NMC Horizon Project

2010 Australia-New Zealand Edition Short List

Time-to-Adoption Horizon: One Year or Less
- Cloud Computing
- Electronic Books
- Mobiles
- Social Networking

Time-to-Adoption Horizon: Two to Three Years
- Augmented Reality
- Game-Based Learning
- Open Content
- Virtual Worlds

Time-to-Adoption Horizon: Four to Five Years
- Gesture-Based Computing
- Semantic Web
- Telepresence
- Visual Data Analysis

Key Trends

Critical Challenges

Cloud Computing

The practice of cloud computing has not changed substantially since its appearance as *Private Clouds* in the *2009 Horizon Report: Australia-New Zealand Edition*, although it has continued to grow and remains an important and interesting technology. Cloud computing includes three broad areas of development: cloud-based applications, which are designed for many different tasks and which are hosted in the cloud; development platforms for creating cloud-based applications; and massive computing resources for storage and processing, such as the EC2 or the GoGrid.

Cloud-based applications that allow work and information to be distributed and shared have become particularly worthy of attention by campus planners. Collaboratively-authored documents can be developed by several writers simultaneously. In the classroom, shared documents between students and teachers can change the model of turning in assignments and waiting for feedback; teachers can look in on work in progress, offering assistance at the moment the student is thinking about the task rather than a day or two after it has been completed. For many, the issue is no longer whether to accept cloud-based tools, but how to develop and manage cloud-based work patterns.

Relevance for Teaching, Learning & Creative Enquiry
- The Medical College of Wisconsin Biotechnology and Bioengineering Center in Milwaukee developed a cloud-based program that allows institutions and individuals inexpensive access to large-scale protein research.
- Carnegie Mellon University in Qatar offers one of the first cloud platforms in the Middle East, providing its students, researchers, and local businesses new opportunities.
- Cornell University has developed plans to use cloud computing — especially the cloud's affordances in working with large amounts of data from multiple sources — to study and promote wildlife conservation and biodiversity.

Cloud Computing in Practice
- The Cloud Computing Testbed (CCT) is a research effort at the University of Illinois at Urbana-Champaign to explore cloud-based solutions for system-level support for data-intensive computing: http://cs.illinois.edu/research/centers/CCT
- MIT's Climate Modeling Initiative looks at ways to use cloud computing resources to perform scientific research: http://www-paoc.mit.edu/cmi/technologies/cloudcomputing.htm
- The cloud-based event organizer WeJoinIn began as a student lab project at UC Berkeley: http://www.wejoinin.com

For Further Reading

7 Things You Should Know About Cloud Computing
http://net.educause.edu/ir/library/pdf/EST0902.pdf
> (Educause, August 2009.) The use of cloud computing as it relates to higher education is discussed in this issue of the *7 Things You Should Know…* series.

Cloud Computing: "Be Prepared"
http://www.educause.edu/er/GoldenInterview
> (Bernard Golden, *Educause Review*, July/August 2009.) Cloud computing is more than a fad. This article examines practical, political, and policy issues of the cloud.

Ohio Takes to the Clouds
http://campustechnology.com/Articles/2009/10/22/Ohio-Takes-to-the-Clouds.aspx?Page=2
> (Guest Viewpoint, *Campus Technology*, 22 October 2009.) Cloud computing lowers IT costs, promotes clean technology, and links the University System of Ohio together.

Time-to-Adoption: One Year or Less

Electronic Books

As the technology underlying electronic readers has improved and as more titles have become available, electronic books are quickly reaching the point where their advantages over the printed book are compelling to almost any observer. The convenience of carrying an entire library in a purse, pocket, or book bag appeals to readers who find time for a few pages in between appointments or while commuting. Already firmly established in the public sector, electronic books are gaining a foothold on campuses as well, where they serve as a cost-effective and portable alternative to heavy textbooks and supplemental reading selections. The availability of portable electronic reading devices like the Apple iPad, the Amazon Kindle, the Nook, the Sony Reader, and many book-reader applications designed for mobiles has made it easy to carry a wide selection of reading material in a small package, with that material updated wirelessly as new content becomes available. The iPad show the promise of new classes of devices that merge the utility of ebook readers with much of what laptops offer, including web browsing, a wide variety of applications, and an expanding set of entertainment options.

Relevance for Teaching, Learning & Creative Enquiry
- Electronic books provide teachers and students with access to books for little to no cost; online resources can be purchased at the campus level that grant students free access to thousands of books.
- Electronic book readers can allow students to record, archive, and share commentary and notes about what they are reading, facilitating the work of study groups and research teams.
- An obvious draw for students is the advantage of having a single handheld reading device that can easily accommodate the entirety of readings involved in one's study, as well as all the essential reference texts.

Electronic Books in Practice
- A pilot program at Northwest Missouri State University has determined that students prefer interactive digital readers that allow them to post virtual sticky notes and mark chapters: http://www.edtechmag.com/higher/march-april-2009/swapping-textbooks-for-e-books.html
- Bookglutton invites users to set up a free online account. Readers choose a book (many at no cost), select a reading group (if desired), and comment on the book as they read: http://www.bookglutton.com
- The University of Virginia's Darden School of Business is participating in an Amazon-sponsored program to test the Kindle DX: http://www.virginia.edu/uvatoday/newsRelease.php?id=9509

For Further Reading

Clive Thompson on the Future of Reading in a Digital World
http://www.wired.com/techbiz/people/magazine/17-06/st_thompson
(Clive Thompson, *Wired Magazine*, 22 May 2009.) Thompson makes a case for digital books: in addition to enhancing sales of print books, e-books enable ongoing reader dialogs.

E-Books in Higher Education
http://ici9.oum.edu.my/pdf/paper06.pdf
(Jim Sinopoli, for the International Conference on Information, August 2009.) This paper briefly discusses the environment necessary to optimize e-books in higher education.

Librarians Desperate for E-books as Demand Outstrips Supply
http://www.timeshighereducation.co.uk/story.asp?storycode=408039
(Rebecca Attwood, *Times Higher Education*, 10 September 2009.) Publishers needn't worry that e-books will replace paper textbooks: a UK study found that while ebooks are very popular, students and faculty prefer to use them as a supplement.

Mobiles

Mobiles as a category have proven more interesting and more capable with each passing year. The mobile market today has more than 4 billion subscribers, more than two-thirds of whom live in developing countries. Over 1.2 billion new phones are produced each year, producing a flow of continuous enhancement and innovation that is unprecedented in modern times. The fastest-growing sales segment belongs to smart phones — which means that a massive and increasing number of people all over the world now own and use a computer that fits in their hand and is able to connect to the network wirelessly from virtually anywhere. Tens of thousands of applications designed to support a wide range of tasks on virtually any smart-phone operating system are readily available, with more entering the market all the time.

There are still some obstacles to adoption; in general, access to the Internet outside school or work is still a key concern for many Australian consumers, and finding any kind of wireless Internet service is often difficult outside of urban centers. 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 & Creative Enquiry
- Mobiles make it possible for students to do meaningful fieldwork, taking measurements and sharing data and findings in ways similar to those used by researchers.
- Nearly every student carries a mobile device, making it a natural choice for content delivery, reference material storage, and even field work and data capture.
- The suite of tools available for mobiles, particularly smart phones, continues to grow, adding to the list of references, flash cards, games, and quizzes available for nearly every subject.

Mobiles in Practice
- At the University of Louisville School of Medicine, residents use smart phones instead of prescription pads and multiple reference books: http://www.allbusiness.com/health-care/health-care-professionals-physicians-surgeons/13161277-1.html
- Students at Central Michigan University use mobiles during classes to answer questions: http://www.cmich.edu/CMU_Media_Channel_Home/iPod_technology_in_classroom.htm
- CourseSmart, a new mobile application, offers over 7000 e-textbooks; each is fully searchable and available via mobile or online: http://www.coursesmart.com/iphone

For Further Reading

The Mobile Campus
http://www.insidehighered.com/news/2009/09/21/iphones
(Steve Kolowich, *Inside Higher Ed*, 21 September 2009.) One year after implementing its campus-wide policy of issuing each freshman an iPhone or iPod Touch, Abilene Christian University challenged instructors to integrate mobile learning into their classes and surveyed the campus community about the results.

World's Largest Open University Goes Mobile
http://www.pr-inside.com/world-s-largest-open-university-goes-r1553595.htm
(Press release, *PR-inside.com*, 29 October 2009.) The Indira Gandhi National Open University, in partnership with Ericsson, will now offer courses on mobile phones to more than 2.5 million students, allowing learners in rural India to seek a higher education.

Social Networking

Social networking is a category of Internet communications technology that uses a wide variety of simple tools to help people make connections with each other and to use those connections as pathways to bring them together around shared activities and interests. Students are tremendously interested in social networking sites because of the community, the content, and the activities they can do there. They can share information about themselves and what they are doing, find out what their peers think about topics of interest to them, share photos and links, and post updates or exchange messages easily with all their friends. Relationships are the currency of these systems, but we are only beginning to realize how valuable a currency they truly are.

The next generation of social networking systems will change the way we search for, work with, and understand information by placing people at the center of the network. Social operating system aim to enable sophisticated new tools, that can learn and infer context from our social graphs —who we know — and use those connections to assess credibility, affinities, and even our likes and dislikes. Using the inherent body of background information in our communications flows, these tools make it easy to identify useful connections to people or groups of people that are a likely fit for our interests, be they casual, social, or even work or learning related.

Relevance for Teaching, Learning & Creative Enquiry
- Social networking promotes the exchange of experiences and creates opportunities for students to participate in the construction of knowledge and manage their own learning.
- Social networks naturally lend themselves to educational use because they are easy to access, affordable, versatile, and widely used by young people.
- Social networking tools can enable teachers to build strong learning-focuses communities around their courses and even their disciplines, encouraging students to interact around topics or media, and to share relevant information. A key concern here is protecting student privacy, but this is a caution, not an obstacle.

Social Networking in Practice
- A professor at the University of Texas at Dallas is engaging students in class discussions using Twitter: http://mashable.com/2010/03/01/twitter-classroom/
- Social Syllabus is a new, experimental social networking platform designed for developing courses: http://www.socialsyllabus.com/
- Boston College uses SocialText to encourage conversation between students and teachers: https://www.socialtext.net/cases2/index.cgi?boston_college_case_study

For Further Reading

Social Media and Young Adults: Pew Research Center
http://www.pewinternet.org/Reports/2010/Social-Media-and-Young-Adults.aspx
(Amanda Lenhart, Kristin Purcell, Aaron Smith and Kathryn Zickuhr, *Pew Internet*, 3 February 2010.) This study examines the ways in which young people use social networks and media in their lives.

Using the Technology of Today, in the Classroom Today:
The Instructional Power of Digital Games, Social Networking, and Simulations
http://education.mit.edu/papers/GamesSimsSocNets_EdArcade.pdf
(Eric Klopfer, Scot Osterweil, Jennifer Groff, and Jason Haas, *The Education Arcade*, MIT, 2009.) This article discusses the impact of three technologies, including social networking, on students and learning.

Augmented Reality

The concept of blending (augmenting) data — information, rich media, and even live action — with what we see in the real world is a powerful one. Augmented reality aims to do just that as a means to enhance the information we can perceive with our senses. The first applications of augmented reality appeared in the late 1960s and 1970s, and by the 1990s, augmented reality was being put to use by a number of major companies for visualization, training, and other purposes. Now, the technologies that make augmented reality possible are powerful and compact enough to deliver augmented reality experiences to personal computers — and even mobile devices. Wireless applications are increasingly driving this technology into the mobile space where they offer a great deal of promise.

The camera and screen embedded in smart phones and other mobile devices now serve as the means to combine real world data with virtual data; using GPS capability, image recognition, and a compass, augmented reality applications can pinpoint where the mobile's camera is pointing and overlay relevant information at appropriate points on the screen. Augmented reality applications can either be marker-based, using a specific visual cue to call up the correct information — or markerless. Markerless applications typically rely on positional data, such as a mobile's GPS and compass but new versions appearing in the game sector rely more on image recognition.

Relevance for Teaching, Learning & Creative Enquiry
- Augmented reality opens the door to visual and highly interactive forms of learning, allowing the overlay of data over the real world as easily as it simulates dynamic processes.
- AR has significant potential for laboratory-based learning and assessment, where students can explore the virtual counterparts of objects that are too physically remote, dangerous, or expensive to use in teaching.
- Students visiting historic sites can access AR applications that overlay maps and information about how the location looked at different points of history.

Augmented Reality in Practice
- ARIS is an alternate reality gaming engine created by the University of Wisconsin's Games, Learning and Society research group. Virtual objects and characters are placed at certain locations in the physical world and players interact with them using their mobile devices: http://arisgames.org
- With the Wikitude World Browser, users can view their surroundings through the camera on a mobile device, seeing historical information, nearby landmarks, and points of interest: http://www.wikitude.org/category/02_wikitude/world-browser
- This video demonstrates an AR game played with a table board and a mobile device, created at Georgia Tech Augmented Environments Lab and the Savannah College of Art and Design in Atlanta: http://www.youtube.com/watch?v=cNu4CluFOcw&feature=player_embedded

For Further Reading

If You're Not Seeing Data, You're Not Seeing
http://www.wired.com/gadgetlab/2009/08/augmented-reality/
(Brian Chen, *Wired Gadget Lab*, 25 August 2009.) This *Wired* article gives a good overview of augmented reality, including where it currently is situated and what to expect in the future.

Visual Time Machine Offers Tourists a Glimpse of the Past
http://www.sciencedaily.com/releases/2009/08/090812104219.htm
(*ScienceDaily*, 17 August 2009.) New apps for smart phones offer augmented reality on the go. While on location, users view historical sites as they were hundreds of years ago.

Game-Based Learning

The interest in game-based learning has accelerated considerably in recent years, driven by clear successes in military and industrial training. The military, in particular, is using games and simulations to refine skills across the range of their training needs, from basic training to field medicine, to IED removal, to advanced operational strategies. Developers and researchers are working in every area of game-based learning, including games that are goal-oriented; social game environments; non-digital games that are easy to construct and play; games developed expressly for education; and commercial games that lend themselves to refining team and group skills. At the low end of game technology, there are literally thousands of ways games can be applied in learning contexts. Role-playing and other forms of simulated experiences have broad applicability across a wide range of disciplines, and are another rich area for exploration.

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

Game-Based Learning in Practice
- *Virtual Battlespace II* is a game-based operational simulation environment, developed with the Australian Defense Forces, that is used by militaries all over the world as an operational planning tool: http://www.bisimulations.com
- *Ghosts of a Chance* allows visitors to the Smithsonian American Art Museum a chance to decipher codes, follow treasure maps, send text messages, and uncover hidden objects in this multimedia scavenger hunt: http://ghostsofachance.com/
- *World without Oil* was a collaborative imagining of the first 32 weeks of a global oil crisis: http://worldwithoutoil.org/
- *Ricardian Explorer* is an interactive educational computer game that was designed to simulate the functioning of a simple model of international trade: http://www.wesleyan.edu/re/

For Further Reading

Deep Learning Properties of Good Digital Games: How Far Can They Go?
http://www.jamespaulgee.com/node/37
> (James Paul Gee, Arizona State University, January 2009.) This study by noted educational gaming researcher James Paul Gee discusses the merits of good digital games and their design along with the learning that can accompany them.

Moving Learning Games Forward (PDF)
http://education.mit.edu/papers/MovingLearningGamesForward_EdArcade.pdf
> (E. Klopfer, S. Osterweil and K. Salen , *The Education Arcade - MIT*, 2009.) This white paper provides an overview of the current state of the field of educational gaming and proposes strategies for those wishing to enter the domain.

Reality is Broken, Game Designers Can Fix It (video)
http://www.avantgame.com/
> (Jane McGonigal, Institute for the Future, 2010.) This TED talk advocates incorporating principles of game design into the real world to effect social change.

Open Content

The movement toward open content reflects a growing shift in the way academics in many parts of the world are conceptualizing education to a view that is more about the process of learning than the information conveyed in their courses. Information is everywhere; the challenge is to make effective use of it. Part of the appeal of open content is that it is also a response to both the rising costs of traditionally published resources and the lack of educational resources in some regions, and it also offers the promise of a cost-effective alternative to textbooks and other materials.

At the center of many discussions of open content are the challenges of sharing, repurposing, and reusing scholarly works; related to those discussions are concerns about intellectual property, copyright, and student-to-student collaboration. Solid work has been done by groups such as Creative Commons, the Academic Commons, Science Commons, and others to address many of the concerns commonly voiced. Many believe that reward structures that support the sharing of work in progress, ongoing research, highly collaborative projects, and a broad view of what constitutes scholarly publication are key challenges that institutions need to solve. Also to be addressed are reputation systems, peer review processes, and new models for citation of the new forms of content that are likely outgrowths of open content initiatives.

Relevance for Teaching, Learning & Creative Enquiry
- Open content allows teachers to customize their courses inexpensively while keeping up with emerging information and ideas.
- Open educational resources are available to anyone with an Internet connection, thereby increasing access to education, especially in developing nations.
- Communities of practice and learner groups that form around open content provide a source of support for independent or life-long learners.

Open Content in Practice
- Folksemantic's OpenCourseWare Finder helps students find free online courses: http://ocwfinder.com
- OpenLearn, a UK-based open learning site, offers students the opportunity to join a study group, or learn independently; use prepared materials, or join the lab and create their own: http://openlearn.open.ac.uk
- MIT's OpenCourseWare—which provides free, online access to all of MIT's courses—serves as a model for other universities: http://ocw.mit.edu/OcwWeb/web/home/home/index.htm

For Further Reading

Around the World, Varied Approaches to Open Online Learning
http://chronicle.com/article/Countries-Offer-Different/48775
(Simmi Aujla and Ben Terris, *The Chronicle of Higher Education,* 11 October 2009.) Many countries are using open educational resources to reach students who would otherwise be unable to attend university.

Students Find Free Online Lectures Better Than What They're Paying For
http://chronicle.com/article/Students-Find-Free-Online/48776
(Jeffery R. Young, *The Chronicle of Higher Education,* 11 October 2009.) Not only traditional students, but learners whose primary language is not native, advanced high-school students, and working professionals all take advantage of free educational resources.

Virtual Worlds

The capability of virtual worlds has expanded considerably in the past few years, with enormous development in building tools, climate simulators, physics engines, and the overall capability of these platforms to simulate reality. Gartner Research, Inc. has estimated that by 2011, 80% of Internet users will have an avatar in a virtual world, and hundreds of platforms to allow those avatars places to interact are already available or in development. Many institutions have some sort of work going on around virtual spaces, and in just one platform alone, Linden Lab's Second Life®, thousands of educational projects and experiments are actively underway.

Early projects that drew heavily on real-world forms and practices gradually have given way to more experimental ventures that take advantage of the unique opportunities afforded by virtual worlds and other immersive digital environments. The technology that supports virtual worlds is advancing at a rapid rate, paving the way for more realistic environments, connections between different platforms, and new ways to enter and use virtual spaces. As more browsers begin to incorporate WebGL, which allows an interactive 3D experience within a browser, it is expected that virtual worlds will take advantage of it almost immediately.

Relevance for Teaching, Learning & Creative Enquiry
- Virtual worlds are infinitely customizable and lend themselves to detailed simulations in subjects from mathematics to literature to the sciences.
- Virtual worlds provide a rich environment for scenario-based learning, allowing students to interact with — or even construct — places and objects of historical or scientific significance.
- Flexible learning spaces and simulations allow students to take part in activities that are difficult to host in real-life classrooms, such as touring a working industrial plant.

Virtual Worlds in Practice
- *Virtual Worlds — Real Learning!* is an online resource offering information about the benefits of virtual worlds in education: http://virtualworlds.flexiblelearning.net.au
- Third-year architecture students from the University of Auckland had the opportunity to design and build in Second Life: http://slenz.wordpress.com/2009/04/02/the-slenz-update-no-63-april-2-2009/
- Second Life Education New Zealand (SLENZ) focuses on virtual world education issues: http://slenz.wordpress.com/

For Further Reading

Journal of Virtual Worlds Research
http://jvwresearch.org/
> (*Journal of Virtual Worlds,* accessed September 14, 2010.) This online journal includes a number of in-depth research reports and papers concerning virtual worlds.

Serious Virtual Worlds: A Scoping Study
http://www.jisc.ac.uk/publications/reports/2008/seriousvirtualworldsreport.aspx
> This comprehensive study from 2008 examines different virtual world platforms in terms of their suitability for learning and training.

SLOODLE: Connecting VLE Tools with Emergent Teaching Practice in Second Life
http://dx.doi.org/10.1111/j.1467-8535.2009.00938.x
> (Kemp, J., Livingstone, D. & Bloomfield, P. *British Journal of Educational Technology*, 40. 2009.) This paper discusses ways to integrate personal learning tools with a virtual world.

Gesture-Based Computing

It is already common to interact with a new class of devices entirely by using natural gestures. The Microsoft Surface, the iPhone, iPad, and iPod Touch, the Nintendo Wii, and other gesture-based systems accept input in the form of taps, swipes, and other ways of touching, hand and arm motions, or body movement. These are the first in a growing array of alternative input devices that allow computers to recognize and interpret natural physical gestures as a means of control. We are seeing a gradual shift towards interfaces that adapt to — or are built for — humans and human movements.

New interface technologies like Kinect, Sixth Sense, and Tamper are using very intuitive approaches to how we connect with our computers, allowing users to engage in virtual activities with motions and movements similar to what they would use in the real world, manipulating content intuitively. The idea that natural, comfortable motions can be used to control computers is opening the way to a host of input devices that look and feel very different from the keyboard and mouse — and that enable our devices to infer meaning from the movements and gestures we make.

Relevance for Teaching, Learning & Creative Enquiry
- Gesture-based games like those developed by researchers at Georgia Tech University can help deaf children learn linguistics at a critical time of language development.
- Gesture-based interfaces like MIT's Sixth Sense project can be used to augment virtual information into real world spaces.
- After discovering the significant improvement in dexterity that surgeons-in-training gained from playing with the Wii (48%), researchers are developing a set of Wii-based medical training materials.

Gesture-Based Computing in Practice
- This innovative project at the Auckland Museum uses touch-screen interfaces to allow visitors to create custom virtual orchids in lifelike detail: http://vimeo.com/6580702
- Researchers at MIT are developing inexpensive gesture-based interfaces that track the entire hand: http://web.mit.edu/newsoffice/2010/gesture-computing-0520.html
- Dutch company Silverfit uses a gesture-based system to deliver fitness games designed for the elderly: http://www.silverfit.nl/index.php

For Further Reading
Touchy Feely Future for Tech Users
http://news.bbc.co.uk/2/hi/programmes/click_online/8697913.stm
> This BBC video gives an overview of touch-based technologies that provide haptic feedback to users, such as a touch screen with a variety of buttons that feel different when pressed.

University Offers New Technology to Help Students Study
http://www.unr.edu/nevadanews/templates/details.aspx?articleid=5194&zoneid=14
> (Skyler Dillon, *Nevada News*, 1 October 2009.) The Mathewson-IGT Knowledge Center at the University of Nevada in Reno purchased two Microsoft Surfaces. In addition to maps and games, the University added an anatomy study guide.

Why Desktop Touch Screens Don't Really Work Well For Humans
http://www.washingtonpost.com/wp-dyn/content/article/2009/10/13/AR2009101300113.html
> (Michael Arrington, *The Washington Post*, 12 October 2009.) A desktop touch screen isn't comfortable: a more ergonomic design (like an architect's drafting board) would relieve arm fatigue.

Semantic Web

The idea behind the semantic web is that although online data might be easily available for searching, their meaning is not: computers are very good at returning keywords, but very bad at understanding the context in which keywords are used. A typical search on the term "turkey," for instance, might return traditional recipes, information about the bird, and information about the country; the search engine can only pick out keywords, and cannot distinguish among different uses of the words. Semantic-aware applications allow meaning to be automatically inferred from content and context and structured in a useful way. The promise of these applications is to help us see connections that already exist, but that are invisible to current search algorithms.

There are currently two theoretical approaches to developing the semantic capacity of the web. One is problematic in that it assumes metadata will be added to each piece of content to include information about its context. The second appears to have a far greater likelihood of success, as it focuses on developing natural language search capability that can make those same kinds of determinations without any special metadata. Semantic-aware applications are in this category.

Relevance for Teaching, Learning & Creative Enquiry
- A wiki focused on teaching undergraduate math using Wolfram|Alpha helps students with their homework (http://walphawiki.wikidot.com).
- Using semantic web technology, the University of Plymouth has gathered course resources that would formerly be available through the library or bookstore; the materials are available online in one location, so students need not compete for the library's limited resources.
- As the amount of available information continues to grow, semantic tools that can deliver context-sensitive information will become more key for research and sense-making.

Semantic Web in Practice
- Apture is a free semantic application that allows users to find and add relevant multimedia easily to blogs: http://www.apture.com
- Scientists from several schools, including the University of Florida and Cornell University, have been granted funding to create a Facebook-like, scholarly website with semantic search: http://www.networkworld.com/news/2009/102009-facebook-scientists-funding.html
- Hakia, created using Yahoo's new Build your Own Search Service (BOSS), is a semantic web service that provides results based on quality, not popularity. One criterion, for example, is that results come from librarian-recommended sites: http://company.hakia.com/about.html

For Further Reading

The Semantic Web
http://www.scientificamerican.com/article.cfm?id=the-semantic-web
> (Tim Berners-Lee, James Hendler and Ora Lassila, *Scientific American*, May 2001.) This seminal publication provides a solid foundation for understanding this technology, how it applies to the larger ecosystem of the web, and the implications it will have in the future.

Semantic Web at Data.gov
http://www.data.gov/semantic
> This site provides a number of examples of how the semantic web could be used to analyze government data in a visual context.

Talis' *Nodalities* Magazine
http://www.talis.com/nodalities/
> This free publication is a good resource for staying up to date on current and emerging semantic web technologies. The articles provide many examples and case studies.

Telepresence

Telepresence is a form of remote conferencing in which the participants appear to be physically present in the conference space. Body language cues like eye contact are easily transmitted and interpreted because of the fidelity, size, and position of the images, and there are both 2D and 3D implementations of the technology. Several high-profile 3-dimensional demonstrations of the technology have taken place; CNN made extensive use of the technology during coverage of the 2008 US presidential election. Typically, 3D telepresence requires a specially configured space in which to capture a 360-degree image that can then be inserted into a virtual set, and viewed from any angle.

2D telepresence uses two-way high-definition video and displays, seamless integration with software and data presentation tools, and full-surround spatial audio, all configured within a specially designed room to create a sense of physical presence on both sides of the exchange.   Often the furniture in such rooms is configured to enhance the experience, which can be quite immersive.

Relevance for Teaching, Learning & Creative Enquiry
- Telepresence can be used to bring outside expertise into the classroom without requiring expensive travel or taking up too much of experts' time.
- Access to telepresence technology for students could facilitate increased collaboration with peers around the globe.
- Telepresence is being used to some degree in the medical and pharmaceutical industries for training, project collaboration, and advising; educational applications in these fields are likely places in which they will develop.

Telepresence in Practice
- Vidyo is a relatively new system that provides 2D telepresence at a lower cost than previous systems, representing a possible new direction for growth: http://www.vidyo.com/
- Since 2008, Rochester Institute of Technology has participated in an international project to pilot technology for telemedicine, including remote collaboration on surgical operations: http://www.rit.edu/news/release.php?id=46422
- TelepresenceTech markets systems for both 2D and 3D telepresence: http://telepresencetech.com

For Further Reading

Cisco TelePresence on NLR
http://www.nlr.net/telepresence-faq.php
> (*National LambdaRail*, accessed 14 September 2010.) National LambdaRail, a high-speed national US network operated by research and education organizations, maintains a network of telepresence rooms that spans the globe.

A One-Day Lesson in Telepresence Basics
http://www.informationweek.com/blog/main/archives/2007/06/a_oneday_lesson.html
(Mitch Wagner, *InformationWeek's Digital Life Weblog*, June 2007.) This post describes 3D telepresence, some potential applications, benefits, and drawbacks.

Telepresence World Overview
http://www.telepresenceworld.com/
> (*Telepresence World*, accessed September 14, 2010.) This website for the Telepresence World conference includes an overview that describes telepresence and its applications.

Visual Data Analysis

Visual data analysis blends highly advanced computational methods with sophisticated graphics engines to tap the extraordinary ability of humans to see patterns and structure in even the most complex visual presentations. Currently applied to massive, heterogeneous, and dynamic datasets, such as those generated in studies of astrophysical, fluidic, biological, and other complex processes, the techniques have become sophisticated enough to allow the interactive manipulation of variables in real time.

Ultra high-resolution displays allow teams of researchers to zoom into interesting aspects of the renderings, or to navigate along interesting visual pathways, following their intuitions and even hunches to see where they may lead. New research is now beginning to apply these sorts of tools to the social sciences as well, and the techniques offer considerable promise in helping us understand complex social processes like learning, political and organizational change, and the diffusion of knowledge.

Relevance for Teaching, Learning & Creative Enquiry
- Tools for visual data analysis expose trends and relationships among both qualitative and quantitative variables, and make longitudinal relationships easier to find and interpret.
- Models of complex processes in quantum physics, organic chemistry, medicine, or economics demonstrate how the outcomes of visual data analysis can be applied to learning situations.
- Using tools like Many Eyes and Wordle, students can analyze the contents of their papers for insights into what points might need further development, and whether certain language has been overused.

Visual Data Analysis in Practice
- From simulating the way waves break against a ship to visualizing seasonal carbon dioxide accumulation in North America, these videos demonstrate the diversity of data visualization: http://www.wired.com/wiredscience/2009/08/visualizations/all/1
- Analytics and data visualization allowed researchers at the University of Pennsylvania to visually model (in real time) the response of the body's immune system to a parasitic infection: http://www.upenn.edu/pennnews/article.php?id=1531
- A wide variety of data visualization projects are featured on this site, including one that shows changes in the text from one edition of *The Origin of the Species* to the next: http://www.visualcomplexity.com/vc

For Further Reading

7 Things You Should Know About Data Visualization II
http://net.educause.edu/ir/library/pdf/ELI7052.pdf
> (*Educause,* August 2009.) This article discusses data visualization as it relates to higher education: who's using it, why they're using it, and what to expect in the future.

New Visualization Techniques Yield Star Formation Insights
http://www.sciencedaily.com/releases/2008/12/081231152305.htm
> (*Science Daily*, 4 January 2009.) A new computer algorithm developed at the Harvard Initiative in Innovative Computing demonstrated that data visualization is critical in the discovery of new information, not just in the final presentation of data.

Report from the DOE/ASCR Workshop on Visual Analysis and Data Exploration at Extreme Scale
http://www.sci.utah.edu/vaw2007/DOE-Visualization-Report-2007.pdf
> This report describes fundamental research in visualization and analysis that is enabling knowledge discovery from computational science applications at extreme scale.

As digital learning resources are increasingly accepted by students, institutions are considering replacing print resources with more cost-effective options. The ready availability of a variety of electronic readers and a wider acceptance of digital study materials may open the door to solutions that replace print materials with digital ones. Traditional distance education providers in particular may find value in reducing printing and shipping costs. In the context of the current financial crisis, this response may provide additional stimulus for tipping the paradigm from print-heavy formats to digital versions.

As the availability and use of electronic books continue to grow, the traditional publishing (and textbook) market is undergoing a profound and lasting change. Just as the music industry has already discovered, consumers appreciate the ability to purchase raw content formatted for devices of their choice. The content of books is becoming a commodity separate from the form of those books and from the device used to access them. This shift is a dramatic one for an industry long accustomed to attaching value to the container and defining ownership in terms of possession of an object; electronic books are about the content, not about the hardware. Consumers expect to see digital book content divorced from hardware and offered cheaply, conveniently, and in flexible and sharable formats.

The availability of educational content for mobile devices is increasing as more providers develop for these platforms. As e-books and e-readers move into the mainstream, it is natural that educational content providers will be offering more and more content aimed at these devices. These "texts" can easily contain a wealth of dynamic multimedia, and students can buy or rent entire textbooks or just chapters and selections as needed. Annotation features, now emerging on a wider range of platforms, will allow easy recording and sharing of notes and commentary. As the rate of change and growth of information accelerate, keeping paper-based resources up to date can become an ever more daunting task. Easily-updateable electronic content ameliorates this issue as well as provides a means to deliver richer, nonlinear materials to support study.

Devices like Apple's iPad are filling a niche that is neither "big smart phone" nor "small laptop." As people use devices like the iPad, discover new applications for them, and talk about what they are doing, it is becoming clear that these are neither oversized phones nor small-scale laptops. Instead, they represent a new class of devices that perhaps were not even missed until they became available. Day by day they gain a footing in education, the health industry, and other sectors as useful tools for learning and serious work. More than that, they are redefining what a portable device is, at a fundamental level. The opportunities for teaching have not yet been fully explored, but the capabilities of these devices -- the apps they can run, the media they can display, the creative acts they support, and their easy portability -- point to a host of potential uses in the classroom.

More and more, teachers are adopting social media as a classroom resource. Students already inhabit social spaces, and many teachers are involved in professional or interest-based social communities. Social media are being hailed as essential to a 21st-century education, used as a source for research and other scholarly work, providing a way for students to connect and communicate as part of their lessons, and even being employed in the service of classroom instruction by many professors. Four-fifths of professors use social media in their personal or professional lives, and an increasing number are seeing the value of social media as a tool for teaching and learning.

Social and open forms of peer review and scholarship are gradually gaining acceptance. As younger professors enter the ranks of academia and as new forms of online publishing gradually gain

traction, long-established traditions such as peer review may come under closer examination. New technologies and approaches are emerging that may challenge certain elements of scholarship. Though not a new trend, this tendency may accelerate under the impetus of younger faculty and ready availability of alternatives to traditional scholarly processes.

There is an increasing emphasis on student retention, attribution and completion rates. As this pressure increases, institutions may seek technological solutions to identify at-risk students, provide appropriate early interventions, and screen students who are not likely to succeed. Systems that draw on data warehouses to consolidate and present information on student progress are emerging that may assist with these determinations.

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.

Challenges

The advent of cloud computing and the subsequent migration of IT infrastructure to the cloud poses a significant challenge to the skill sets of existing IT groups. Infrastructure management skills are becoming less critical at the institutional level as more services are moved off-campus and into hosted environments where staff are always available. Instead, campus IT specialists need to understand the challenges and opportunities presented by the wide range of possible products. Their jobs will involve much more brokering and integrating of services and much less installation and maintenance activities, and their skills must change accordingly.

Even where technology for learning is strongly promoted, there remains a desperate need for professional development opportunities around emerging technology. One-to-one computer use is an admirable goal and a worthwhile one, and this strategy has been shown to improve student engagement and access to learning materials. Unfortunately, simply making the equipment available is not sufficient to reap the benefits. Where technology is promoted without an accompanying commitment to professional development for staff, learning suffers. This challenge continues from year to year, as emerging technologies change by their very nature, while professional development opportunities fail to keep up with the pace.

Faculty are under pressure to publish and perform, making it difficult to engage with and master new technologies that could be used for teaching and learning. The intensification of academic workload coupled with pressure on university staff to increase research outputs and performance reduces time and energy for exploration of and experimentation with new technologies. The potential of many emerging technologies for educational use is still being discovered, so exploration and experimentation are critical activities that should be promoted and protected.

In today's networked world, learners are placing greater value on knowing where to find information rather than on knowing the information themselves. The form of learning is changing. The amount of knowledge collectively held by humanity is staggering, and being able to find, evaluate, and synthesize material from a variety of sources is arguably more important than holding all that knowledge oneself. Young people entering higher educational institutions — and the workforce — are accustomed to constant access to a network of peers on whom they rely for entertainment, mutual learning, collaboration, and expertise. This cohort may well expect to be able to make use of their own personal learning and social networks, and the technologies that support them, in their places of work or study. Their world is open and mobile, and they will resent being cut off from it.

Institutional inertia prevents innovation and promotes the status quo. Decisions already in place regarding technology choices are difficult to change, even when the changes in technology outpace previous solutions. One example of this challenge is often found in learning management systems, many of which have failed to evolve along with other tools. Once adopted, LMS platforms often remain in place despite frustration from teachers and students using them, and innovation is not encouraged. Further, campuses tend to be slow to support the personal technology students bring with them and thus miss an opportunity to leverage tools that students are already willing and able to use.

Reduced funding continues to present challenges in adopting new technologies for many institutions. Faculty who want to adopt new technologies — mobile devices, hosted subscription-based software applications, wireless access, and so on — run into the issue of whether such equipment and services should be the responsibility of the student or of the institution. Institutional

budgets are tight, but so are the students'. If the institution purchases the devices, there is the further issue of managing distribution and collection on a regular basis.

There is a conceptual mismatch between pedagogical practice and the design of many emerging technologies that makes it difficult for teachers to appreciate or use new tools. Many new technologies are based on underlying philosophical beliefs such as openness, collaboration, connection, and student-centeredness that simply are not in alignment with the majority of teaching practices. Adoption suffers because teachers do not see the connection between their classroom practice and technology tools, particularly social tools that emphasize communication and sharing — two activities often seen as antithetical to learning, study, and especially assessment. Syllabi and lecture notes are often converted into digital formats that mirror their print forms instead of taking advantage of the dynamic nature of online 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 realization that these skills are as important as written, spoken, and information literacy, and they must be formally taught.