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Growing up with Google
What it means to education

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Describing the Net Generation

In the words of one of our students,

- My computer is the nucleus of my workspace
- When I need information I go online
- Besides IM or email my cell phone is my primary method of communication
- I'm usually juggling five things at once[1]

This is the Net Generation, students who were born after 1982 – students who have never known life without the internet. Although educators may see students every day, we don't necessarily understand their habits, expectations or learning preferences. But it is obvious that technology is an integral part of their lives. To them, IM, text and Google are verbs, not applications. The Net Generation have integrated technology into everything they do, essentially putting their lives on the internet.

[1] Carie Windham. Educating the Net Generation. NC State University Graduate School Colloquium, September 14, 2007.

Photo: Jon Page

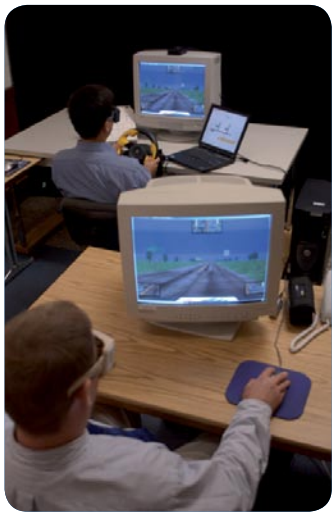

Photo: Department of Communications, North Carolina State University

Today's students use technology (IM, Facebook, Flickr, Skype) to be constantly connected – to friends, family, information and entertainment. Technology allows them to connect with more people, in more ways, more often. As one student explained, "Why would I call someone when I can talk to eight people at the same time on IM?"[2] Mobile phones, for example, aren't just for talking – they are also for texting, sending photos, accessing the Web, or watching video.[3] Although older generations may find communicating via technology impersonal, the Net Generation sees technology as improving their communication. According to one student, "My parents don't understand. They think that talking online must be impersonal. Or that it leaves some sort of void. Online is how I talk. I can communicate with so many more people and manage so many more relationships. She thinks I'm more isolated than her generation – I think it's the opposite."[4]

The current generation seamlessly transitions between their 'real' and digital lives. Facebook may be the starting point for a friendship. Twitter provides constant updates on activities, feelings and observations to friends and followers. Sarah becomes Sapphire Laurasia when she enters Second Life. Students spend hours in virtual worlds and online gaming communities, where many of their friendships originate.[5]

The Net Generation demands immediate response, expecting answers at the click of a mouse. As one student commented, "They call this the information age or something, right? Look, I want things fast! I don't wait for video, I don't wait for mail, I don't wait for anything."[6] There is an expectation of 24x7 connectivity and service. Tools like instant messaging have an inherent appeal for this generation.

Today's students bring a consumer orientation to education, which is viewed as a commodity to be consumed, acquired and accumulated.[7] Students place a high value on the convenience technology provides, whether that means

[2] Carie Windham. Father Google and Mother IM: Confessions of a Net Gen Learner. Presented at ELI Annual Meeting, January 23, 2007. **http://connect.educause.edu/library/abstract/FatherGoogleandMothe/39228**

[3] Oblinger, Diana and Marilyn Lombardi. In Press. 'Common Knowledge: Openness in Higher Education.' IIn Toru Iiyoshi and M. S. Vijay Kumar (Eds), *Opening Up Education: The Collective Advancement of Education through Open Technology, Open Content, and Open Knowledge.* MIT Press, Cambridge MA.

[4] Carie Windham. Educating the Net Generation. NC State University Graduate School Colloquium, September 14, 2007.

[5] Julie Evans. K-12 Students Speak Up about Technology: Are We Listening? Presented at ELI Annual Meeting, January 22, 2007. **http://connect.educause.edu/library/abstract/K12StudentsSpeakUpAb/39232**

[6] Carie Windham. Educating the Net Generation. NC State University Graduate School Colloquium, September 14, 2007.

[7] Mark Taylor (2006). 'Generation NeXt Comes to College: Today's postmodern student.' **http://globalcscc.edu/tirc/blog/files/Gen%20NeXt%20handout%2006%20oln.pdf** Accessed September 19, 2007.

accessing course material from anywhere at any time or being able to see course grades as soon as they are posted. Many students describe education as a business where efficient, convenient, technology-mediated transactions are expected.[8] Consumerism can sometimes bleed into an entitlement culture, however. An increasing number of students – and their parents – expect academic success with little academic effort.[9]

Their learning styles are influenced by the immediacy and visual richness of the environment they have grown up in, particularly television and the internet. Net Generation students expect to be engaged by their environment, with participatory, sensory-rich, experiential activities (either physical or virtual) and opportunities for input. They are more oriented to visual media than previous generations – and prefer to learn by doing rather than by telling or reading. "Don't just tell us – let us discover."[10] To illustrate, one student described how she learned about video. "Well…I opened up the camera box, started messing around, and then figured out how to upload it. Took a while. Had to Google it a few times to figure out how to splice stuff together. Just took an hour or so."[11] They teach themselves how to use technology – or learn it from peers.

Harbingers of change

One reason for trying to understand the Net Generation is that our students may be harbingers of change. Their habits, expectations and behaviours may anticipate what the rest of society will come to consider as its culture or norms. In fact, indicators suggest that society's shared beliefs, values, customs and behaviours are being reshaped by globalisation and technology. These changes apply across the spectrum of age and occupation – not just to young people.

Communicating and connecting

The internet is a major channel for socialising. For students of all ages, communication drives many of their uses of IT. In a survey involving almost 800,000 school-aged children in the US, 23 per cent say they are connecting with people around the country – not just in their class, or their neighbourhood.

[8] A Net Gen Student Perspective: Technology in Higher Education. May 7, 2007. **http://www.educause.edu/ELIWEB075**

[9] Mark Taylor. 2006. 'Generation NeXt Comes to College: Today's postmodern student.' **http://globalcscc.edu/tirc/blog/files/Gen%20NeXt%20handout%2006%20oln.pdf** Accessed September 19, 2007.

[10] Carie Windham. Father Google and Mother IM: Confessions of a Net Gen Learner. Presented at ELI Annual Meeting, January 23, 2007. **http://connect.educause.edu/library/abstract/FatherGoogleandMothe/39228**

[11] Carie Windham. Educating the Net Generation. NC State University Graduate School Colloquium, September 14, 2007.

Photo: Department of Communications, North Carolina State University

Seventeen per cent are connecting with young people around the world. Approximately one third of their friends are people they've never met face-to-face. 'Globally, the average young person connected to digital technology has 94 phone numbers in his or her mobile, 78 people on a messenger buddy list, and 86 people in their social networking community.'[12]

Social networks, such as MySpace, Facebook and Bebo, are part of how students communicate. From Facebook they send messages (email or instant messages), they blog, they post pictures, and they 'poke' each other. But communicating and connecting isn't limited to text. Students share photographs through sites like Flickr or by emailing photos from mobile phones. An increasing number are using geolocation services to find friends who are in the area.

Moreover, communicating and connecting are not limited to the real world or real people. An increasing number of students meet friends through online gaming communities, often establishing friendships with students from other continents – something that would be impossible in the real world. Others establish connections in virtual worlds, such as Second Life, in which users are represented by avatars and by pseudonyms, which are also common among bloggers. For users of online worlds, identity has become a flexible concept – being 'yourself' is not necessarily limited to your physical being or given name. Pseudonyms and avatars can expand one's identity.

No matter what medium, communication is an imperative for the Net Generation. Among students surveyed, 100 per cent communicate with others each time they log onto the network; 70 per cent check IM as the first thing they do when they turn on their computer.[13]

Collaborating and co-creating

A host of Web 2.0 technologies enable collaboration and co-creation activities, perhaps exemplified by Wikipedia, in which users write and edit their own encyclopaedia. Since the Web has become our information universe, we have developed a do-it-yourself approach to finding information. Whether it is booking travel, researching a paper, or seeking entertainment, the first stop is likely to be the Web.

The Web is no longer just a way to receive information – it is a medium for commenting, collaborating and creating. Blogging, where anyone can create

[12] MTV, Nickelodeon and Microsoft challenges assumption about relationship between kids and Digital Technology. July 8, 2007. **http://advertising.microsoft.com/sverige/NewsAndEvents/PressRelease.aspx?Adv_PressReleaseID=630**

[13] MTV, Nickelodeon and Microsoft challenges assumption about relationship between kids and Digital Technology. July 8, 2007. Ibid.

and publish their ideas and opinions, is one form of internet-based self-expression. More than 50 million blogs were created by mid-2006; estimates indicate that two new blogs are created each second.[14] The power of blogs goes beyond self-expression. For example, the 2007 uprising in Burma was made known to the outside world through blogs. Blogs are influencing mainstream media through the emergence of 'citizen journalism'. Individuals can make their voices heard worldwide, whether through blogging, podcasts, or sharing opinions on sites like Digg.com. Due to the creation and co-creation possible on the Web, control of information has shifted from being highly centralised (through, for example, major media outlets) to highly distributed.

Collaboration and co-creation enable 'collective intelligence' or distributed cognition. For example, 'We Are Smarter Than Me' is a book project where the material was developed using a wiki. Collective intelligence recognises that nobody knows everything but that everyone knows something. Diverse groups of people can pool knowledge, research, debate, and create new insights thanks to a networked culture that is redefining power structures.[15]

Collective intelligence is a powerful force that is reshaping what our traditional IT infrastructure is capable of. One of the distinctions between traditional IT infrastructure and cyber-infrastructure (or e-science) is the enablement of distributed cognition, where the infrastructure has a role in creating social connections and facilitating the work of virtual organisations. 'Professional scientists and amateur enthusiasts form virtual research communities advance the study of astronomy, ornithology, and other fields that rely on the collection of large data sets. No longer the exclusive purview of credentialed scientists, data collection and analysis is open to all interested parties. With distributed cognition, contributors come from all walks of life, information flows in multiple directions, and a bottom-up energy drives discovery.'[16]

Moving beyond text

Students seem to be more at home with images (icons, video, photos) than text – the opposite of what most educators consider their comfort zone. According to a 2005 study, more than one half of all American teens – and 57 per cent of teens worldwide who use the internet – could be considered media creators, producing blogs and Web pages, posting original artwork, stories, or videos

[14] Amanda Lenhart and Suzannah Fox (2006). 'Bloggers: A portrait of the internet's new storytellers.' **http://www.pewinternet.org/pdfs/PIP%20Bloggers%20Report%20July%2019%202006.pdf**

[15] Henry Jenkins. November 27, 2006. Collective Intelligence vs. The Wisdom of Crowds. **http://www.henryjenkins.org/2006/11/collective_intelligence_vs_the.html**. Accessed October 2, 2007.

[16] Diana Oblinger and Marilyn Lombardi (2007). 'Common Knowledge: Openness in Higher Education.' In Toru Iiyoshi and M. S. Vijay Kumar (Eds), *Opening Up Education: The Collective Advancement of Education through Open Technology, Open Content, and Open Knowledge*. MIT Press, Cambridge MA.

online or remixing the online content of others.[17] Students capture images with mobiles or video cameras then share experiences with friends and strangers alike through MySpace or Facebook-like environments.[18] Socialising involves images as well as text. And, visual literacy is an important part of digital literacy.

Today's visual options are expanding rapidly. Students email photos from their mobile phones but also post images on Flickr. Video can be shared on YouTube or on sites designed for young people such as UthTv. But images represent only one possible dimension. For example, Flickr goes beyond just photo sharing – users can geotag photos, pinpointing the photo's exact latitude and longitude. Images can be integrated with Google Maps as well, allowing users to populate locations with their own tags and documentation, sharing a personal history associated with the space.[19]

Another media form is the mashup, which combines stand-alone technologies into a novel application, allowing users to put together different types of data. Mapping mashups, in which maps are overlaid with information, may be the best known example of this rapidly growing genre. Some mashups provide details for specific locations. Others bring together different data sources, such as combining crime data with location information (ChicagoCrime.org for example). A music mashup mixes tracks from two different source songs. Tools (for example, Google's Mashup Editor, Intel's mashup maker, or MIT's Piggy Bank [http://simile.mit.edu/wiki/Piggy_Bank]) allow non-technical individuals to mix up data, find new meaning, and present it in interesting ways. Educationally, mashups can be extremely valuable (helping students integrate previously disparate types of information), but they are not without their cautions (such as use of others' intellectual property).

Many educators express concern that students do not read – well or enough. Yet we find ourselves in an increasingly visual world. Graphic representations sometimes reveal relationships in data, for example, that could not be readily discerned from tables of numbers. Applications are emerging that capitalise on visual relationships (for example, Quintura [http://www.quintura.com] which displays visual relationships; their website promotes Quintura for kids as the first 'visual search engine for the youngest Web users'). Visuwords [http://www.visuwords.com] allows users to look up words to find their meaning as well as discover associations with other words and concepts, which are displayed graphically.

[17] Henry Jenkins with Katie Clinton, Ravi Purushotma, Alice J. Robinson, and Margaret Weigel (2006). 'Confronting the Challenge of Participatory Culture: Media Education for the 21st Century.' **http://digitallearning.macfound.org/atf/cf/%7B7E45C7E0-A3E0-4B89-AC9C-E807E1B0AE4E%7D/JENKINS_WHITE_PAPER.PDF** Accessed February 2, 2007.

[18] Cyprien Lomas and Diana Oblinger (2006). Student Practices and their Impact on Learning Spaces. In *Learning Spaces*.

[19] Ibid.

But even visual images may merit enhancement. A team of researchers at Zhejiang University is developing the Emoplayer, a tool that highlights the emotional state of the characters on a video timeline. The emotional markers make it easier for users to navigate video content compared to standard media players. Users who search with emotional markers find the desired segments more quickly than those using traditional search techniques.[20]

Blending real and virtual worlds

Today's students grow up playing video/computer games, join guilds in massively multiuser online games (such as World of Warcraft), and participate in virtual worlds (such as Second Life). Students blend the real and virtual worlds, moving seamlessly between them.

For example, immersive multiplayer virtual environments let players participate in new worlds, inhabiting roles that would otherwise be inaccessible to them. They allow people to think, act, and talk in new ways. Rather than relying on words and symbols, learners experience the virtual world – participating in a mission to Mars, experiencing a native culture, travelling through the human body. In these virtual worlds students assume the role of an expert, experiencing how a particular discipline thinks about and solves problems, as a physicist, an astronaut, an anthropologist, or a physician. As a member of a community of novices and experts, learners develop knowledge, skills and values; novices are exposed to the ways professionals deal with problems, mirroring the practice of being an expert.[21]

Augmented reality is another example of blending real and virtual environments, in which digital information is superimposed on the real world, many times involving a handheld device or mobile phone. Users can view the Empire State Building, for example, and superimpose on its image the names of businesses in the building, the cost of visiting the building's observatories, or hours and menus for its five restaurants.[22] Such techniques can be used for nature walks, museum tours, or simulations (Environmental Detectives for example[23]).

Students are also taking advantage of geotagging to leave 'virtual messages' that can be read by handhelds at specific physical locations. Some campuses are encouraging students to geotag places of importance to them or to explain the history of the campus. Others use geotagging as the basis of games, such as virtual scavenger hunts.

[20] **http://www.newscientist.com/blog/technology/2007/07/adding-emotions-to-online-video.html**

[21] Diana Oblinger (2006). 'Games and Learning.' EDUCAUSE Quarterly 29(3): 5-7. **http://www.educause.edu/ir/library/pdf/eqm0630.pdf**

[22] **http://www.technologyreview.com/Infotech/18291** Accessed October 2, 2007.

[23] **http://education.mit.edu/ar/ed.html**

Misconceptions/assumptions

Technology preferences

Although the effortless use of technology by this generation may be striking, appearances are often deceptive. While this generation shows no fear of technology, 'digital comfort' does not necessarily mean technology proficiency – particularly with academic tools. When queried, students often advise, "Don't assume we can plug a formula into Excel. Or that we know how a wiki works. Sometimes it is just new to us."[24] Nor does comfort with technology equate to a full appreciation of issues such as intellectual property, privacy or security. When asked, most students confess, "Sometimes we just don't think about what we're doing online."

Information fluency

Students need to know how to find and use information, and technology is a critical enabler. However, only 31 per cent of information searches are successful.[25] Just because students know how to open a Web browser, educators should not assume that everyone knows how to search for information. And just because students can find information doesn't mean it is reputable or truthful. As a do-it-yourself culture where we find information for ourselves online, we need the skills to vet what we find, understand the context in which the information is situated, and adjust our interpretation accordingly. Also, in a cut-and-paste and mashup-friendly environment, students must develop an appreciation for intellectual property and the work of others.[26]

Access to technology

In a wired world it is easy to assume that all students have access to a computer and the network, whether at home or at school. However, a digital divide still exists in many communities – one defined as more than just having access to a computer. A 'second-level digital divide' may exist based on machine vintage, connectivity, online skills, autonomy and freedom of access, and computer-use support.[27] Another common assumption is that all students are attracted to technology. No group is entirely homogeneous. Not all students have computers, not all are skilled users, and not all want to use technology.

[24] Carie Windham. Father Google and Mother IM: Confessions of a Net Gen Learner. Presented at ELI Annual Meeting, January 23, 2007. **http://connect.educause.edu/library/abstract/FatherGoogleandMothe/39228**

[25] Study from Information Online conference.

[26] DianaOblinger (2007). 'Becoming Net Savvy.' EDUCAUSE Quarterly 30(3): 11–13. **http://www.educause.edu/ir/library/pdf/eqm0731.pdf**

[27] Hawkins, Brian and Diana Oblinger. July/August 2006. 'The Myth about the Digital Divide.' EDUCAUSE Review 41(4): 12-13. **http://www.educause.edu/ir/library/pdf/erm0647.pdf**

Maturity

It is easy to assume that learners – with their tech-savvy attitudes and world-wise veneer – have greater maturity than their years. We are cautioned that this presumption of maturity is unfounded on many levels. In a multi-tasking, fast-forward world, learners may not be stopping to reflect on what they know, how they behave, and the values they hold. In fact, the tendency of young people to not be reflective – to pause, think, and ponder – may simply be a characteristic of youth. However, in an environment where students are posting their lives on the internet, stopping to consider what they are doing and its future impact is essential. It is all too easy for students to follow their peers and not stop to consider whether their behaviour mirrors their values and beliefs. Just as students may not reflect on their online behaviour, they may not reflect on their learning habits.

Becoming net savvy

Although we may assume students are technologically savvy, most indications are to the contrary. As a result, educators, parents and communities must develop the policies and practices that students need. Although specific policies must be determined in a local context, some questions may guide their development. For example:

- Whose responsibility is it to help students be thoughtful in their use of the internet, whether that means limiting the amount of personal information posted online or not assuming that 'childish pranks' are easily erasable on the internet?
- In an environment in which it is all too easy to cut-copy-and-paste, how do we ensure students develop respect for intellectual property and the ethical use of information?
- How do we ensure that all students have the opportunity to develop the requisite technology skills, whether or not they have access to a computer at home?
- How do we ensure that information fluency becomes a habit of mind rather than of an isolated library requirement if parents, teachers, and staff do not integrate into their daily interactions with students?
- How do we ensure that students develop the critical thinking skills necessary to survive and thrive in an age when anything (true or false) can be found on the internet? What programs will help students develop understanding based on evidence, critical thinking, values, and dialogue rather than the first item on a Google search?

The goal is to ensure that our students – and the rest of us – are net savvy. 'Becoming net savvy isn't a one-time affair – it is a lifelong educational process – and something that should be integrated into all aspects of our lives. Ensuring that we are all net savvy will require a team effort – libraries, IT, instructors, parents, community centres, and others. It calls for a protracted effort, starting in the early years, extending throughout life. Being net savvy – or not – is no longer an option. It is an imperative in the age of information.'[28]

Implications for education

Student needs and expectations, the technological and pedagogical tools available, as well as what it means to be educated in the 21st century are leading educators to envision education that is interactive, engaging and challenging. We are also learning that students may be among the best advisors on how to strengthen education.

What it means to be educated

Education designed for the economic processes and institutions of the 20th century may only prepare students to work in organisations that are now rapidly becoming obsolete. In the future, more students will run their own businesses rather than work for others. More jobs will be created in small, medium, and entrepreneurial firms than in large multi-nationals. Workers must constantly, quickly, and efficiently learn new skills and information. Today's students must graduate able to deal with ambiguity and capable of higher-order analysis and complex communication.[29]

Learners need skills that go far beyond reading, memorisation and communication. Educational institutions have an obligation to help students cultivate those skills that learners have the most difficulty attaining on their own, such as:

1. judgement, or the ability to distinguish the reliable from unreliable information
2. synthesis, or the capacity to follow the longer argument or narrative across multiple modalities

[28] Diana Oblinger (2007). 'Becoming Net Savvy.' EDUCAUSE Quarterly 30(3): 11–13. **http://www.educause.edu/ir/library/pdf/eqm0731.pdf**

[29] Dede, Chris, Spence Korte, Robert Nelson, Gil Valdez, and David J. Ward (2005). 'Transforming Learning for the 21st Century: An Economic Imperative.' Naperville, IL: Learning Point Associates. **http://www.learningpt.org/tech/transforming.pdf** Accessed February 2, 2007. Page 3.

3 research, or the activity of searching, discovering, and disseminating relevant information in a credible manner

4 practice, or the opportunity to learn-by-doing within authentic disciplinary communities

5 negotiation, or the flexibility to work across disciplinary and cultural boundaries to generate innovative, alternative solutions.[30]

Expansion of learning opportunities

Today's students are motivated by solving real-world problems, preferring to do rather than simply listen, and most educators consider learning-by-doing the most effective way to learn. There is a significant difference between learning about physics and learning to be a physicist, for example. Isolated facts and formulae do not take on meaning and relevance until learners discover what these tools can do for them. Immersive and authentic learning environments, such as simulations, visualisations, haptics, augmented reality or virtual worlds can be both engaging and motivating.[31]

Virtual worlds

A virtual world is an online environment whose 'residents' are avatars representing individuals participating online. The functioning of a virtual world can mirror that of the real world, or it can allow residents to do such things as fly, wander around underwater, or teleport themselves to other locations. Today's virtual worlds are immersive, animated, 3D environments that operate over the internet, giving access to anyone on the world. Dartmouth College, for example, is creating a virtual world to train community emergency response teams. Harvard University created River City, a virtual world that presents users with an outbreak of disease, allowing them to move through the environment, make inquiries, and examine data to try to discover the source of the illness.[32]

Consider, for example, a virtual world that is a clinic in which Marie, a first-year medical student, assumes the role of a doctor through her avatar. The world closely mimics a real doctor's office, and Marie 'walks' her avatar into an examination room, where she finds a patient waiting. By typing dialogue, Marie speaks to the patient, introducing herself, and the patient stands up and introduces himself. An important element of becoming a doctor is learning how to interact well with patients, and the virtual clinic gives Marie an opportunity to do that. Marie's avatar and the patient – who is the avatar of

[30] Jenkins, et. al. (2006), 4.

[31] Marilyn Lombardi (2007). Authentic Learning for the 21st Century: An Overview. **http://www.educause.edu/ir/library/pdf/ELI3009.pdf**

[32] 7 Things You Should Know About Virtual Worlds. June 2006.

another medical student – talk about what's bothering the man, which turns out to be a flare-up of gout. Controlling her avatar through the interface, Marie asks questions, reads the patient's chart, and conducts a clinical examination. Faculty monitor the sessions in the virtual world and can interrupt to offer suggestions about better ways to ask certain questions and to earn the patient's confidence. Because it has both real and simulated components, Marie finds that the interface to the virtual world requires her to be extremely conscious of her actions and the words she uses when interacting with patients, a skill she understands she will need to apply when in a real office with real patients.[33]

Remote instrumentation

Remote instrumentation provides control of scientific instruments over a network from remote locations, such as telescopes, shake tables, or electronics equipment. Because of their expense and complexity, many specialised scientific instruments are out of the reach of some institutions; even for those that can afford them, scheduling and other logistical issues may prevent full utilisation of those tools. Remote access addresses issues of access and efficiency, providing students with real experiences, ultimately improving educational quality.[34]

Think of a scenario in which a consortium of universities and oceanographic institutes installs a bank of sensors and testing equipment on the ocean floor, as well as atmospheric instruments at the water's surface. The project includes underwater cameras, water-sampling and analytical tools, and other devices to monitor and measure a wide range of oceanographic and meteorological activity. The equipment is linked to the institutions in the consortium, where researchers and faculty can control the devices. Dr Morgan, a biology professor at one of the participating institutions, frequently turns to the undersea lab to demonstrate experiments and show students the results. He can control video cameras on the sea floor, collect water samples and feed them into a tool that analyses pH and other parameters, and even position the water sample under a microscope, all through a browser interface. He uses data from the instruments to show the class correlations between atmospheric conditions and the conditions of the water and marine life. Outside class, students can perform most of the same manipulations from their dorm rooms, repeating experiments to see how the results change over time or devising new tests. Students at other universities can also access the instruments, and the undersea lab is in use most hours of the day, transmitting data and observations across the internet.[35]

[33] Ibid.

[34] 7 Things You Should Know About Remote Instrumentation. April 2006.

[35] 7 Things You Should Know About Remote Instrumentation. April 2006.

Augmented reality

Many of today's students move seamlessly between the physical and virtual worlds, and blending the two can provide a valuable learning environment. Augmented reality does this, but adding digital information to a real object or place. Unlike virtual reality, augmented reality does not create a simulation of reality but takes a real object or space and incorporates technologies that add contextual data to deepen a person's understanding of the subject.[36]

Josie, a student who missed a field trip to a botanical garden, for example, might use augmented reality make up that trip on her own, using a guided tour that the professor created. She would go to the garden and launch the tour, which is loaded on her PDA. Josie starts at a cedar, which, according to the material on her PDA, is more than 500 years old. As she approaches the tree, the GPS in her PDA notes her location, and she hears a recording of the professor giving his theory about the role that trees like this one play in the ecosystem. As she moves through the garden, she selects photos and movies of other trees, depicting the history of the garden, seasonal differences, and changes that have occurred. In addition to the material supplied by the professor, Josie can also download the notes, photos, and keywords that the rest of her class recorded when they took the field trip. She adds her own observations, assigning appropriate keywords and GPS coordinates to her notes.[37]

Mapping mashups

Mapping mashups overlay data on maps with clickable markers showing specific points of interest. Data interoperates with an online mapping service, putting information in a geographic context. In a wide range of academic disciplines, understanding the geographical context of places and events is central to a deep comprehension of the subject matter. Mapping mashups do this by combining a mapping tool with other applications and online resources to create interactive learning experiences.

Consider a history course about World War II, for example. The instructor, Dr Martinez, develops a mapping mashup that represents major events leading up to and during the war. Users can navigate around the world with the tool, zooming in and out, showing the map with dates and events superimposed. When students zoom in on Europe, for instance, they see markers scattered around the continent and into Asia. When clicked, each marker opens a pop-up box that names the location, explains what happened there and when, and shows a photograph of that site. The markers correspond to important battles, political events, treaties that were signed, and cities such as Vichy, the wartime capital of France. The text in each box also includes links to articles that talk in depth about what took place in each location and its significance.[38]

[36] 7 Things You Should Know about Augmented Reality. September 2005.

[37] Ibid.

[38] 7 Things You Should Know about Mapping Mashups. July 2006.

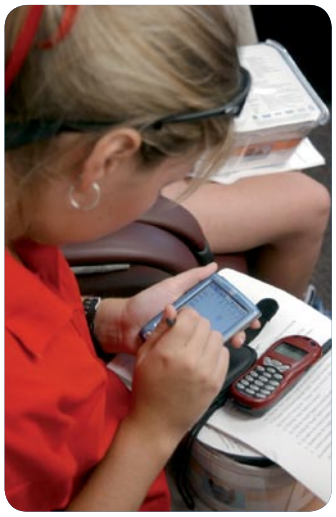

Photo: Department of Communications, North Carolina State University

Data visualisation

Data visualisation is the graphical representation of information. Bar charts, scatter graphs, and maps are examples of simple data visualisations that have been used for decades. Although data visualisations have long been used in academic settings, instructors are using new technologies that combine the principles of data visualisation with powerful applications and large data sets. The results are rich, compelling visualisations, including sophisticated images as well as animations, that help students understand concepts more quickly and deeply than with older tools.[39]

Imagine a data visualisation tool designed to help athletes improve their performance. Olivia, a graduate student in kinesiology, works with faculty in the computer science department to develop a data visualisation tool that correlates data including average, resting, and maximum heart rate; lactate threshold, blood oxygenation, and other variables. The tool creates 'pictures' of the performance of members of the track team. Each image looks something like a 3D map of hilly terrain, with colour differences that reinforce the contours. Peaks represent efficient performance, and the runners can see in visual terms how their performance is affected, for example, by exceeding their aerobic thresholds. During treadmill workouts, the athletes can watch a computer screen that displays visualisations based on data collected in real time. In this way, the runners can watch a representation of their efficiency and see how it changes as they modulate their effort or change their breathing patterns. Over the course of a semester, Olivia could use the tool to help the runners understand – through the visual representations of effort and efficiency – the factors that most benefit and hurt performance. One runner might discover that her performance is maximised by a very even effort, whereas another might find that her best time comes from varying her intensity. The visualisations might show previously hidden correlations between weight training and aerobic capacity, leading to changes in the training programme for the whole team.[40]

Digital and convenient

Today's students use the computer as their notebook, locker, backpack, and organiser.[41] They expect technology to provide solutions for their wants and needs. Students say they want more 'learning-on-the-go' options and mobile device services to align with their mobile lifestyle. Others ask that applications be integrated so students can access their schedules, campus events, and other information from the same login.

[39] 7 Things You Should Know about Data Visualization. October 2007.

[40] Ibid.

[41] D. Levin and S Arefeh. August 14, 2007. The Widening Gap Between Internet Savvy Students and their Schools. Pew Internet & American Life Project.

Students expect cross-platform access to content, the ability to download and upload material, and the integration of digital media in their learning tasks.[42] They ask that course content, class notes, lectures and syllabi be searchable with common tools such as Google and available 24x7. Students also suggest that a wide array of courses should be available online, providing greater flexibility than traditional class schedules and that lectures be available as video-on-demand.[43]

The ways institutions communicate with students today, mostly in text, are described by students as 'flat'. Students suggest more visual options. They see opportunities to use multimedia to enrich services as well as courses. For example, students suggest that information in a degree audit would be more understandable with a graphic interface rather than lines of text. They advocate maps pinpointing open parking spaces or open computers in the library.

Students also suggest that institutions might do more to foster a sense of community among students. Remembering that our current generation of learners does not limit the definition of communication to face-to-face interaction, suggestions include integrating social technologies in institution websites, allowing students to share photos, using social bookmarking, and blogging.

Peer production

The Economist has declared that the era of peer production has arrived.[44] 'From Amazon.com (where much of the value comes from millions of customer reviews) to MySpace to Craigslist, the most successful Web companies are building business models based on user-generated content.'[45] It is a model that has instant credibility and applicability in education. The open-source movement epitomises peer production.

Open educational resources, or the sharing of teaching materials (content modules, courseware, learning objects, online learning communities), is an increasingly popular model. Notable examples include MIT's OpenCourseWare or Open University's OpenLearn. While an open source model brings advantages, it challenges our existing educational practice of assessment and attribution. How does the community judge the quality of its collective output? Who receives credit for creating it?

[42] Ibid.

[43] A Net Gen Student Perspective: Technology in Higher Education. May 7, 2007. **http://www.educause.edu/ELIWEB075**

[44] *The Economist*. April 22, 2006.

[45] Brenda Gourley. March 23, 2007. 'How Technology is Shaping Educational Agendas' Presented at the 36th Scottish Council Forum.

Control and authority

In an environment where an instructor's statements can be immediately verified or discounted – based on information on the internet – and in a world of collective intelligence, 'control' and 'authority' take on different meanings. Whether due to the internet or the current generation's empowerment, the automatic acceptance of academic authority is a thing of the past.[46]

Institutions cannot control content because so much is on the Web, and many web-based resources have been created by amateurs rather than by institutionally appointed authorities. In addition, in a Web 2.0 world, those resources might have been remixed by someone else. The traditional assumption that information comes from the library, which implies quality control by publishers, peer-review panels, and librarians, is no longer guaranteed to be true. Students seek information on the internet first; visiting the library stacks may be a relatively rare occurrence. In fact, many students have a very limited working knowledge of the library. What has become increasingly important is helping students develop information fluency or becoming 'net savvy'.[47]

Authority in an internet world may be based more on reputation and the strength of one's network than on educational credentials or position. Where in one's academic credentials do you cite your reputation as a blogger or tout how popular your YouTube video is?

[46] Mark Taylor (2006). 'Generation NeXt Comes to College: Today's postmodern student.' **http://globalcscc.edu/tirc/blog/files/Gen%20NeXt%20handout%2006%20oln.pdf** Accessed September 19, 2007.

[47] **http://www.educause.edu/ir/library/pdf/ELI3006.pdf, http://www.educause.edu/ir/library/pdf/ELI3008.pdf**

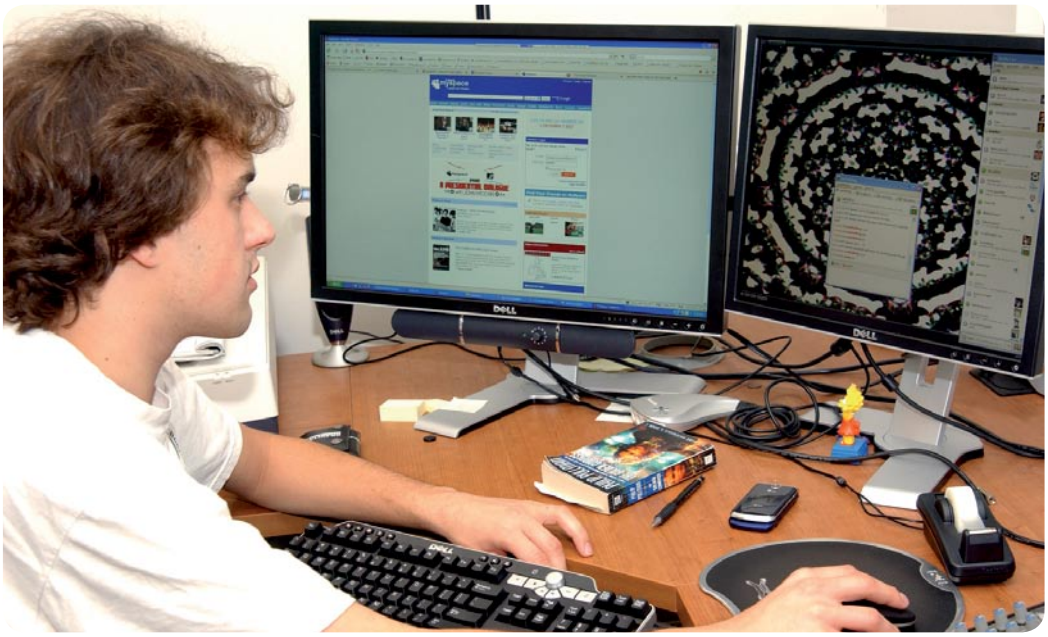

Photo: Department of Communications, North Carolina State University

Newspapers and media outlets have learned that citizens may have the hottest stories or the most relevant photos that can augment the historic strength of media channels. Wikiversity 'put [traditional institutions] on notice that even the world of education will be challenged by this new world where lectures are turned into conversations among people formerly known as the audience.'[48]

Although today's students don't necessarily generate course content, there is nothing to preclude that in the future. Some envision a global networked community of tutor and student volunteers who would produce resources that are evaluated and ranked by the community as a whole. The model might mirror today's open source or internet 'reputation' model. Rather than the content being fixed, it could be distributed globally to be sampled, mashed up, remixed, and re-contextualised for local use.[49]

Learning spaces

Space can open opportunities for new pedagogies, interactions, and connections, particularly since wireless technology makes it possible for almost any place to be a learning space. Beyond classrooms, institutions are redesigning space to ensure that student learning and interaction with faculty can take place across the entire campus. Libraries are being transformed to information commons, where the floor-to-ceiling book stacks and carrels designed to ensure solitude and silence are giving way to open spaces where technology is integrated with talk and food. Whether the conversation is about math, music, or football, space can bring people together providing them with opportunities to learn from others – academically, socially, culturally.[50] Institutions are:

- designing space around learning rather than instruction
- creating socially catalytic spaces – places where people meet, congregate, and socialise
- integrating technology in spaces and putting services where students are
- involving users in the design of spaces.

[48] Brenda Gourley. March 23, 2007. 'How Technology is Shaping Educational Agendas' Presented at the 36th Scottish Council Forum.

[49] Hylén, Jan (2006). 'Open Educational Resources: Opportunities and Challenges.' **http://www.oecd.org/dataoecd/5/47/37351085.pdf** Accessed February 13, 2007

[50] Diana Oblinger (2007). What Growing up with Google may mean to graduate education. Council of Graduate Schools Communicator.

Changing mental models

An ongoing challenge is changing educators' mental models and assumptions about learners, technology, and the skills needed in a global economy. The default is a model in which learning and teaching take place in a classroom, yet we know that most learning occurs outside formal educational settings. Even those who go beyond the limitations of assuming learning happens in the classroom may have difficulty getting past the assumption that learning takes place in a course. Although we may have many mental models to update, a few examples illustrate the challenge.

Technology allows us to store massive amounts of information; the internet and search tools make it almost instantly accessible. If so, does memorisation lose some of its value? Are tomorrow's best learners those who can use the tools and technologies to sift, search and synthesise information or those who can memorise places, numbers, and formulas? Is knowing something or knowing how to make a decision more valuable? 'Will the ability to synthesise information become the primary goal of education?'[51] In a world full of images, audio, and spatial relationships, do schools put less emphasis on reading and print and more on other skills?[52] Is individual effort most important, or has thinking become a distributed activity – among people, devices, and digital resources?[53]

If the most important skills in the 21st century are finding information and experts, engaging in complex communication, solving ill-defined problems, and making decisions, what are the implications for testing and assessment practices? Should exams be given without access to books, calculators, and the internet, or is the real measure of a learner's skill demonstrating how to use the tools and technologies to augment their own capabilities?

Other mental models also present challenges. Many of our students, and their parents, are focused on achievement: 'getting an A' so they can get a good job. If there is too much focus on getting the grade – and getting it as easily as possible – students may not be learning all they should. Problem-based learning methods and authentic learning models have been proven to be highly effective. However, students often complain that these alternative approaches require too much time. We need to help our students, parents, and communities see the value in these more complex learning environments. If instructors and students don't see the value of putting additional work into learning, it will be impossible to change the status quo or improve the competitiveness of the future workforce.

[51] Futurelab (2007). *2020 and Beyond*. **http://www.futurelab.org.uk/resources/documents/opening_education/2020_and_beyond.pdf** Accessed September 19, 2007. Page 19.

[52] Ibid, p.25.

[53] Ibid.

Our mental model for educational resources tends to be that we create something (such as a textbook) and it is fixed. What does developing academic material mean in a world of mashups and co-creation? Since the traditional tenure/merit and peer system is strongly linked to publication record, do you only step outside that model at your professional peril? Does it mean our students should be learning how to co-create or remix material rather than just authoring it? What advice does the academy have for Web 2.0 skills? The potential implications of Web 2.0 on education – and society – are extensive.

Conclusion

Our assumptions about students and what is best for their education may not be matched by today's reality. It is dangerous to assume that we understand students simply because we were once in the same shoes. Times change. Technologies change. Students change. And so does education.

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