Jokaydia

<http://jokaydia.com>

The island of Jokaydia, located in Second Life, is an exploration of the uses of virtual worlds in education, arts, and social change. A vibrant community of artists and educators occupy this virtual island; they support a number of educational endeavours, such as professional development, formal and informal meetings, and instruction for newcomers to Second Life.

A Lesson in Architecture

<http://slenz.wordpress.com/2009/04/02/the-slenz-update-no-63-april-2-2009>

Third-year architecture students from the University of Auckland had the opportunity to design and build in Second Life. Their work was critiqued by others, including members of the community and practising architects.

Hoodlum

<http://www.hoodlum.com.au>

Hoodlum is a company that creates cross media experiences for businesses. The immersive expe-

periences encourage audiences to move between media forms to participate in a storytelling event.

Second Life New Zealand

<http://slenz.wordpress.com>

Second Life Education New Zealand (SLENZ), New Zealand's virtual world education group, has created a virtual research centre in Second Life to study effective uses of multi-user virtual environments.

Stock Track: Global Portfolio Simulations

<http://www.stocktrak.com>

People interested in economics can explore market simulation games, which allow users to purchase stocks with simulated money. Painless lessons of risk-reward are explored in this game. Also see the article *Market Simulation Games Promote Education, Fun, Sense of Community* at http://www.stocktrak.com/pdf/NationalPost_Oct09_2008.pdf.

Virtual Worlds – Real Learning!

<http://virtualworlds.flexiblelearning.net.au/content/homepage.htm>

This Australian-based website offers information about the benefits of virtual worlds in education. The project was designed to capitalise on the willingness of students to engage in virtual worlds by using a range of pedagogical activities to move learners from playing to an enhanced learning experience.

Zombie Truth: Preparing for the Z1 Pandemic

<http://zombietruth.com>

This alternate reality game is based on the spread of a virus that turns humans into zombies. Players sift through clues to uncover research into the virus, trace its spread, and discover ways to combat it.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about virtual, augmented, and alternate realities.

7 Things You Should Know about Alternate Reality Games

<http://www.educause.edu/ELI/7ThingsYouShouldKnowAboutAlter/163614>

(ELI, EDUCAUSE, January 2009.) This succinct report describes alternate reality games and identifies their educational uses, drawbacks, and potential for development.

Alternate Reality Games for Developing Student Autonomy and Peer Learning

<http://lick2008.wikispaces.com/file/view/Strand+1+-+Nicola+Whitton+-+V1+Paper.pdf>

(Nicola Whitton, Manchester Metropolitan University, 2008.) The educational uses of alternate reality games (ARGs) are discussed in this paper, including an introduction to the topic and a review of the benefits of using ARGs in the classroom.

Journal of Virtual Worlds Research: Pedagogy, Education and Innovation in Virtual Worlds

<http://www.jvwresearch.org>

(Jeremiah Spence, editor, *Journal of Virtual Worlds Research*.) The *Journal of Virtual Worlds Research* includes many articles regarding education and virtual worlds, spanning topics from physics to media studies.

The Open Polytechnic Explores Augmented Reality Distance Education

http://www.hitlabnz.org/wiki/The_Open_Polytechnic_explores_Augmented_Reality_Distance_Education

A collaborative project of HITLabNZ and the Open Polytechnic of New Zealand seeks to utilise Hitlab's augmented reality software, BuildAR, in the Polytechnic's engineering classes.

Papermotion Experience lets Readers see Interactive

<http://www.news.com.au/dailytelegraph/story/0,22049,25458440-5001021,00.html>

(Stephen Fenech, *The Daily Telegraph*, 11 May 2009.) Learn how an Australian newspaper incorporated augmented reality into a daily edition.

Sci-Fi Learning: The Power of POV

http://kt.flexiblelearning.net.au/tkt2009/?page_id=19

(Leigh Blackall, Simon Brown, and Vicki Marchant, *The Knowledge Tree: Edition 18, 2009*.) This article describes point-of-view or wearable technologies and some of their applications for teaching and learning.

Virtual Experience of Risk-Based Learning (VERBL)

http://verbl.flexiblelearning.net.au/Immersive_elearning/pdfs_for_release/2_VERBL_model_overview.pdf

(Delia Bradshaw, et al., Commonwealth of Australia, 2008.) This paper describes ways to use immersive environments to safely train students or employees who will undertake risk-based behaviour (for example, responding to individuals under the influence of alcohol or drugs).

Delicious: Virtual, Augmented, and Alternate Realities

http://delicious.com/tag/hz09au+virtual_reality
(Australia–New Zealand Horizon Advisory Board and Friends, 2009.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report*, including the ones listed here. To add to this list, simply tag resources with “hz09au” and “virtual_reality” when you save them to *Delicious*.

LOCATION-BASED LEARNING

Time-to-Adoption Horizon: Four to Five Years

Location-based learning is rapidly becoming one of the most pervasive uses of mobile devices. While early experiments with location-based media have focused on marketing and advertising, we are starting to see educational applications emerge. Location-based learning takes advantage of the ability of mobile devices to know where they are located and deliver information that is time- and place-relevant. There is a considerable amount of work that must be done in this area before it becomes mainstream for teaching and learning, but the potential advantages are great: from basic uses such as guided historical tours to more complex applications for mapping, fieldwork, and immersive activities, location-based learning holds promise for just-in-time learning tied to a student's physical location.

Overview

The rise of mobile Internet devices equipped with geolocation capability is opening the door to a host of applications that take advantage of the user's physical location. Contextual data about the place one finds oneself, from historical, photographic, or videographic information to the location of points of interest or nearby friends, is easy to acquire using tools that run on mobiles and other small, location-aware devices. The information can be conveyed to the user in a number of ways: as audio, images, video, or text; overlaid on maps or on photographs of the location; or superimposed on a live view of the area. Location-based information is very easy to access using common mobile devices, and it is becoming easier to create and distribute, as well.

The technologies that support location-based learning — geolocation, data visualisation, mobile devices, wireless internet — are already established, and a multitude of social and consumer applications already exist. Using simple online tools, digital resources can be easily connected with physical locations and objects. Creating a virtual walking tour that can be accessed via mobiles is already trivial, and more sophisticated applications are appearing day by day.

Using Mscape, users can create mediascapes (<http://www.mscape.com/what-is-a-mediascape>) of places they visit, including annotated material in a variety of media. Other viewers access the mediascape when they visit the same location, following the original user's walking tour and sharing his or her perspective. TransFormat's TransGo system (<http://www.location-based-media.de>) is designed for developers rather than end-users, but it too enables rapid development of location-based applications using GPS, RFID, network triangulation, and other technologies.

Social uses of location-based media are common. Initial applications took the form of services for locating trusted friends and colleagues, or listing where people in your network were at a given time. Now, however, location-based applications are being used to facilitate serendipitous connections between people with common interests who do not yet know one another. Applications like Loopt (<http://www.loopt.com>) and Brightkite (<http://brightkite.com>) show nearby friends, places of interest, and people who might be worth meeting, based on the user's physical location and activities. Yelp (<http://www.yelp.com>) allows mobile users in the United States to search for nearby restaurants and businesses and displays community reviews to assist in making a decision about which to visit. Woices (<http://woices.com>) offers an interesting twist on the walking-tour concept; users capture ambient sounds at different points along their path, creating a "listening walk" that conveys the audible flavour of a particular spot.

We are starting to see uses for location-based media that hint at its developing potential for education. The collaborative project Red Centre Way Memes (<http://redcentreway.blogspot.com>) seeks to create a location-based tourist guide to inform visitors about the points of interest along the 430 km Red Centre Way loop in Central Australia. Podcasts, songs, video clips, images, text, and animations, are provided at points of interest, along with maps of the area. At the same time, the project is geotagging data captured in the field for the purpose of providing it to government agencies and others who can use the information to populate maps, track changes over time, and so on. Educational games — including alternate reality games, scavenger hunts, and others — also make use of location-based media to engage and assist players as they move through the physical world.

Relevance for Teaching, Learning, and Creative Inquiry

As an educational tool, location-based learning offers the promise of just-in-time content delivery, giving students access to data that is clearly tied with what they are seeing and experiencing at the moment. Since the technologies that facilitate location-based learning support both access and production of information, learners have a key opportunity to create content as well as receive it. Students can make notes of their perceptions, document objects or wildlife, record local sounds, and develop their own location-based projects to share with others.

Many institutions are already using location-based media to provide incoming and prospective students with campus tours and introductions to the library, museum, and other campus features. Students simply use mobile phones to access information linked to their precise location on campus. Students can also access bus schedules, special event guides, and other features based on their location.

Students doing fieldwork can acquire information in a variety of media about the site they are visiting, reinforcing the connection between the physical world and historical, cultural, or environmental events. Using tools like WikiMe (<http://www.whatsoniphone.com/reviews/wikime-review>), an application for the iPhone that accesses relevant Wikipedia articles for a specific location using the GPS in a mobile device, students can find information about their physical location or research other places using postal codes.

Other applications for location-based learning make use of the GPS data itself, rather than using the mobile's location to find related media. A schoolteacher in Cedar City, Utah uses location-based learning to teach math concepts. His students use GPS-enabled mobile devices to calculate area and perimeter, slope, and more in outdoor locations. In Victoria, British Columbia, a naturalist leads whale-watching tours and uses mobiles to record sightings, tracking the animals over time. These location-based learning experiences represent some of the initial applications. As the technology continues to develop, we will see more complex uses emerge.

A sampling of applications of location-based learning across disciplines includes the following:

- **Archaeology.** In the field, students can photograph sites as they work, creating a composite photographic map of an area with geotagged data. Future visitors can use the information to see exactly where objects were found. With Flickr's mobile site, iPhone and Android users can also see other photos taken near their current location.
- **Environmental Studies.** Location-aware devices can track and map levels of carbon monoxide in city streets. Additionally, students in the field can record the location of heavy areas of litter or pollution and the quality of local bodies of water. With tools like Widenoise for the iPhone, students can measure noise levels and send the data to maps, creating a picture of noise pollution.
- **Medicine.** Researchers at the University of Wisconsin are distributing location-aware asthma inhalers that track where and when patients use them through a secure, online mapping system. It is hoped this information will enable patients and physicians to better manage the disease and advance research on what triggers asthma attacks.

Location-Based Learning in Practice

The following links provide examples of location-based learning in educational settings.

Compass and Camera Used in Innovative Location-Based Apps for G1

<http://www.wired.com/gadgetlab/2009/02/compass-and-cam>

(Jose Feroso, *Wired*, 11 February 2009.)

This article describes two location-aware applications that overlay information about locations, events, and points of interest onto the image seen through the phone's camera.

Enkin for Android

<http://www.enkin.net>

Enkin combines GPS, orientation sensors, 3D graphics, live video, and web services into a navigation system for mobile devices that bridges the gap between reality and traditional maps. Annotations are overlaid on a live view, street view or 3D map.

Glympse

<http://www.glympse.com>

Glympse is an application that allows a user to specify a brief time during which his or her location is trackable to certain contacts. Glympse can be used as a safety feature while attending parties or one-time meetings, or it can help colleagues who are meeting face-to-face for the first time.

Layar

<http://layar.eu>

Take a picture of your street to find clubs, restaurants, theatres, and more. Layar displays geo-specific, digital information over the image from your mobile's camera.

Location-aware System Projects

<http://www.locationaware.usf.edu/research.htm>

Researchers at the University of South Florida are investigating the uses of location-aware technology for public emergency alert systems, assistive applications for disabled persons using public transit, and research into commuter traffic patterns.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about location-based learning.

7 Things You Should Know About Location-Aware Applications

<http://www.educause.edu/ELI/7ThingsYouShouldKnowAboutLocat/163839>

(ELI, EDUCAUSE, 16 March 2009.) A thorough primer, this article outlines and explains the many facets of location-based media. Specific examples of location-aware applications in higher education are discussed.

Coming Soon: A New Web — It's Global, Mobile, and as Transformative as the World Wide Web

http://www.huffingtonpost.com/rahul-sonnad/coming-soon-a-new-web---i_b_214515.html

(Rahul Sonnad, *Huffington Post*, 11 June 2009.) Combining mobile devices with geolocation introduces a new way of interacting with old technology. The author emphasises the social uses of web browsing and location awareness via mobiles.

Google Latitude on your iPhone

<http://googleblog.blogspot.com/2009/07/google-latitude-on-your-iphone.html>

(Marc Wilson, *The Official Google Blog*, 23 July 2009.) Google offers an optional feature that uses the GPS on a mobile phone to allow one's location to be tracked on a Google map.

Location-Aware Computing

<http://net.educause.edu/ir/library/pdf/DEC0803.pdf>

(A. Michael Berman, Sue M. Lewis, and Anthony Conto, EDUCAUSE, November 2008.) This white paper provides information about location-aware technologies and how they are currently being implemented in higher education.

Location-based Technologies for Learning

http://emergingtechnologies.becta.org.uk/index.php?section=etr&catcode=ETRE_0001&rid=14147

(Steve Benford, *Emerging Technologies for Learning*, November 2008.) This white paper discusses innovative research projects and explores the educational possibilities of location-based media.

The State of Location-Based Social Networking On The iPhone

<http://www.techcrunch.com/2008/09/28/the-state-of-location-based-social-networking-on-the-iphone>

(Mark Hendrickson, *TechCrunch*, 28 September 2008.) This article reviews several location-based applications available for the Apple iPhone.

Delicious: Location-Based Learning

<http://delicious.com/tag/hz09au+locationmedia>

(Australia–New Zealand Horizon Advisory Board and Friends, 2009.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report*, including the ones listed here. To add to this list, simply tag resources with “hz09au” and “locationmedia” when you save them to *Delicious*.

SMART OBJECTS AND DEVICES

Time-to-Adoption Horizon: Four to Five Years

Smart objects and devices connect objects in the physical world with one another and with relevant information. A host of underlying technologies support smart objects, but the key to their potential is not in the technology but in its ability to collect, store, and transmit data about themselves and the world around them. Smart objects and devices are increasingly common in the consumer world, but they are just beginning to enter the educational arena. Early applications focus on real-world data collection and linking multimedia information to everyday objects, but additional uses are emerging as the supporting technologies become smaller, cheaper, and easier to use.

Overview

Smart objects are physical things connected to the virtual world through information, such as where they are located, what they are, who is using them, and how they are being used. This connection can be as simple as a printout of a quick response (QR) code taped onto the object that leads to a URL, or as complex as an embedded microchip and sensor apparatus that gathers, stores, and transmits data. Other technologies that support smart objects and devices include RFID tags, smart cards, and increasingly tiny and flexible sensors.

Smart devices take this capability one step further, combining the ability to collect and transmit information with the means to immediately use that information. The Pulse smart pen by Livescribe is such a tool; used with special paper, the pen can record and play back audio (a lecture, meeting, or conversation) that corresponds with notes taken with the pen while the speaker was talking. The Amazon Kindle is another such device. The Kindle can connect to the network, download and store reading material, keep track of the reader's current position, and so on.

Smart objects and devices have been in use in the consumer world for some time, for everything from enhanced advertising to medical equipment tracking in hospitals. Increased capabilities allow objects to sense and communicate with other smart objects and to report and update their own history and status. The data collected by smart objects and devices has many uses, from monitoring a person's health remotely, to keeping tabs on energy usage and efficiencies in buildings, to tracking the movements of objects over time as they are used or transferred from one owner to another. Such tools also have the potential to impact a variety of field-based disciplines like medicine, anthropology, ecology, journalism, ethnography, and many others.

Many smart objects are not inherently more capable than their normal counterparts. They can be very simple and have only a single essential function, like the Kindle. But because they are connected with information in the online world, they have more potential than unconnected objects. A poster for a local concert can include a printed QR code that, when photographed by a mobile phone with a free QR reader, provides a URL that includes information about the band, audio and video clips, record sales, and upcoming events in other places. The person who sees the poster does not need to remember the band's name or remember to look it up later — all the information needed to link the viewer with the band is there in the QR code.

Smart object technology continues to develop. One key factor that will greatly influence the widespread adoption and use of smart objects is the standard for assigning unique identifiers. Mass production requires a vast number of unique IDs to distinguish, say, one mop or tire or pen from another. Organisations like the Internet Protocol for Smart Objects Alliance (IPSO) are seeking to promote the adoption of Internet protocol (IP) as the network for tracking and connecting smart objects. Formed in January 2009, IPSO comprises fifty companies — including Cisco, Intel, Sun, and others — who are working with standards organisations to promote acceptance and use of a unified standard for networking smart objects.

In order for the vision of ubiquitous, inexpensive smart objects and devices to be realised, many believe that IP version 6 (IPv6) must be in place. The Internet today is supported by IPv4, and IPSO recognises the importance for interoperability; however, the alliance also acknowledges the importance of features in IPv6 — such as increased address space and address auto-configuration —

that will open up the possibilities for smart objects to become adopted into common use.

Relevance for Teaching, Learning, and Creative Inquiry

Certain forms of smart objects, especially RFID-tagged books and materials, have been in use in campus libraries for years; likewise, barcodes have been used to track inventory, and students are quite familiar with smartcards that buy their meals and give them access to dormitories and labs. As smart objects and devices continue to penetrate the consumer market, they will also find larger and more widespread use on campuses.

Devices like the Pulse pen, the Kindle, and the Sony Reader have obvious application for students. The Pulse pen records an entire lecture or presentation while the user listens, changing the nature of note taking by allowing the listener to take reflective notes that are tied to a particular point in time rather than attempting to record exactly what is being said. When the student reviews his or her notes later, tapping the pen on a written word plays back what the teacher was saying at the moment in time when that note was written. Recordings and notes can be stored and searched on the student's computer or uploaded for review and sharing. The pen can also translate a few dozen words from English into Spanish, Swedish, Arabic, or Mandarin: simply write the word or phrase, and then select the desired translation to hear it spoken. Electronic readers like the Kindle are an ideal platform for course readings, being lighter than full-size textbooks (and often cheaper in the long run). A number of universities are beginning to offer textbooks on these platforms.

Sensor technologies — including accelerometers, temperature and pressure sensors, and GPS — are increasingly small and cheap, making precision data collection far easier. Mobile devices can be used to identify and explore smart objects, a fact that is beginning to be exploited for educational uses. Mobilae, a project at Western Sydney Institute in New South Wales is incorporating smart objects with mobile technologies to link real-world objects with text, photographs, sound, and video. Students use mobiles to identify the smart objects, which are tagged with 2D barcodes, and to access the related multimedia content. The project also seeks to explore ways to gather evidence using mobile devices.

As smart objects and devices become more common and as the technologies that support them continue to evolve, we will see additional educational applications for the linking of the physical and the virtual.

A sampling of applications of smart objects and devices across disciplines includes the following:

- **Engineering.** Using relatively inexpensive smart technology embedded into the infrastructure of bridges, civil engineers can track shifts in temperature, expansion and contraction, and vibration and erosion; students have access to the same information and can study the effects of stress and weather on complex structures in real time.
- **Marine Biology.** Researchers at the University of Melbourne and James Cook University are deploying a multi-depth wireless sensor network to detect temperature differences in the waters around the reef. The sensors relay their data to an onshore system where it is used to draw a 3D picture of temperature upwellings that may affect plankton populations.
- **Nursing.** A project co-engineered by IBM and Google gathers patient data, such as blood pressure, heart rate, and glucose levels, and transmits the information to a central computer, allowing for remote monitoring of multiple patients.

Smart Objects and Devices in Practice

The following links provide examples of smart objects and devices in educational settings.

The Educational Point of View

<http://learnonline.wordpress.com/2009/03/26/the-educational-point-of-view>

(Leigh Blackball, *Learn Online*, 26 March 2009.) EDUPOV's camera-glasses provide a unique point-of-view experience that can be used for remote assessment and development of instructional materials. As an example, watch this video: using EDUPOV's mobile device, a chef from Otego Polytechnic prepares a variety of culinary delicacies, including saffron ice cream and duck confit (<http://www.youtube.com/user/adrianwoodhouse>).

IBM Australia Smarter Energy Video

<http://asmarterplanet.com/blog/2009/07/ibm-australia-smarter-energy-video.html>

This video describes the Australian initiative to use smart grids as an energy efficient part of the power supply. Smart meters at home, work, or school would save additional energy and money.

NEC's Visual Processors Help Cars Spot Objects on the Fly

<http://www.wired.com/gadgetlab/2008/12/necs-visual-pro>

(Jose Ferosa, *Wired*, 23 December 2008.) Smart chips embedded in automobiles detect objects in the road, including stop signs and pedestrians. The software assists in lessening delayed reactions from drivers, which is the main cause of accidents.

RFID Tags Survive Hospital Sterilization

<http://www.rfidupdate.com/articles/index.php?id=1775>

(Brian Albright, *RFID Update*, 7 April 2009.) RFID tags have long been used in hospitals to locate and track equipment. Unfortunately, facilities have been unable to use the tags on surgical equipment that must undergo severe sterilisations. A recent breakthrough has allowed the University of California San Diego Medical Center to use durable RFIDs to track and locate surgical equipment, saving time and money.

Siftables: Making the Digital Physical

<http://www.siftables.com>

Siftables are small, block-like smart objects that include a digital display and the ability to sense their own location, orientation and the proximity of other Siftables. The blocks interact with one another to communicate, spell, create music, and solve math problems. The link above provides a brief video demonstration.

Tweet-a-watt Crowned Winner of Greener Gadgets 2009 Design Competition

<http://www.engadget.com/tag/greener%20gadgets>

(Ross Miller, *Engadget*, 2 March 2009.) The Tweet-a-watt sends daily wireless updates about power consumption via Twitter, allowing homeowners to track their power usage.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about smart objects and devices.

Dell Looks to Turn Netbooks into Navigation Devices

<http://www.wired.com/gadgetlab/2009/07/dell-netbooks>

(Priya Ganapati, *Wired*, 1 July 2009.) Dell combines a small laptop, or netbook, with a GPS system that delivers turn-by-turn instruction. The device also makes the netbook location-aware, allowing for easy geotagging of blog entries, photographs, and more.

Interactive Technology Keeps Classes 'Relevant'

<http://mlearningworld.blogspot.com/2009/05/interactive-technology-keeps-classes.html>

(Matthew Nehrling, *mLearning-World.com*, 1 May 2009.) Interactive technology like the InterWrite pad keeps students and teachers equally engaged in lectures. This article describes a variety of technologies used in the classroom.

IPSO Alliance Demonstrates Smart Objects at Las Vegas Expo

<http://www.smartmeters.com/the-news/559-ipso-alliance-demonstrates-smart-objects-at-las-vegas-expo.html>

(*Smart Meters*, 20 June 2009.) Green energy smart tools take humidity, temperature, and light readings from points across the globe, then transmit that data to a central location. Each device costs less than AU\$8, making this technology efficient and cost-effective.

Letting Google take your Pulse

http://www.forbes.com/2009/02/04/google-ibm-healthcare-technology-internet_0205_google.html

(Andy Greenberg, *Forbes*, 5 February 2009.) Google and IBM launch a collaborative project that enables medical equipment to send data to a patient's online health chart.

Spime Watch: Cisco Launches Consortium for 'Smart Objects'

http://www.wired.com/beyond_the_beyond/2008/09/spime-watch-cis

(Bruce Sterling, *Wired*, 25 September 2008.)
An alliance of leading tech companies, IPSO aims to promote Internet protocol (IP) as the method of collecting and sharing data gathered by smart objects.

The Use of QR Codes in Education: A Getting Started Guide for Academics

http://opus.bath.ac.uk/11408/1/getting_started_with_QR_Codes.pdf

(A. Ramsden, University of Bath Opus, 2008.)
This paper is how-to guide for using quick response (QR) codes in the classroom. The author offers clear instruction and explanation of the uses of these codes.

Delicious: Smart Objects and Devices

<http://delicious.com/tag/hz09au+smartobject>

(Australia–New Zealand Horizon Advisory Board and Friends, 2009.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report*, including the ones listed here. To add to this list, simply tag resources with “hz09au” and “smartobject” when you save them to *Delicious*.

METHODOLOGY

Every edition of the *Horizon Report* is produced using a carefully calibrated process that is informed by both primary and secondary research. Nearly a hundred technologies, as well as dozens of meaningful trends and challenges are examined for possible inclusion in the report each year; an internationally renowned Advisory Board examines each topic in rounds of progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected. The entire process takes place online and is fully documented at <http://horizon.nmc.org/anz>.

About half of the thirty to forty members of an Advisory Board are newly chosen each year, and the board as a whole is designed to represent a wide range of backgrounds, nationalities, and interests. To date, more than 300 internationally recognised practitioners and experts have participated on one or more of the Horizon Project Advisory Boards.

Once the Advisory Board is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertain to emerging technology. Advisory Board members are provided with an extensive set of background materials when the project begins, and then are asked to comment, identify those which seem particularly worthwhile, and add to the set. A carefully selected collection of RSS feeds from some 50 leading publications ensures that these resources stay current as the project progresses, and they are used to inform the thinking of the participants through the process.

Following the review of the literature, the Advisory Board engages in the process of addressing the five research questions that are at the core of the Horizon Project. These questions are designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the Advisory Board, and are the same within each of the various Horizon Project research areas so as to facilitate longitudinal analyses. The questions used for the Australia-New Zealand Edition are:

- 1 *What would you list among the established technologies that learning-focused institutions in Australia and New Zealand should all be using broadly today to support or enhance teaching, learning, or creative inquiry?*
- 2 *What technologies that have a solid user base in consumer, entertainment, or other industries should learning-focused institutions in Australia and New Zealand actively try to apply?*
- 3 *What are the key emerging technologies you see developing to the point that learning-focused institutions in Australia and New Zealand should begin to take notice during the next 3 to 5 years? What organisations or companies are the leaders in these technologies?*
- 4 *What do you see as the key challenges related to teaching, learning, and/or creative inquiry that learning-focused institutions in Australia and New Zealand will face during the next 5 years?*
- 5 *What trends do you expect will have a significant impact on the ways in which learning-focused institutions in Australia and New Zealand approach the practice of teaching, learning, and/or creative inquiry?*

One of the Advisory Board's most important tasks is to answer these five questions as systematically and broadly as possible, so as to generate a large number of potential topics to consider. As the last step in this process, past *Horizon Reports* are revisited and the Advisory Board is asked to comment on the current state of technologies, challenges, and trends identified in previous years, and to look for metatrends that that may be evident only across the results of multiple years.

To create the *2009 Horizon Report: Australia-New Zealand Edition*, the members of this year's Advisory Board engaged in a comprehensive review and analysis of research, articles, papers, blogs, and interviews; discussed existing applications; and brainstormed new ones. A key criterion was the potential relevance of the topics to teaching, learning, and creative inquiry.

Once this foundational work was completed, the Advisory Board moved to a unique consensus-building process based on an iterative, Delphi-based methodology. In the first step, the responses to the research questions were systematically ranked and placed into adoption horizons by each Advisory Board member in a multi-vote system that allowed members to weight their selections. These rankings were compiled into a collective set of responses.

From the more than 80 technologies originally considered, twelve emerged at the top of the initial ranking process — four per adoption horizon. Once this “short list” was identified, a significant amount of time was spent researching applications or potential applications for each of the areas that would be of interest to practitioners.

Each of the twelve semi-finalist topics was written up in the format of the *Horizon Report*. With the benefit of the full picture of how the topic would look in the report, the “short list” was then ranked yet again, this time with a reverse ranking approach. The six technologies and applications that emerged at the top of the rankings — two per adoption horizon — are detailed in the preceding sections along with the challenges and trends also selected by the advisory board.

To anchor the report in a stream of timely and relevant information about the topics highlighted here, an ongoing component of the project generates an expanding set of web links, tagged on Delicious.com, which has been established to help extend the findings of the project and allow new information to be shared within the community. The Delicious.com tags used for the project are listed under the “Further Reading” section of each of the six topic areas, and readers are invited to view not only the resources that were listed in the report, but many others that were used in our research as well. Readers are further encouraged to add their own examples and readings to these dynamic lists by tagging them for inclusion in each category.

For additional detail on the project methodology or to review the actual instrumentation, the ranking, and the interim products behind the report, please visit <http://horizon.nmc.org/anz>.

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