Emerging Technologies for Learning

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Becta

Contents

Foreword

Welcome to the second edition of Becta's *Emerging technologies for learning*. It is important for many reasons that the education sector remains continually alert to technology developments and possibilities, not least because those developments, and related implications, can be very rapid. This is particularly true in the context of young peoples' everyday uses of technology and approaches to using technology in professional and other environments to enhance knowledge development and transfer.

In last year's edition, for example, we noted the importance of developments in social networking and Web 2.0 to educational uses of technology. Already we can observe an increasing range of educational activities which incorporate the use of those technologies. It is essential that educators can learn from those examples to understand what's effective and sustainable in supporting learning.

Our first edition, published in 2006, was both popular and well-received within the education sector. Most importantly, however, it has helped generate discussion and debate about the role of emerging technologies in the development of education.

It is important that those debates continue. As you will see from this new edition, technology developments touch on some fundamental issues and questions in learning practice. A central issue is the role of both the learner and their community in the development of knowledge and understanding. Many technology tools promote active, participatory and collaborative knowledge building. We need to understand how effective those approaches are in practice and discuss the implications for education and education professionals.

I hope this publication stimulates that discussion and debate. As ever, Becta always welcomes your feedback on the value of publications of this kind. If you have any views on the ideas in these articles that you would like to share with us, we are more than happy to receive and respond to them.

Stephen Crowne
Chief Executive

Introduction

Thus the task is not so much to see what no one yet has seen, but to think what nobody yet has thought about that which everybody sees.

Schopenhauer

Emerging technologies for learning aims to help readers consider how emerging technologies may impact on education in the medium term. The publication is not intended to be a comprehensive review of educational technologies, but offers some highlights across the broad spectrum of developments and trends. It should open readers up to some of the possibilities that are developing and the potential for technology to transform our ways of working, learning and interacting over the next three to five years.

This follow-up edition complements the original document published in March 2006. It offers new perspectives and challenges in the light of a rapidly changing technology landscape. However, *Emerging technologies for learning* is not intended to present a unified view of the future. It deliberately presents a broad range of opinions with the intention that they will stimulate debate and challenge current thinking.

We have been able to expand the range of experts to offer their own particular takes on how technology developments may affect the future of education. You will find some echoes of articles in the earlier publication and some new directions. An overarching theme is that of knowledgeable users customising their tools, services, sources of information, methods of communication and networks of people to suit their personal needs. Distinctions between learning, socialising, working, playing and entertainment are beginning to blur, along with when, where and with whom these activities take place.

A recent Demos study looked at the way many young people are using technology in every part of their lives. It examines some of the softer skills such as creativity, communication and collaboration they are developing through the use of technology. These skills will be increasingly important in a globally networked, knowledge economy.

> The current generation of young people will reinvent the workplace, and the society they live in. They will do it along the progressive lines that are built into the technology they use everyday – of networks, collaboration, co-production and participation. The change in behaviour has already happened. We have to get used to it, accept that the flow of knowledge moves both ways and do our best to make sure that no one is left behind.
>
> *Their Space: Education for a digital generation* (Green, H., Hannon, C., Demos, 2007)[1]

Some of the technologies and trends discussed in this publication are already beginning to have an impact; others are only just beginning to be explored, but show potential: The future is already here – it's just unevenly distributed[2] (William Gibson).

1 [http://www.demos.co.uk/files/Their%20space%20-%20web.pdf]

2 William Gibson, quoted in the *Economist*, June 23, 2000

Articles in this edition include:

Emerging trends in social software for education

Lee Bryant (Headshift) examines the development and convergence of social software tools and services and the wider Web 2.0 ecosystem. He looks at how these connected networks of people, data and services offer great potential for education and the ability to help socialise and personalise learning.

Learning networks in practice

Stephen Downes (NRC) explains network theory, which puts the network at the heart of learning. Learning networks prioritise learning in communities, content creation and context based learning. He explores the emerging concept of the Personalised Learning Environment (PLE), a loose collection of tools, services, people and resources, as a way of harnessing the power of the network. This approach would promote autonomy, encourage diversity, enable interaction and support openness.

The challenge of new digital literacies and the 'hidden curriculum'

Jo Twist (ippr) looks at how young people are using digital media and new technologies outside of the classroom. She explores the challenges for education in understanding this 'hidden curriculum' and the need to teach the skills, knowledge and digital literacy for young people to become full participants in the networked knowledge society.

How to teach with technology: keeping both keeping both teachers and students comfortable in an era of exponential change

Marc Prensky looks at the challenges for some teachers in trying to keep up with the speed of technology developments and the 'digital natives' they find in their classrooms. He suggests a possible approach to this problem which allows each group to make the best use of their particular strengths.

Computer games in education

In these two articles Futurelab and Tim Dumbleton (Becta) look at the use of commercial games in education. Keri draws on research carried out by Futurelab/Electronic Arts to explain what happens when commercial computer games are put into an educational setting, including the tension between the aims of games and those of the curriculum. She goes on to explore whether consumer games have a place in formal education. Tim looks in detail at what elements make games so popular, engaging and motivating including the cultural factors. He discusses whether these elements can be 'bottled' and used to improve future educational software.

Ubiquitous computing

David Ley (Becta) explores how a range of technologies are enabling computing to move from the virtual to the physical world as more devices, objects and places become connected and addressable. This is already providing potential for innovative uses in education and a whole new set of real-world interactions for learners. Eventually ubiquitous computing could offer a much more intuitive and intelligent interface for humans to use the power of computer systems.

Previous edition

The first edition of Emerging technologies for learning (March 2006) covered five technology areas:

- Mobile learning (Geoff Stead)
- The ambient web (Bill Sharpe)
- Human computer interaction (Paul Anderson)
- Social networking (Leon Cych)
- The broadband home (Michael Philpott)

Copies can be downloaded or ordered from the Becta website: **http://www.publications.becta.org.uk**

Although technology has moved on incrementally since the last publication, the articles are forward looking enough to still be relevant now. Therefore this new edition of *Emerging technologies for learning* should be seen as complementary to the last edition and is not intended to replace it.

Emerging technologies discussion forum

A discussion forum has been set up at:

http://communities.becta.org.uk/technology/emergingtechnologies

We would encourage you to become involved in the forum as your feedback and thoughts on this publication are valuable to us.

The discussion forum aims to provide a space to:

- Respond to and discuss the articles in *Emerging technologies for learning*
- Suggest ideas and themes for any future editions of *Emerging technologies for learning*
- Propose writers for any future editions of *Emerging technologies for learning*
- Inform other readers of developments in technology and encourage debate around them

You can also send us your feedback on the publication via email to: **emtech@becta.org.uk**

Useful resources

TechNews

In order to keep up to date with relevant developments in technology we would also encourage you to sign up to Becta's TechNews service.

TechNews is a technology news and analysis service aimed at those in the education sector keen to stay informed about technology developments, trends and issues.

Each issue contains news related to the following main subject areas:

1. Networking and wireless
2. Hardware
3. Multimedia
4. Software and internet

Each subject area has a news section and a more detailed analysis piece which highlights the potential impact and likely future direction of a particular technology.

TechNews is published as a PDF once every half-term. Readers can either become subscribers to TechNews, or it can be downloaded directly from the website. An archive of back issues is also available.

To subscribe to TechNews or download previous issues please visit our website:

http://www.becta.org.uk/technews

Becta technology research

Becta commissions and manages various research projects on ICT in education. Recent projects looking at specific technologies in education include the Tablet PC evaluation and the Thin Clients in schools study.

Reports from Becta research can be downloaded from:

http://www.becta.org.uk/partners/research

The writers

Lee Bryant, Headshift

Lee is a founding director of Headshift, a leading social software consultancy and implementer, and a regular speaker and writer on the role of online social networking in transforming business, education and public participation. He has been playing with words and computers since the age of 10, and has been creating innovative online applications for over a decade. He is also a board member of the social enterprise Involve, which focuses on new forms of public participation and a trustee of the Foundation for Science Technology and Culture. **http://www.headshift.com**

Stephen Downes, National Research Council of Canada

Stephen Downes is a senior researcher with the National Research Council of Canada based in Moncton, New Brunswick at the Institute for Information Technology's e-Learning Research Group. Stephen has become a leading voice in the areas of learning objects and metadata, weblogs in education, content syndication, digital rights and related issues. Stephen is perhaps best known for his daily research newsletter, OLDaily (short for Online Learning Daily), which reaches thousands of readers across Canada and around the world. His work also includes the development of educational content syndication systems such as Edu_RSS and DLORN along and the design of a digital rights management system for learning resources. Stephen is also frequently to be found on the road giving seminars and lectures on the field of online learning.

Jo Twist, ippr

Dr Jo Twist is Senior Research Fellow and heads up the Digital Society & Media research team at the Institute for Public Policy Research (ippr), the UK's leading public policy think tank. Before joining the ippr in 2005, she spent five years at the BBC, starting at CBBC Newsround where she was involved in shaping the programme's online community, news, and interactive content. Between 2003 and 2005, Jo was technology reporter for the BBC News website, covering most aspects of citizen/consumer technologies and participatory media. Before joining the BBC, Jo was a cultural geographer at the Centre for Urban Technology (CUT) at the University of Newcastle where she completed an ESRC/BT Case Award PhD (1997-2000) on virtual communities, young people, and the UK Government's vision for an inclusive information age. Jo blogs and podcasts in her spare time, and contributes to BBC TV and radio regularly. She also writes for a monthly BBC Ariel newspaper column, Cutting Edge.

Marc Prensky

Marc is an internationally acclaimed thought leader, speaker, writer, consultant, and game designer in the critical areas of education and learning. He is the author of Digital Game-Based Learning (McGraw Hill, 2001) and Don't Bother Me, Mom, I'm Learning (Paragon House, 2006). Marc is the founder and CEO of Games2train, a game-based learning company, whose clients include IBM, Bank of America, Pfizer , the U.S. Department of Defense and the LA and Florida Virtual Schools. He is also the creator of the sites **www.SocialImpactGames.com**, and **www.GamesParentsTeachers.com**. Marc holds an MBA from Harvard and a Masters in Teaching from Yale.

More of his writings can be found at **www.marcprensky.com/writing/default.asp**

Keri Facer, Futurelab

Keri Facer is Research Director, Mary Ulicsak and Richard Sandford are Learning Researchers at Futurelab. Futurelab is a charity with a remit to explore the implications of emerging technologies for education through prototype development, classroom based research, and workshops, seminars and conferences bringing together representatives from technology, education and creative media sectors. Previous projects the team have worked on include ESRC funded projects such as ScreenPlay: children's use of computers in the home, and the TLRP project 'InterActive Education', major DFES evaluation studies of ICT in education, and a range of prototype development projects in the fields of mobile, games, haptic and tangible and immersive technologies.

See **www.futurelab.org.uk** for more information on this research.

Tim Dumbleton, Becta

Tim manages Becta's advice services aimed at educational content developers (**www.becta.org.uk/industry/content**). As part of this work, he is responsible for monitoring and advising on research and practice related to the use of digital games in educational settings. This includes providing advice to developers about using aspects of games in educational resources and for maintaining dialogue with the games industry and Government partners.

Tim was involved in establishing Becta's original Computer Games in Education Project (2001-2). The project report and other recent publications are available from the Becta research website. He has also contributed to the recent Sage publication 'Understanding Digital Games', (ISBN 1412900344).

David Ley, Becta

David works for Becta in the role of Strategic Analyst Technology Innovation. He has a background in education and IT management. His area of focus is emerging technologies and their application in education, particularly mobile and wireless. He manages various Becta technology research projects and publications. David has lived and worked in both Japan and the UK.

Emerging trends in social software for education

Lee Bryant, Headshift

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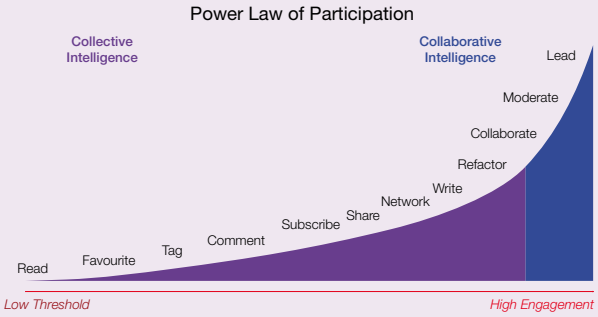
The adoption of social software tools, techniques and ideas will be the most important and visible example of the use of emerging technology in education over the next few years; but it is the social affordances, not the technology itself, that is really new and exciting.

Over the past three years, we have seen an exciting convergence of tools, ideas and networks under the labels Web 2.0 and 'social software' or social media. Now, we are starting to see this innovation on the consumer internet translated into a new approach to the use of online technology in supporting work and education, which has huge potential for positive change.

It is not so much 'emerging technology' as 'emerging humanity'[1] in the sense that it is about connecting and socialising our use of computing, and making it more personal. The tools are important, though changing all the time, but the connected networks of people, data and services that are emerging around them are what this is really all about. The 'always on' culture of internet access resulting from broadband adoption, combined with the fact that more and more people are now sharing ideas through blogs, wikis, messaging and other online tools, is creating a critical mass of connectivity that is driving innovation. Tim O'Reilly, who coined the phrase Web 2.0, saw this new generation of social tools as part of an emerging 'architecture of participation'[2], and this phenomenon has great potential to socialise online learning to a greater extent than we have previously seen.

To be meaningful, this requires second-wave adopters to drive usage, rather than just self-selected 'geeks'. In education, as in business, early adopters are already using Web 2.0 tools in everyday settings, but the potential impact of the second wave is already evident in the growing appetite for online sharing and interaction even in traditional media such as TES[3] and the BBC[4]. But until enough schools and colleges are contributing, and until enough students and teachers within these institutions are comfortable moving beyond passive consumption of e-learning 'content' to become active participants in their own relationship with technology, then the new Web 2.0 tools will not gain the traction required to enable the emergence of the network effects they promise. Not everyone needs to contribute, and indeed an absolute majority of most groups never will, but enough to create conversation and flow.



Social tools span a wide spectrum of engagement, from light-touch find and store actions through to in-depth participation and debate:

Source: http://ross.typepad.com/blog/2006/04/power_law_of_pa.html

I believe Web 2.0 tools and social software in general will have a genuinely transformational effect on technology in education over the next few years, and this will not only be limited to the ICT domain. A defining feature of this new wave is the way it is both driven by and also a driver of new norms of online behaviour. It may be that the resulting

1 *In 2006, this was evident at the annual O'Reilly Emerging Technology conference in San Diego, which focused on augmenting human intelligence and enhancing our ability to connect, rather than artificial intelligence.*

2 *http://radar.oreilly.com/archives/2005/10/web_20_compact_definition.html*

3 *See for example http://www.tes.co.uk/blogs/main.aspx?path=/Your%20Blog/*

4 *See for example http://news.bbc.co.uk/1/hi/talking_point/default.stm*

1

socialisation of teaching and learning, if it occurs, will go hand in hand with less prescriptive, target-driven and centralised policy. Looking back five years from now, I suspect the apotheosis of mechanistic, e-learning 'content delivery' systems will coincide with the peak of target-driven, test-based education policy, and what follows will be more personal and aimed towards a broader set of personal development goals in both technology and pedagogy. The personalisation agenda is not only about interface options and learning styles, but the whole experience of how, what and with whom we learn.

Social software = (tools + services + aggregation)^scale

Social software is not just about new applications. Technically, it can be described as a combination of various lightweight social tools within a growing ecosystem of online data and services, all joined together (aggregated) using common protocols, micro-formats and API (Application Programming Interface) methods. But it is also underpinned by some general principles about how to engage people as active participants in networks and communities to achieve new and exciting network effects[5] through distributed collaboration, co-production and sharing in online social networks.

Central to this is the idea of scale: the notion that the tools become more useful as more people use them. They are still useful on their own, but really come into their own when the simple actions of many individuals are combined 'at scale' in an application like Wikipedia, eBay or Google that appear to exhibit a kind of collective intelligence. This is what people refer to by the term 'wisdom of crowds'[6]; it is what makes prediction markets work[7] and Google's algorithm so useful. This may seem a bit esoteric to a 300-person school, but network effects can be seen even at the level of a few thousand individuals (for example on the level of the community linked to a school); also, the school's students can both contribute to and take advantage of the collective 'wisdom' of the Web using connected learning tools and services.

In terms of the basic social tools, weblogs (blogs) are perhaps the phenomenon that comes most readily to mind when thinking about the impact of social software on education.[8] There are some good education blogs that track the development of social tools in schools and colleges, and some schools have been using and teaching blogging for several years.[9] We are now starting to see the results of the first wave of student, class and faculty blogging, which is informing second-wave adoption. A number of teachers have encouraged the use of blogs by students as a simpler, more flexible form of personal portfolio, and others have used blogs for group projects and exploration. Inevitably, this new practice does not always work perfectly, but the great thing is that because these early adopters are blogging their experiences, they are openly sharing the things that don't work as well as those that do[10], in contrast to previous generations of tools whose adoption was led by software vendors with a tendency to talk up the wonderful benefits of their (expensive) products.

5 *http://en.wikipedia.org/wiki/Network_effects*

6 *http://en.wikipedia.org/wiki/Wisdom_of_crowds*

7 *http://en.wikipedia.org/wiki/Prediction_market*

8 *See for example http://news.bbc.co.uk/1/hi/magazine/3804773.stm*

9 *Barbara Ganley has been blogging her own experiences for some time at http://mt.middlebury.edu/middblogs/ganley/bgblogging/*

10 *http://education.zdnet.com/index.php?p=615*

This growing body of evidence suggests that blogs can be a key tool in developing literacy and writing confidence. Mark Ahlness, of Seattle's Arbor Heights Elementary School, told the *Seattle Times*:

> "Never in 25 years of teaching have I seen a more powerful motivator for writing than blogs. And that's because of the audience. Writing is not just taped on the refrigerator and then put in the recycle bin. It's out there for the world to see. Kids realize other people are reading what they write."[11]

If adoption in education follows a similar pattern to the professional world over the past few years, then the next phase will be about their role in promoting dialogue, debate and networking skills, as described by Lilia Efimova and Sebastian Fiedler in their 2004 paper 'Learning webs: Learning in weblog net works'[12]. In the professional sphere, where weblogs have been used more widely for personal development and knowledge sharing, experience suggests that the conversational, sense-making and social networking aspects of blogging are what keep people engaged beyond the motivation simply to write and reflect for personal benefit.

Another fundamental social software tool is the wiki, exemplified by the community-maintained online encyclopaedia Wikipedia. Despite the popularity and scale of Wikipedia and other public wiki sites, the majority of wikis are actually being used in private realms, such as teams, companies, projects and closed communities, for a variety of purposes from documenting knowledge to organising projects or events. They are less prevalent in education than blogs currently, but they provide another key 'mode' of interaction – co-production through community editing – that will have an equally big impact on learning.

Whilst public wiki sites are undoubtedly useful as resources for education, there is a legitimate debate about the reliability of completely open systems like the original wikipedia.[13] On the one hand, they are vulnerable to vandalism, the influence of special interest groups and error; on the other hand, they have such scale that clearly identifiable vandalism is famously 'corrected' in under five minutes. However, much of the current debate is not about vandalism, but rather minor errors and also the sometimes low quality of writing on pages that have been subject to many edits by different people with different views – the 'writing by committee' problem. As a result of this debate, a founding 'wikipedian' Larry Sanger has created a new public project (a major 'fork' in wiki-speak) called Citizendium with slightly more process and also a special role for identified 'experts' in various domains. It will be interesting to see how the results of both projects differ based on their contrasting social dynamics.

In an educational context, wikis have an extremely practical role to play in allowing students and teachers to quickly and easily explore an area of knowledge, developing only as much structure as they need along the way. By placing structure at the service of content, groups of people have freedom to build on each other's work and build up resources in a genuinely collaborative way. In a relatively mature wiki, people typically tend to assume different roles based on their own strengths and styles[14]: for example, some will check texts for accuracy and grammar, whilst others tidy up the structure or create new pages and new links for colleagues to help populate. The so-called 'wiki way' – open, pre-structured asynchronous collaboration in a text-based environment – can teach some very important skills and help prepare

11 http://blogs.zdnet.com/Ratcliffe/?p=19
12 http://blog.mathemagenic.com/2003/11/20.html#a844
13 http://www.elearnspace.org/blog/archives/002623.html
14 http://www.socialtext.net/exchange/index.cgi?wiki_gardening_tips

young people for a world in which everything is not formal, ordered and perfect. Wikis encourage people to share early drafts, interim thoughts and texts for others to contribute, plus they move beyond individual ownership of documents towards a more open, collaborative approach. These are important capabilities for a world in which online knowledge sharing is far more rapid, informal and iterative than previous generations.

We now have a variety of case studies relating to the use of wikis in a classroom context to learn from, such as Stewart Mader's online collection of project stories.[15] An increasing number of classes are now managed and organised entirely in a wiki[16], implying a greater degree of oversight and involvement by students than many teachers are used to. What we need now is more effective networks of practitioners to share some of this learning and emerging practice.

Just as wikis are opening up documents and turning them into socially constructed, dynamic, iterative structures, so too social software is changing the way we find, gather and organise information. Social bookmarking and tagging have been around for a few years, but they are only just moving beyond personal usage among early adopters and into mainstream businesses, schools and organisations. Social bookmarking is an extremely easy and effective way of sharing and filtering interesting links based on social networks. It allows people to subscribe to the bookmarks of others in their network or group, or to a particular 'tag' (keyword) assigned to bookmarks stored by others.

Social bookmarking is ideally suited to classroom use as it enables groups to build up a collection of resources very easily around a particular topic such that each individual can benefit from the work of others.[17]

Social tagging – the application of free-text keyword 'tags' that others can see and share – is potentially even more revolutionary because it provides an alternative means of categorising and organising knowledge based on emergent usage rather than pre-determined classification.[18] Potentially, this gives people a tool for developing language and negotiating shared meaning that acts as a counterpoint to one of the main sources of institutional power in education: control of language and terminology.

Cognitive Science can tell us a lot about the way that new words emerge and gain currency in different cultures and social contexts. New concepts are often subject to a state of polysemy, with multiple words acting as pointers to a new idea, but a process of implicit negotiation between people using these words will usually whittle this down to a tighter set of accepted terms that achieve predominance over other variants.[19] Social tagging tools mirror this natural process of language development, but when used at scale within large communities, they can also accelerate the process.

Allowing young people and learners in general to 'tag' resources they find can provide a fascinating insight into their emerging worldview, and the aggregate view of the tags they use is often a more reliable indication of their current interests and thinking than pre-written 'profiles' where they are asked to explicitly state their interests. The resulting 'tag clouds' provide both personal navigation of stored resources and also a representation of the themes and subjects somebody is interested in, which provides opportunities for serendipity and the discovery of shared interests.[20]

15 *http://www.wikiineducation.com/display/ikiw/Home*

16 *See for example http://westwood.wikispaces.com/*

17 *See for example http://del.icio.us/headshift/education for a list of links I have bookmarked for this article*

18 *See for example http://www.headshift.com/ideas/themes.cfm for a list of tags relating to my company's links and articles*

19 *http://www.headshift.com/archives/002386.cfm*

20 *http://theobvious.typepad.com/blog/2006/08/a_small_world_j.html*

The resources being shared by social software tools are not just limited to text, and the rise of systems for sharing, modifying and storing photo, video and audio-based content is set to accelerate. Podcasts[21] are an engaging way of sharing ideas and information, and the prevalence of MP3 players and multimedia devices among young people makes them an obvious choice for experimentation, and useful for many forms of teaching. Enhanced podcasts, linking slides and images with audio, are also being used as an alternative to traditional PowerPoint presentations. Sharing and commenting on home-made videos has turned out to be a $1.65bn business for YouTube, which suggests it is a popular activity among internet users, and sites like Flickr and Photobucket host a huge amount of discussion and social networking around user-uploaded images.

The popularity of these non-text-based social networking forms supports research by people such as Jyri Engeström into what he calls 'object-based sociality'[22] – that is, social networking and discussion centred around shared objects (photos, videos, music, etc.) rather than just being 'about' people. People are often more comfortable learning about each other by reference to common experience and perception than they are in direct inter-personal discussion. Some people, learners included, are more comfortable talking about a work of art, for example, than they are talking about art in general. Simply allowing online resources to accrete comments and discussion around them is proving a useful way of stimulating discussion.

Finally, another class of social tools that is likely to be part of the future learner's toolkit includes synchronous interaction tools such as Instant Messaging, chat, Voice over IP and video conferencing. Whilst these are already in use in some areas, these tools are undergoing a shift in emphasis from being purely communication tools to more generalised presence sharing tools, which are increasingly integrated with geographical data. The most obvious example of this is the use of presence-indicating 'status messages' among young people as a form of expression all of their own, or shared Flickr photos to indicate current mood or location. These tools can play an important role in group formation and identity development in social networks, and as such are worthy of consideration in an educational context even if they only have a tangential role in actual learning. Also, as the use of these tools is an established feature of business today, young people can potentially benefit from their use in school in order to develop the experience needed to use the tools effectively.

A growing ecosystem of data and services

Each of the basic models of social tool will play an important role in education in the future, but they are neither new nor significantly more advanced from a technological point of view than many current systems. What sets them apart, and makes social software so potentially game-changing, is the way they operate as part of a growing ecosystem of data and services, and how the output of all these tools and services is aggregated and re-combined to create new applications and outcomes. Future learning applications will not necessarily take the form of shrink-wrapped desktop software that takes years to build, nor will their value lie just in the code that drives them, but rather the role they play in the wider network of people, data and services. We are already seeing a move away from desktop office tools for example, which have evolved into bloated, over-complex beasts that nobody fully uses, towards lighter, more usable web-based office tools such as Google mail[23], Wikicalc[24], Writely[25] and Basecamp[26].

21 *See for example http://www.podcastdirectory.org.uk/*
22 *http://www.zengestrom.com/blog/objectcentered_sociality/index.html*
23 *http://gmail.google.com/*
24 *http://en.wikipedia.org/wiki/WikiCalc*
25 *http://docs.google.com/*
26 *http://www.basecamphq.com/*

1

The future is browser-based, multi-device and mobile, which should come as a relief to over-stretched schools IT people – a network connection and a modern browser are all we need to get started. In fact, tools such as TiddlyWiki[27] can also work offline.

The fundamental characteristics that set these applications apart from previous generations of software include the fact that they are network-based, are open rather than closed by default, and allow data portability and interoperability based on simple, shared protocols[28] and micro-formats[29] (RSS, Atom, OPML, hCard, hCalendar, XFN, etc.). In addition to data interoperability, a key design feature of many social software systems is that they expose their functionality to other software via open Application Programming Interfaces (APIs)[30]. This is how, for example, popular mapping services provide 'white label' services to other applications, and how the new social web browser 'Flock' manages to integrate a user's Flickr photos within their blogging tool. Whereas previous IT initiatives to create shared web services have been over-engineered and complex (SOAP, for example[31]), the current trend is radical simplicity (such as REST[32]), which mirrors the way that lightweight formats such as RSS have achieved incredible levels of data sharing and interoperability whereas top-down schemes such as Dublin core metadata and 1990s learning standards have not gained anywhere near the same level of traction.

Microformats

Microformats are simple shared data formats for contact information, calendar events and other types of information, and they have emerged from below rather than as a result of lengthy, top-down standardisation processes. They are 'designed for humans first and machines second' according to the http://microformats.org web site, and seek to build on the success of RSS to create light structure for information shared by many different websites and applications.

People and Organizations:
hCard

Calendars and Events:
hCalendar

Opinions, Ratings and Reviews
VoteLinks, hReview

Social Networks
XFN

Licenses:
rel-license

Tags, Keywords, Categories
rel-tag

Lists and Outlines
XOXO

http://micoformats.org

27 *http://www.tiddlywiki.com*
28 *http://en.wikipedia.org/wiki/RSS_(file_format)*
29 *http://microformats.org/*
30 *http://www.programmableweb.com/apis*
31 *http://www.w3.org/TR/soap/*
32 *http://en.wikipedia.org/wiki/Representational_State_Transfer*

This network computing approach, which is beginning to make real the 'Small Pieces, Loosely Joined' ideas[33] of pioneering writers in the social software field, enables information, services and data to be made available as individually addressable objects. The huge wealth of content and services now available via the internet means that ease of aggregation and 'findability'[34] are now vitally important if we are to be able to make sense of it. Social tagging is one part of the solution to better findability of resources, but better ways of aggregating information are also emerging. From a personal information management point of view, the most important tool is the (RSS/Atom) newsreader[35] that provides access to regular updates from sites, services, searches or other subscriptions a user has elected to receive, joining together this diverse ecosystem of information.

There are several principal advantages of newsfeed aggregation over email:

- Subscriptions are chosen by the user – they receive only those updates they wish to.
- Individual items do not need to be filed or deleted; they just flow by as a 'river of news' and unless you decide to keep them they eventually disappear.
- By reading all updates in one place and in one format, users can skim read much larger amounts of information to find what they find useful than with email.
- When a source ceases to be useful, or if interests change, a user can simply delete unwanted feeds.

Personal and group newsreaders are still in the early stages of adoption within the population as a whole, but those who use them rarely go back. People often move from using it to track just websites to tracking searches, comments on their blog or photos, mentions of their name on other blogs and even incoming email using RSS or Atom feeds.

Another useful aggregation tool is the personal web portal, such as those offered by Netvibes[36] or Pageflakes. These allow people to create customised portlets for certain websites, services such as news, weather or sports results, RSS feeds and so on, all within a single page that updates automatically. In a mixed environment where learners are using various tools and also want access to their own online content, then this kind of personal portal can provide a single point of aggregation. In fact, tools that encourage learners to bring in and link to their own existing online content (personal blogs, wikis and content on social networking sites, for example) are more likely to engage them in online-supported learning in schools, colleges or universities than if we continue to insist on a rigid separation between institutional life and the outside world. Recognising that many people carry with them a variety of content that forms part of their online identity across different sites and systems, some social networking sites now allow people to bring content with them from other sources and also take it away again when they leave. This idea has been dubbed the 'Digital Lifestyle Aggregator'.[37]

Mashups, permanent beta and the deconstruction of software

The implications of small pieces, loosely joined, web services and aggregation go way beyond how we find, access and store information. They are also changing the way we think about software applications. One of the most obvious shifts between the 1990s and the current decade is in the way we make and share software – the idea of permanent beta and co-development with users.

33 *http://www.smallpieces.com/*
34 *http://findability.org/*
35 *http://en.wikipedia.org/wiki/Aggregator*
36 *http://www.netvibes.com/*
37 *http://blogs.it/0100198/stories/2004/03/26/digitalLifestyleAggregation.html*

Example Google maps mashup: http://www.yourhistoryhere.com

In other words, rather than spend millions and wait a year or more to deliver a product, only to discover the market has moved on or people just don't like it, developers are getting '0.9' versions out of the door as quickly as they can and then continuing to iterate based on early user feedback. The most obvious example of this is Google, whose best known and most used products are often still officially in the beta testing phase. This also says a lot about the influence of Open Source culture, which is quite comfortable with the idea that software is often not finished and other developers can come along and fix bugs or make improvements.

Recently, this idea has been taken even further with the idea of mashups[38] and user-generated applications. It is now possible to build an impressive application purely on the client (browser) side using Javascript, AJAX, Web Services or tools such as Greasemonkey that extend the web browser. Many mashups typically use data services from Google maps[39] (such as Chicago Crime) or Amazon (such as BookBurro[40]), which are transformed in some way to create new applications. The Ning project[41], led by Netscape-founder Marc Andreeson, provides ready-built modules that allow people to build their own photo-sharing site or social networking site by replicating functionality created by others. Other sites such as Squidoo[42] have tried to do the same for data, in the sense that users build and share their own collections of re-mixed data, but with wikis and other social tools it is not too difficult for people to do this for themselves.

The potential for education hardly needs spelling out in terms of project work and also the teaching of higher-order ICT skills – in other words moving beyond the teaching of basic software and programming tools to begin addressing the social and network effects of new ways of working, sharing and communicating.

Some implications for education and educational ICT

The first and most obvious conclusion to draw from looking at current thinking in social software is that we need a sea change in how we think about IT and IT support. The good news is that this sea change is coming, partly by choice and partly by necessity. The IT function can no longer act as the high priest of all technology, especially when technology is so pervasive and many IT 'users' (including students) are more knowledgeable than the people telling them what they can and cannot do. The age of complete control or network security is in the past, and in return, people using IT need to bear some of the support load themselves.

IT functions in schools, just as in small businesses, must focus on providing underpinning services and infrastructure rather than seeking to control how people use them. This means more diversity of software and hardware rather than top-down standardisation decisions that lock users into tools that are out-dated by the time they are implemented. Interoperability does not require central control, as the proliferation of RSS and microformats have proved. Maintaining a sensible degree of external security is fine, as long as this does not stop people from doing the basics, such as consuming web services or linking with the outside world. But inside the network, experimentation and innovation should be encouraged. Anything less runs the risk of turning educational IT into an irrelevant

38 *http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid)*
39 *http://googlemapsmania.blogspot.com/*
40 *http://bookburro.org/*
41 *http://www.ning.com*
42 *http://www.squidoo.com*

backwater that is far below the expectations of young people that they simply do their learning elsewhere. Of course, there are real issues about security, privacy and online safety, but as their real-world analogues, these are better pursued by education than control and coercion.

For education and teaching more generally, the implications are manifold and arguably difficult to realise without greater freedom on the level of policy, and a reduction in emphasis on targets, prescriptive practice, standards and 'content delivery'.[43] But they also pose a challenge to teachers about the way they engage with learners and the role they play in stimulating communities of learning, and in co-creating with them, rather than just imparting information.

The new forms of online collaboration we are seeing emerge in education can support a wide range of behaviours that are needed to survive and thrive in the modern world, and therefore in theory at least, help develop the kinds of skills that education should aim to provide. For example, the recent IPPR report *Freedom's Orphans: Raising Youth in a Changing World*[44] talked about the urgent need to develop better social skills among young people in the UK, and emphasised that qualifications alone are not enough to succeed in the new service-based economy. There is a growing body of evidence that many young people are achieving a kind of self-empowerment and, arguably, engaging in self-managed learning through their participation in online social networks and their use of social tools in general.

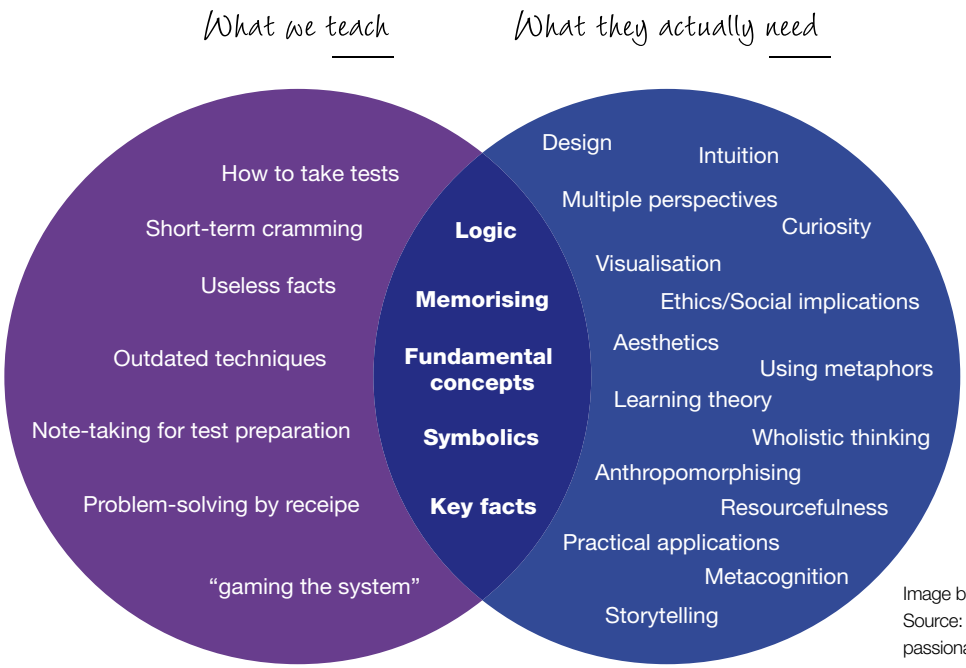


Image by Kathy Sierra.
Source: http://headrush.typepad.com/creating_passionate_users/2006/11/why_does_engine.html

43 *See for example http://www.preoccupations. org/2006/11/the_knowledge_1.html for a practitioner perspective*

44 *http://www.ippr.org/pressreleases/?id=2415*

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Young people are often operating within entirely new online social contexts that provide alternative spaces in which to explore, interact and learn new skills, such as massively multiplayer online games, online social networking sites, blog networks, wikis and online groups. As Danah Boyd's anthropological research into the behaviour of young people within online social networks[45] suggests, there are many positives to take from the way young people are using these spaces, despite the inevitable scare stories, and so it makes sense to engage with them and embrace online social networking and social tools within education if we are to help deal with the shortcomings that IPPR have highlighted. Wikis and online games are already being used as places in which new forms of learning and skill development can take place, but in general this is still not regarded as 'serious' learning.

In the medium term, we can expect to see social tools being used to help develop critical skills such as networking, search and assimilation of new topics, sense making, pattern recognition and decision making, as well as in the development of shared values. These tools are about connections and context not content, in contrast to previous generations of e-learning that were obsessed with 'delivering' 'learning objects' – an approach we now understand is useful only for repetitive training. They are also highly contextual and personal – they support learning as a process, not an outcome, and encompass a more diverse range of learning and behavioural styles than perhaps any previous generation of technology. But perhaps more interesting is the fact that they operate at the intersection of technology, teaching and creativity, which is a need that Sir Ken Robinson, a leading expert on innovation, identified so eloquently at the 2006 TED conference.[46] In this respect, the fundamental pattern of learning and innovation using social tools – **find → remix → share** – seems ideally suited to the way most young people like to discover and make sense of the world around them, which is reason enough for an optimistic view of their likely impact.

45 *http://www.zephoria.org/thoughts*

46 *http://www.ted.com/tedtalks/tedtalksplayer.cfm?key=ken_robinson&flashEnabled=1*

Learning networks in practice

Stephen Downes, National Research Council of Canada

2

While the learning management system succeeded in emulating the classroom online, a second wave of applications and approaches, drawing on what has come to be described as Web 2,0, is redefining the concept of online learning. This second wave is characterised by the 'personal learning environment' (PLE). The values that underlie the PLE and Web 2.0 are the same: the fostering of social networks and communities, the emphasis on creation rather than consumption, and the decentralisation of content and control. But why should we think that these values improve learning? This paper argues that the personal learning environment and Web 2.0 are instances of a more fundamental concept, the learning network, and that networks with identifiable properties such as the fostering of diversity and autonomy are more reliable producers of learning and knowledge.

The Personal Learning Environment

Beginning in 2005 and continuing through 2006, discussion at the forefront of the educational technology community centred not around instructional design and the learning management system, but rather on approaches that dramatically shift the centre of e-learning; things like social networking applications such as ELGG[1], things like informal learning and e-portfolios, and most of all, things like personal learning environments (PLE). These in turn are centred around, and draw from, a concept in the world of online computing called Web 2.0.

The use of Web 2.0 technologies in education came to be called e-learning 2.0. However, in Stephen O'Hear's view, we have a long way to go: 'Like the web itself, the early promise of e-learning – that of empowerment – has not been fully realized. The experience of e-learning for many has been no more than a hand-out published online, coupled with a simple multiple-choice quiz. Hardly inspiring, let alone empowering. But by using these new web services, e-learning has the potential to become far more personal, social and flexible."[2] These technologies, in other words, would *empower* students in a way previous technologies didn't. O'Hear continues:

> The traditional approach to e-learning… tends to be structured around courses, timetables, and testing. That is an approach that is too often driven by the needs of the institution rather than the individual learner. In contrast, e-learning 2.0 takes a 'small pieces, loosely joined' approach that combines the use of discrete but complementary tools and web services – such as blogs, wikis, and other social software – to support the creation of ad-hoc learning communities.

Through 2005 and 2006, the concept of the Personal Learning Environment (PLE) slowly began to take form in the educational technology community, coalescing with a 'Future VLE' diagram (see page 27) released by CETIS's Scott Wilson. Colin Milligan (JISC) believes PLEs 'would give the learner greater control over their learning experience (managing their resources, the work they have produced, the activities they participate in) and would constitute their own personal learning environment, which they could use to interact with institutional systems to access content, assessment, libraries and the like.'[3] The idea behind the personal learning environment is that the management of learning migrates from the institution to the learner. The PLE connects to a number of remote services, some that specialise in learning and some that do not. Access to learning becomes access to the resources and services offered by these remote services. The PLE allows the learner not only to consume learning resources, but to produce them as well. Learning therefore evolves from being a transfer of content and knowledge to the production of content and knowledge.

1 *http://www.elgg.net*

2 *Education Guardian, 15 November 2005 [http://education.guardian.co.uk/elearning/story/0,10577,1642281,00.html]*

3 *JISC PLE event and project: http://www.elearning.ac.uk/news_folder/ple%20event*

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Mark van Harmelen suggests that PLEs are motivated by the need for 'a standard interface to different institutions' e-learning systems' as well as 'pedagogic approaches which require that learners' e-learning systems be under the control of the learners themselves'. Such a system is needed, additionally, to support mobile learning or offline learning 'in a wireless-free hospital, or on a remote mountainside'.[4]

The PLE is a recognition that the 'one size fits all' approach characteristic of the LMS (Learning Management System) will not be sufficient to meet the varied needs of students. It is, indeed, not even an application *per se*, but is rather a characterisation of an approach to e-learning. 'The PLE is not a software application as such,', according to Graham Attwell, 'but rather a 'mash up' of different applications and services although of course, it is possible to develop applications such as ELGG which bring together much of this functionality and allow ease of access to different services.'[5]

As such, the key to understanding the PLE consists not in understanding a particular type of technology so much as in understanding the thinking that underlies the concept, and in turn, the responses to that thinking as found in Web 2.0. This includes, as Attwell notes, 'the changing ways in which people are using technologies to communicate and to learn and the accompanying social effect of such use.'

The PLE, then, consists in effect of a set of related concepts, each associated with the technologies and applications of Web 2.0, and each describing a shift in emphasis away from that which would characterise learning using the traditional LMS.

Learning in communities

Frequently mentioned from Wenger onwards is the occurrence of learning in what have come to be called 'communities of practice'. According to Wenger, 'Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly'.[6]

In essence, in this theory, to learn is to immerse oneself in the network. It is to expose oneself to *actual* instances of the discipline being performed, where the practitioners of that discipline are (hopefully with some awareness) *modelling* good practice in that discipline, or as Thomas Kuhn would say[7], knowing how to solve the problems at the end of the chapter. The student then, through a process of interaction with the practitioners, will begin to *practise* by replicating what has been modelled, with a process of *reflection* (the techies would say 'back propagation'[8]) providing guidance and correction.

Learning, in other words, occurs in communities, where the practice of learning is the participation in the community. A learning activity is, in essence, a *conversation* undertaken between the learner and other members of the community. This conversation, in the Web 2.0 era, consists not only of words but of images, video, multimedia and more. This conversation forms a rich tapestry of resources, dynamic and interconnected, created not only by experts, but by all members of the community, including learners.

Hence in the first instance the tools that characterise Web 2.0 are communication tools. Communication tools support direct interaction between individuals. They provide an individual with a means of communicating

4 *Mark van Harmelen (2006) 'Personal Learning Environments', Proceedings of the Sixth International Conference on Advanced Learning Technologies, IEEE http://octette.cs.man.ac.uk/~mark/docs/MvH_PLEs_ICALT.pdf*

5 *http://www.knownet.com/writing/weblogs/Graham_Attwell/entries/6665854266*

6 *http://www.ewenger.com/theory/*

7 *http://www.des.emory.edu/mfp/Kuhn.html*

8 *http://www.seattlerobotics.org/encoder/nov98/neural.html*

with one or more members of a network, and hence, support social networking. Members typically have a unique identity in such systems and communicate with a collection of other people organised either by membership in a group or forum or by belonging to a list of 'friends' or 'buddies' created by the individual.

Instant messaging (IM) has been identified as the predominant form of communication among younger net users. Each of the major IM tools – ICQ, AIM, YIM and MSN – allows a user to create a list of contacts (known as 'friends' or 'buddies'). A similar functionality, SMS, operates on mobile phones. IM is an advance over email because it promotes diversity and decentralisation. Each person's list of contacts is unique. Conversations are typically person-to-person (and hence, these are called peer-to-peer (P2P) networks) though in some cases multi-party conferences are created. P2P file sharing networks, such as Gnutella or Kaaza, work along similar principles, though the creation and maintenance of contact lists is handled automatically by the software.

Instant messaging and conferencing tools have expanded from text into audio and video. Skype, for example, is an application that allows free online audio conversations. Each Skype user has a unique identity and Skype users maintain a contact list of other Skype users. Video conferencing, meanwhile, is already supported by several of the commercial IM products, such as AIM, as well as (more recently) by Skype.

Probably the greatest misapplication of online community in online learning lies in the idea that a community is an adjunct to, or follows from, an online course. This is perhaps most clearly exemplified by the existence in itself of online class discussions. It is common to see the discussion community created with the first class and disbanded with the last. The community owes its existence to the course, and ends when the course does. We see this in the evolution of community on the web as well. Early online communities followed the model proffered by Hegel and Armstrong[9], where the community was centred around a certain website, which in turn, would monetise that activity. In both cases, the depiction is community as a group centred on some location or activity.

Community on the web evolved differently, however. While individuals did from time to time cluster around a certain website or service, they did not confine their communications to a single mode or channel. An online community might be a much looser set of associations, what social network theorists such as Mark Granovetter would call 'weak ties'[10]. A community in this sense could best be described as a cluster of common associations, where these associations are represented as membership in buddy lists, connections in peer-to-peer networks, and other sorts of contact lists. Weak ties are necessary in order to allow the spread of knowledge, and in order for weak ties to be created, 'there must be several distinct ways or contexts in which people may form them'.

So learning occurs in communities, but communities cannot be based on the group, but rather, the network, where connections cut across existing boundaries, via weak ties, to form layers of association. The implication is that the course content (if any) ought to be subservient to the discussion, that the community is the primary unit of learning, and that the instruction and the learning resources are secondary, arising out of, and only because of, the community. And, in the Web 2.0 world, it was only a matter of time before they were created by the community.

9 *Net Gain: Expanding markets through virtual communities, (1997) Harvard Business School Press*

10 *Mark Granovetter, 'The Strength of Weak Ties: A Network Theory Revisited', Sociological Theory, Volume 1 (1983), pp. 201-233.*

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Creation, not consumption

Even LMS-based learning recognises that learning is best accomplished through some sort of activity, rather than through rote content consumption and memorisation. That said, the history of online learning is remarkable for its emphasis on content consumption, as evidenced by the activity surrounding course creation and learning object design. George Siemens asserts that 'As learners move beyond content consumption and into stages of critical thinking, collaboration, and content creation, LMS weaknesses become apparent'.[11] Content creation tools enable the creation of content. What distinguishes the current set of content creation tools is that the content creation occurs, or is largely supported, online, and hence converts the act of creating content into a social and connected act.

Learning management systems, insofar as they support content creation at all, support online community, or 'group', tools that have their origins in the early days of the web. Their influence has been widespread. Both Yahoo Groups and Google Groups support massive mailing list and bulletin board services. Large communities have also formed around some specialised sites, such as Slashdot, Metafilter and Digg, each of which displays a series of selected posts, around which a discussion occurs. Smaller communities have also developed using popular content management systems such as Drupal, Plone, PostNuke and Scoop. Some learning management software, such as Moodle, can be used in this way, as for example by EdNA Groups.

These sites all have in common, however, their focus on the group or institution, rather than the individual. Typically, such sites will be managed by one or two people, and other people contribute subject to the consent of the owner. Autonomy, therefore, is minimal, and in some cases, diversity is either tacitly or explicitly discouraged. A common complaint found on such sites is the plea to ''stay on topic' or 'keep the discussion off-list'. Many such groups require registration and identification before posting is allowed, maintain strict acceptable use policies, and often prohibit non-members from viewing the discussions.

Consequently, recent years have seen the rise of personal content authoring and delivery services. The prototypical personal publishing system is the weblog. These greatly simplify personal publishing, allowing writers an autonomous voice, and thus have greatly diversified the content available online. Some blog services are hosted, that is, they are located on a remote server and accessed using a web browser. Early hosted services included Blogger and LiveJournal. Additionally, blogging software allows a user to host a blog on their own server. Moveable Type was an early commercial application, while WordPress is the most popular Open Source blogging application.

Related to blogging applications is a set of tools known as social networking applications. These services essentially combine the 'buddy lists' of IM with the content creation capacities of blogs. Arguably, LiveJournal was one of the first social networking applications. Other such systems include Friendster, Tribe, Orkut and Yahoo 360. These sites stressed social interaction. Social networking sites combining personal content creation and interaction, however, took the lead. In 2005, the social networking site MySpace, a music fansite, emerged as a phenomenon, becoming the most popular site on the web. MySpace allowed people to upload photos, music and video. Sites similar to MySpace include Bebo and Facebook, both of which are marketed directly at students.

11 *George Siemens (2006), 'Learning or Management System? A Review of Learning Management System Reviews', Learning Technologies Centre*

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Content creation sites have formed the vanguard of Web 2.0. This movement is based on the idea that the web is a place where people can create and communicate – in other words, to network. Flickr allows people to store their photos online – and to share them with a network of contacts and friends. Podcasting, a phenomenon that began in 2003, involved the creation of MP3 audio files edited using (free) software such as Audacity, then distributed to the world via sites such as Audioblogs, Odeo or iPodder. Some communication tools became content creation tools. Skype, for example, became a popular way to record online interviews and conversations. In 2006, user-created video took the centre stage, with YouTube, a video hosting service, taking the top spot from MySpace. Hundreds more services, allowing users to create all manner of content, were launched, some of the more popular being Jotspot (wiki), Writely (word processing), Gliffy (diagrams) and Jumpcut (online video editing).

What we have seen, in essence, is a convergence between the characteristics that have redefined online community and those that have characterised online content creation. In order to express themselves, web users have moved away from the group sites. The constraints of creating content within a limited environment have been overcome through the use of a network of separate services, each with its own particular capacity, joined together with social networks. The result is that people, students included, have a much greater capacity to create, and therefore, insofar as a capacity to create supports learning, a much greater capacity to learn.

The 'pedagogy' behind the PLE – if it could be still called that – is that it offers a portal to the world, through which learners can explore and create, according to their own interests and directions, interacting at all times with their friends and community. 'New forms of learning are based on trying things and action, rather than on more abstract knowledge. 'Learning becomes as much social as cognitive, as much concrete as abstract, and becomes intertwined with judgment and exploration.' (Graham Attwell)[12]

And – crucially – *teaching* becomes the same thing as well. As I wrote in 2002, 'Educators play the same sort of role in society as journalists. They are aggregators, assimilators, analysts and advisors. They are middle links in an ecosystem, or as John Hiler puts it, parasites on information produced by others. And they are being impacted by alternative forms of learning in much the same way, for much the same reasons.'[13]

Context, Not Class

When learning becomes the creation of content in the context of a community of practice, then learning becomes something that is characterised not by instruction in a classroom, but rather by dialogue and communication within a given context. Jay Cross is talking about a similar thing when he talks about informal learning. He writes, 'For sixty years, we've thought of learning as residing in the formal models exemplified by schools, universities, and training programs. Common to these top-down formats is a curriculum that rests on the beliefs and worldview of the authorities in charge. Informal learning is more democratic. It's responsive to learners and often ad hoc.'[14]

What needs to be understood is that learning environments are multi-disciplinary. That is, environments are not constructed in order to teach geometry or to teach philosophy. A learning environment is similar to some 'real world' application or discipline: managing a city, building a house, flying an airplane, setting a budget, solving a crime, for example. In the process

12 *http://project.bazaar.org/2006/06/01/personal-learning-environments/*
13 *http://www.downes.ca/cgi-bin/page.cgi?post=84*
14 *http://www.learningcircuits.org/unworkshop2.htm*

2

of undertaking any of these activities, learning from a large number of disciplines is required. Indeed, as in the case of electronic performance support systems, these environment may *be* some real world application.

These environments cut across disciplines. Students will not study algebra beginning with the first principles and progressing through the functions. They will learn the principles of algebra and other fundamental subjects as needed, progressing more deeply into the subject as the need for new knowledge is provoked by the demands of the simulation. Learning opportunities – either in the form of interaction with others, in the form of online learning resources (formerly known as learning objects), or in the form of interaction with mentors or instructors – will be embedded in the learning environment, sometimes presenting themselves spontaneously, sometimes presenting themselves on request.

The idea of context-sensitive learning is not new. It is already supported to a large degree in existing software; Microsoft's help system, for example, would be an example of this were the help pages designed to facilitate learning and understanding. In a similar manner, learners interacting with each other through a learning environment will access 'help' not only with the software but also with the subject matter they are dealing with. Learning will be available not so much in learning institutions but in any given environment in which learners find themselves.

The Personal Learning Environment (PLE) ought to be seen in this light. It is tempting to think of it as a content management device or as a file manager. But the heart of the concept of the PLE is that it is a tool that allows a learner (or anyone) to *engage* in a distributed environment consisting of a network of people, services and resources. It is not *just* Web 2.0, but it is certainly Web 2.0 in the sense that it is (in the broadest sense possible) a *read-write* application.

What makes this possible, and what distinguishes the current crop of applications from those that are *merely* content creation tools, is RSS. Originally designed to list indices of newspaper and magazine articles, RSS worked well for personal publishing, and especially serialised content as is found in blogs. RSS allows individual web users to create custom subscription pages for themselves using applications called News Readers. Early RSS readers were stand-alone applications, such as Carmen's Headline Reader and Amphetadesk. Today, news readers have also become online applications, with services like BlogLines and Google Reader being popular choices. Both the Internet Explorer and Firefox web browsers have built-in news readers, while another application allows you to subscribe to blogs by email.

Some services have emerged in an attempt to aggregate all RSS or blog content. Early listings of popular sites included Blogdex, DayPop, PodDex and PubSub. The current leader in this field is Technorati, which indexes some 50 million blogs. Technorati also introduced to the environment the concept of 'tagging', a system whereby, instead of classifying articles according to a pre-determined taxonomy, readers simply picked whatever words they felt appropriate, hence 'tagging' the articles with a vocabulary of their own choosing. Tagging quickly spread to other social networking applications, most notably, Flickr.

What RSS does is to transform a piece of content created by a student or instructor from something that is a static and stand-alone object into something that resembles a stream or a flow. Contents syndicated in RSS become *part* of other contents, and this interaction occurs seamlessly, with no conscious intervention on the part of the creator needed to make this happen. A learning environment that contains RSS feeds becomes dynamic; the contents of those feeds are what makes it dynamic.

The system of linking and metadata employed by blogs using RSS created an open network with a very low threshold for joining. This approach is being emulated in other areas, from the simple and easy web services model, REST, to the grass-roots personal profile metadata format, FOAF. Each step in content organisation has tended towards increased diversity and increased autonomy on the part of readers. Additionally, content creation and aggregation applications have become increasingly transparent as RSS and similar formats allow people to extract content, while APIs (such as the Blogger API) allow people to submit content.

Support tools

In addition to the standard network infrastructure, such as the web browser, probably the most important support tool for Web 2.0 applications will be an identity manager. Numerous attempts have been made, and the web has seen a large number of centralised (or Federated) approaches – from Microsoft Passport to Liberty to Shibboleth (recently adopted by the UK education system). None of these has caught on widely, and while Google and Yahoo have added their own (proprietary) single-sign-on systems, no user-centred system yet exists. At the time of writing, there is hope in the form of some initiatives. Two major commercial distributed identity systems, LID and SxIP, have been proposed. The developers of LiveJournal have proposed an open and non-commercial OpenID system. Various developers have attempted to collaborate, forming a (now quiet) initiative called YADIS (Yet Another Distributed Identity System).

Another major issue surrounds digital rights management. As content is created, reused, repurposed and fed forward around the web, it becomes both more important (especially from a commercial perspective) and more difficult to assert ownership, much less enforce conditions of use. A variety of digital rights management schemes have been proposed, but users have stayed away from such systems (as one person commented, nobody is demanding to be able to do *less* with their stuff), favouring open protocols such as MP3 and (more recently) Flash video. In addition, distributed and lightweight rights expression models, such as Creative Commons and ODRL, have been widely adopted. By *expressing*, rather than *enforcing*, digital rights, these systems enable, rather than restrict, the free flow of information.

The semantic principle postulated by learning networks is a theoretical principle. But an examination of the trends exhibited by Web 2.0 software illustrates this principle in practical use. Online applications in Web 2.0 are supporting greater user autonomy, from greater content creation capacities to better ways to personalise their information sources. They support diversity, allowing not hundreds but millions of different voices to be heard, and to be heard not only in text but in all manners of multimedia. The applications support openness. They tend to support simply and widely usable protocols, open standards, open source applications, and even open identification and open digital rights. And they support interactivity, supporting communication at all levels.

Learning networks

Why this, rather than that? Why the PLE and learning networks, rather than the LMS, the lecture and the class?

Taken together, the ideas that underlie the PLE – learning in communities, creation over consumption, and context over class – constitute an instance of a more general approach that may be characterised as ‘learning networks’. A network is a collection of connected entities, where a connection is something that allows one entity to send a signal to another entity. The internet is a network; it connects computers together and allows their operators to send messages to each other. And as we

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have seen, the users of Web 2.0 applications organise themselves into a network as well.

When networks are properly designed, they reliably facilitate learning. This is because, when properly designed, the network will itself learn. Through the process of interaction and communications, the entities that constitute the network will form a mesh of connections. Knowledge is embedded in this mesh of connections, and therefore, through interaction with the network, the learner can acquire the knowledge. Foresters learn about trees by working with foresters; lawyers learn about the law by working with lawyers.

It is the *organisation* of the network that supports learning, and that if the network is designed appropriately, it will *organise itself* – just as we see happening in Web 2.0 communities – in order to best support learning. Thus, when we talk about 'learning networks' we are talking about networks in two distinct ways: first, we are talking about *the use of networks to support* learning, and second, we are talking about *networks that learn*. Though these may seem to be very distinct, the central thesis of 'learning networks' as a theory is that these two things are one and the same.

The theory, though, does not describe the particular type of organisation that best facilitates learning, partially because there is no one way that fits that description, but also because any such organisation is so complex it defies description (it would be akin to attempting to describe the knowledge that 'Paris is the capital of France' by describing a particular set of neural connections). Hence, what is described are the *properties* of the network that are known to most reliably lead to network knowledge. As seen, learning networks therefore depend on a 'semantic principle', consisting of four parts:

First, *diversity*: entities in a network should be diverse. In a society, this means involving the widest possible spectrum of points of view. In a human mind, this means being exposed to a wide spectrum of experiences. Diversity allows us to have multiple perspectives, to see things from a different point of view. These views moderate each other, and prevent us from jumping to a conclusion. Diversity is supported through weak ties. The loose connections enabled through the use of social networking applications allows us to reach beyond our groups and to connect with, and learn from, a wide range of influences.

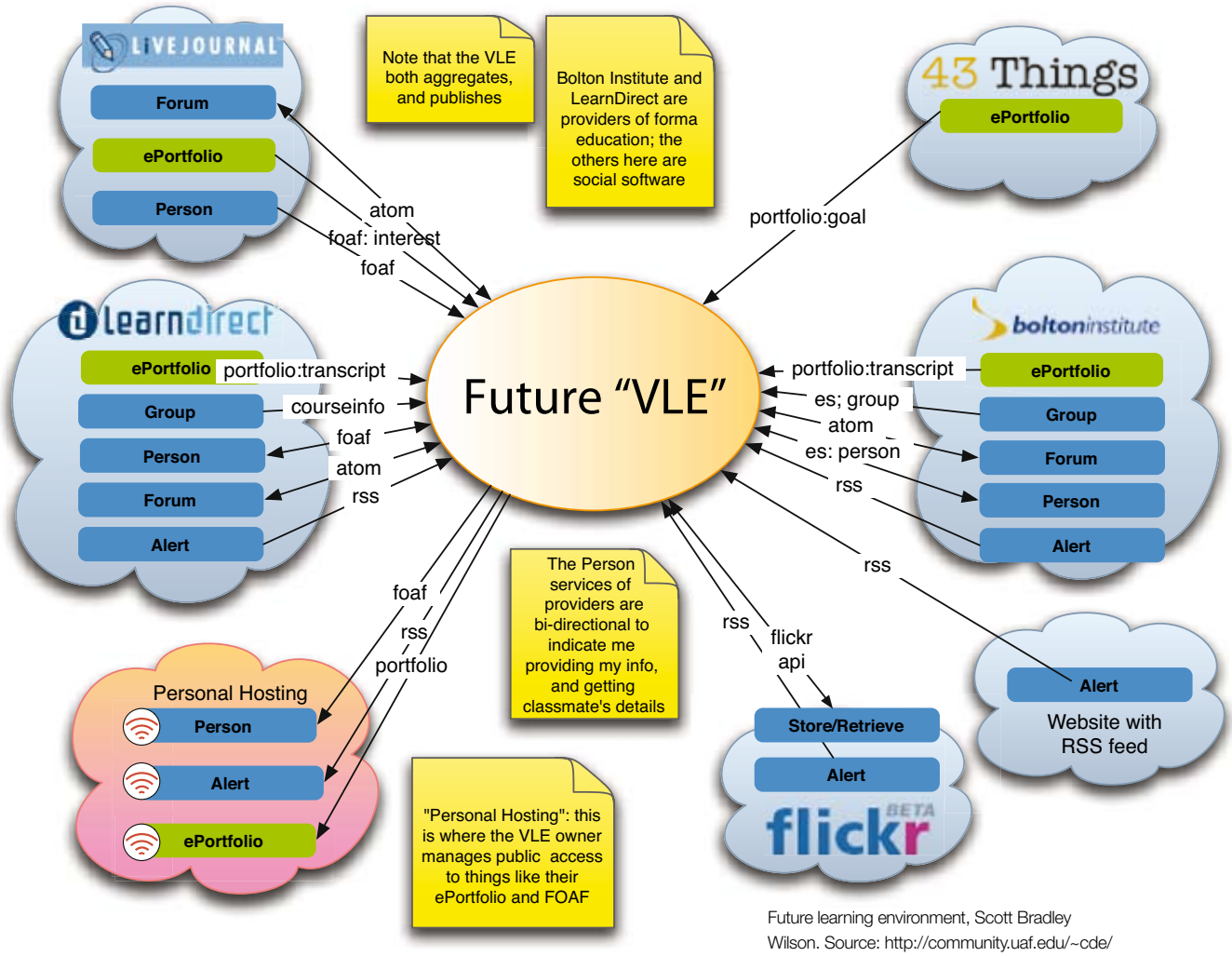
Second, and related, *autonomy*: each entity operates independently of the others. This does not mean that it operates without input, but rather, it means that it operates according to an individual and internal set of principles and values. Autonomy is what allows diverse entities to respond and react in a diverse manner. Autonomy is enabled through a personal software environment. In Web 2.0, it is enabled through the provision of content creation tools such as blogging software. In learning, it is enabled through a personal learning environment.

Third, interactivity, or *connectedness*: the knowledge produced by a network should be the product of an interaction between the members, not a mere aggregation of the members' perspectives. A *different* type of knowledge is produced one way as opposed to the other. Comparing two points of view, for example, allows us to see what they have *in common*, while merely counting or aggregating views forces us to pick one or the other. Web 2.0 software is about much more than listing connections or tallying memberships. It is about the conversation that happens between individuals. And so, too, the personal learning environment supports not just content consumption but interaction and communication.

Fourth, and again related, *openness*: each entity in a network must be able to contribute to the network, and each entity needs to be able to receive from the network. Openness is what makes interactivity possible; barriers

that make it difficult or impossible to communicate within the network limit the network's capacity to learn. Web 2.0 software freed users from the confines of mailing lists and discussion boards, environments owned by authorities where access was controlled and often restricted. Personal learning environments allow the learner to take their learning out of the classroom and to make it something they can share with the world, to make learning the *result* of sharing with the world.

All learning technology will be at least to some degree network technology, since it is designed to facilitate the interaction between public knowledge and personal knowledge. Thus though these principles may be theoretical in origin, they can be employed in practice as a metric for selecting and designing learning technology. Learning technology that promotes autonomy, encourages diversity, enables interaction and supports openness will, in the main, be more effective than technology that does not. And thus we will see learning technology evolve from the approach defined by the learning management system to the idea that is the personal learning environment.



Future learning environment, Scott Bradley Wilson. Source: http://community.uaf.edu/~cde/wiki/SSW/VirtualLearningEnvironments

The challenge of new digital literacies and the 'hidden curriculum'

Jo Twist with Kay Withers

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The way we understand the world, our place in it, and how we have our say about it, has always been through communications media. Throughout the centuries the media which convey messages have changed. Each change has profoundly shaped society's understanding of itself and one's place within it.[1] In the 21st century, as the digital age moves into adolescence, our understanding of 'the media' is being transformed once more. In a networked society, the choice of channels through which knowledge, creative works and communication can be produced, expressed, distributed and consumed are more abundant than ever before.

Use of devices – 15-24-year-olds

Video recorder – 51%

DVD – 71%

Internet – 59%

MP3 players – 55%

Games console – 56%

PC for TV viewing – 38%

PDA – 7%

Source: Ofcom (2006), *The Communications Market* (based on 2005 figures)

Many characterise these changes as a move from a passive to a more active relationship with media, while others talk of a fundamental shift in the nature of our participation and role in a digitised society. The tools to produce and publish were once accessible to only a few, but the internet and more recent digital media tools make this a cheaper, easier and a more accessible process. Processes have been democratised. Scarcity is no longer such a powerful bargaining chip, and power lines are being re-laid. Traditional gatekeepers and hierarchies are losing grip as the only controllers of knowledge flows, communication, creativity and opinion. Blogs, podcasting and social networking sites such as MySpace and YouTube have given people space to be creators of content in ways that are more innovative, direct and social. For many, this is what the Web was meant for.[2] Consequently, the practices and language of media that young people are growing up around are changing, which in turn re-shapes their expectations of media and communication.

But significant challenges lie at the core of these shifts for educators and public institutions, which also challenge those nations intent on becoming competitive knowledge powerhouses. As we strive towards some ideal of innovation to compete on a global scale, some suggest education in the UK remains at odds in its design with these emerging innovative cultures which are characterising the digital age (Leadbeater, 2006).

This paper focuses on one aspect of these challenges for educators and learning: media or, rather, new media literacies. We draw on the progressive work of US academic Henry Jenkins and the MacArthur Foundation which tackles these challenges head on. This paper outlines some of the practices and understanding of the kinds of 'hidden curricula', which Jenkins describes as the learning which young people are encountering through the everyday use of digital media and technological spaces (Jenkins *et al*., 2006). We need to understand the consequences of the hidden curriculum at a deeper level if we are to know how future generations will participate in public life, as well as how they might fuel an innovative economy as citizens of a digital society.

1 *See McLuhan (1964), McLuhan (1967)*

2 *Several recent books, technologists and theorists have popularised this idea, which has been broadly described as the next evolution of the web, coined in the term 'Web 2.0'. The term is a mere marketing hook to describe the technical and philosophical shifts in what people are doing online because of easy-to-use tools of creation, distribution and networking – also known as 'social software'. Others characterise recent changes as a move towards the 'read-write', or 'semantic web'. See O'Reilly (2005), Gillmor (2006), Berners-Lee et al. (1999). For a more detailed analysis of how these changes affect learning, see also Owen et al. (2006).*

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Digital cultures, digital divides

It is acknowledged that the kind of participatory culture we see emerging as part of the shifting digital media sands is one with lower barriers to creative expression and civic engagement. Because of the networked nature of digital cultures, there appears to be more support for creating and sharing one's own work, and there seems to be an appetite for a kind of informal mentorship, so that what is known by the most experienced is passed along to those who are less so (Jenkins *et al*., 2006).

Jenkins' analysis of this kind of cultural shift is defined by four practices that are becoming more common: affiliations, expressions, collaborations, and circulations.

1) **Affiliations:** these occur through informal membership of online communities, such as MySpace, Bebo and YouTube.
2) **Expressions:** there are more opportunities for young people to be more expressive through the creation of new digital content out of existing videos, texts, images or sounds.
3) **Collaboration:** there is more opportunity to participate in collaborative problem solving which involves working together formally or informally to complete tasks, as part of Wikipedia-style knowledge-building or alternative reality gaming.
4) **Circulations:** blogging and podcasting, as examples, which can shape the flow of media

Source: Jenkins *et al*., 2006

The so-called 'networked generation', usually characterised by teenagers to 24-year-olds, are almost three times more likely than the average internet user to post material on the internet, and almost one in five has a website or blog (Ofcom, 2006a). Seventy per cent of this age group (compared to 41 per cent of the UK online population) have used some kind of social networking site, such as MySpace. Half of that group owns a games console and/or an MP3 player. Further studies suggest that 19 per cent of teenagers take content they find online and use it in their own artistic or expressive creations. In doing so, they are already picking up new skills, habits, and protocols of literacy, and creating new social spaces in which elements of 21st-century citizenship are re-sampled and recreated. They are actively 'weaving innovative networks of civic connection which both refresh and reshape the civic and political landscape' through their networked existences (Coleman, 2005).

These generations are also conceptualised variously as 'Millennials', digital natives (Rainie, 2006), or Generation Y. They generally use technology and digital media as devices to do what they want, when, and wherever they want, according to their needs and desires.[3] Although the desktop computer still dominates digital media experiences, other connected devices play a crucial and increasingly complex role. The mobile phone, for instance, is simultaneously a symbol of personal power, a social nexus, an identity badge and an entertainment device.[4] Cameraphones and other gadgets can capture a moment in some digital form and let it be instantly expressed and shared with others on a global scale.[5]

3 *This insight into how young people in particular are adapting new digital social contexts to their own needs is reflected in the BBC's Creative Future strategy announced in 2006. [http://www.bbc.co.uk/pressoffice/pressreleases/stories/2006/04_april/25/creative.shtml]*

4 *See Sorensen (2006), and Withers (2006).*

5 *These kinds of participatory practices can also have a more serious reporting purpose, as evidenced by the London bombings and the Buncefield fire events. See Twist (2006).*

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Connecting through networks: mobiles and social nets

71% of 11-19 year olds have their own mobile

90% of 5–9-year-olds have some degree of access to a mobile

85% of 16–24-year-olds would use SMS to arrange meetings

70% of online 16–24-year-olds have used social networking sites such as Myspace, Bebo or Friends Reunited

Source: Ofcom (2006), *The Communications Market*

More significantly, being in a digital world not only offers choice in how you access information and make connections, but also the kinds of information and people with whom you connect. According to William Dutton (2005) our notion of the 'digital divide' is being re-shaped as a result. He describes a move away from traditional notions of digital divides towards digital choices. He sees a 'reconfiguring of access' occurring, whereby access to technology *per se* is no longer the issue, but rather the quality of that access. Research shows that the places people first choose to look for information have changed because of the internet (Dutton *et al*., 2005). For information about local schools, people head for the internet first, but for a good read, book shops remained a more favourable option, illustrating the complex social nature of our choices. More than half of teenagers surveyed turned to the internet first for all information (Dutton *et al*., 2005).

What we do not know is the impact of so much digital choice on the skills and development of younger generations. It is also not clear whether young people in particular have the best cognitive tools to navigate through this abundance of digital choice, and how much the kinds of softer learning and skills cultivated through their digital practices are valued. These questions are crucial if information flows are to be turned into innovative creative flows, and new economic opportunities.

Opinions differ around which aspects of 'the media' are important to our ideas of literacy in general, from the ability to use tools for production (from simple blogging to film making), to critical consumption. Many adults, who are themselves struggling to come to terms with new media, are increasingly concerned about the current provision, scope and quality of 'digital' literacy (Coleman, 2005). Some go further to suggest that the potential learning which can be gained through informal digital spaces might be under threat from a lack of understanding about what kinds of critical skills young people are picking up in their own time – what Jenkins calls the 'hidden curriculum' (Jenkins *et al*., 2006). Millions of young people are already hunter gatherers of information, knowledge, cultures and new forms of expression. Yet the tools they have to find, evaluate, and critically use what they have found, are blunt. So an evolving 'digital divide', some argue, may be growing between those who have critical digital media skills and those who do not.

6 *The statistics offer a picture of the extent to which digital media technologies have reached across our everyday lives in the UK: faster, better, more ubiquitous and cheaper broadband in homes has been a key enabler. Now, online gaming, downloading media and even TV transmission is all possible. But that is only part of the picture. Far more people than ever before have connected and networked devices in their homes – games consoles, handheld gadgets and sophisticated mobiles.*

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Dichotomies and economies

The motivations behind the digital choices young people make when they reach out into different networked social worlds are complex. We have reams of statistics on mobile ownership, internet access, and gaming.[6] But they fail to say much about the quality of interactions through these devices in different contexts, as well as the consequences of these interactions.[7]

It is when we use a qualitative lens to understand changing habits around technologies that we start to see the most interesting aspects of contemporary society. The ippr's own early research has shown that young people use different kinds of technologically-mediated networks to make and maintain different levels of connections to distinct peer groups. Texting can be a more convenient and less public way to contact friends than a face-to-face context, while instant messaging (IM) helps them continue conversations from the school day (Mediappro, 2006). Technologies help cement existing offline relationships and networks as well as forging new, online ones. This mirrors US research suggesting that Millennials expect to gather create and share information across multiple devices and places. They sort out what communication and information 'belongs' on which device and under what circumstances to suit their needs (Rainie, 2006). When a teenager has a public or more intimate question, they can ping a range of different peer networks in different social contexts for answers. Similarly, they will go online, IM, text, play games, research online, or be entertained on multiple devices. But they will also read books and magazines when they wish to immerse themselves in a subject.

Access to the net – 9–19-year-olds

74% have access to the internet at home

3% uses a videogame console or TV to access the internet

99% of UK schools have internet connection

92% have used the internet at school

64% of children have accessed the internet outside home or school: of these 17% of these have accessed the net via mobile, 6% via game console, 4% via digital TV

41% are daily users, 43% are weekly users, and 3% are non users

29% do not have access from a home computer

Source: D. Buckingham (2006), *The Media Literacy of Children and Young People: A review of the research literature on behalf of Ofcom*

It is a challenge, then, to understand how society should, at a practical level, equip its citizens for a knowledge economy. At a basic level, the UK Government has long recognised that access to the internet – the knowledge and opportunities it offers – is essential in the 21st century. In a speech to the CBI at the end of the 20th century, Tony Blair stated:

> The role of government today is to equip people and business for the new economy in which we are going to live and work to encourage innovation and entrepreneurship to improve education, stimulate competition and broaden access to the new technology.

7 *Some 64 per cent of young people have access to the internet at home. More than two-thirds of 12–15-year-olds use the internet on their own and for an average of eight hours a week. It is this period which most interests both technology and content providers (as well as advertising agencies) and has been the concern of regulators, especially since parents of this group are significantly less likely to set rules surrounding their child's internet use (Ofcom, 2006b). In addition 82 per cent of 12–15-year-olds own a mobile phone, although other research places this figure much higher with penetration running to over 90 per cent. Instant messaging and text messages are the most frequently used modes of communication for young people seeking to stay in close contact with their friends.*

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The Government knows that to become a fully literate and successful participant in society, one must have the skills to function and participate in that society. This thinking has led most obviously to policy focused on ensuring access to technology *per se*. A major milestone was the promise of broadband in every UK school by 2006, equipping knowledge workers of the future with the technology required to build skill sets for the emerging economic landscape: one in which ideas, creativity and knowledge are valued above the ability to manufacture 'things' cheaply and efficiently. Rhetoric around the knowledge economy has continued to be coloured by buzz words such as 'enterprise', 'creativity' and 'innovation'.

Much recent debate has focused on the UK's 'top line' as a competitive economy compared to other innovation nations such as China and Japan. General management and business skills, along with specific technical skills, are seen as key aspects of human capital. But that may not be enough. Learning in a networked society requires that an understanding of how networks function and how they can be used: that means understanding the social and cultural contexts within which information emerges, as well as knowing who to trust and when, how to filter, prioritise, and utilise networks to pass on knowledge. It is about attitude, as much as skills, and social skills as much as technical ones are vital (Margo *et al.*, 2006). The focus on skills, attainment and function in a networked society is mismatched with what young people are actually doing and what they might need.

Learning in a digital age, argues cultural commentator, Charlie Leadbeater, should develop everyone for independent critical thinking and collaborative problem solving:

> Learning is more successful the more participative it is, allowing us to shape what we learn, communicate and explore ... When children are excited, motivated and inspired they are more likely to acquire new knowledge, skills and understanding. (Leadbeater, 2006)

This sounds obvious enough to those in education. But the devices we use to capture this are being employed unconsciously by young people in ways that educators are not fully aware of. This is why new media literacies may be a crucial starting point for educators.

Leadbeater suggests profound changes in the design of our education system are needed if we are to move towards a culture of mass innovation that will locate the UK firmly on the global economic map of the future. But, he argues, current debates about education remain obsessed with the means of education: standards and testing.[8] This clouds the ultimate aim of an innovation-led economy which is to foster skills so that creativity can be exploited for social or commercial ends.[9]

'Playing' at life

Games, as well as 3D immersive environments such as the popular online 3D world/platform, Second Life (adult and teen version), perhaps offer more innovative ways to understand how participation may shape what and how young people learn, communicate, and feel inspired to explore.[10] Recent research suggests that digital games are important to the education and development of the next generation of digital citizens and the way they develop practices around networked communication and collaboration (Elspa, 2006).

8 *Indeed, the Government's recent Leitch Review (2006) reinforced this agenda with its focus on attainment.*

9 *See Nesta (2006)*

10 *There are over 15 million active game players aged between 15 and 24, and the average age of a gamer is 29 years. See BBC (2005). More than half (51.2 per cent) of UK men and 25.1 per cent of UK women aged 10–35 play games regularly, according to Elspa. Since 1995, over 25 million computer games devices were sold in the UK – not including PCs – the equivalent of one for every UK household. Younger players have spent a greater proportion of their lives with interactive entertainment, and so are far more likely to play every day (BBC, 2005). Research shows that children at Key Stage 2 (7–11-year-olds) play more than 14–16-year-olds in Key Stage 4 (see McFarlane et al., 2002).*

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Who plays digital games in the UK?

60% of 6–65-year-olds (48% are female)
100% of 6–10-year-olds
97% of 11–15-year-olds
82% of 16–24-year-olds

Source: BBC (2005), 'Gamers in the UK: Digital play, digital lifestyles'

The kind of worlds people interact in through games, online games in particular, can be shared places of learning, contexts for thinking through complex problems, hierarchies, economics, and even science.[11] They offer a sense of 'physical' proximity to others which few other online spaces give.

Game rules offer a framework through which to probe, hypothesise and test. Active discovery in these contexts means the learner becomes a co-producer of knowledge, vital to a 'personalised learning' paradigm (Elspa, 2006).[12] But the new media literacy skills required for an innovation-led knowledge economy may not be fostered by learning about a specific topic through a directed game narrative. Rather more useful skills may be gained from understanding processes and their consequences in a range of different contexts. This critical understanding of why, how and by whom decisions are made, might give young people the sharper problem-solving and analytical capacity they need.

Digitally simulated environments in which young people are actively involved in creating that environment can perhaps encourage this kind of thinking because these platforms are more immersive than others and free from certain constraints. Educational software developers are indeed experimenting with tools which let learners put their knowledge and ideas into action through the production of new creative works, often for the benefit of other learners and educators. This can serve as a hook to stimulate the motivation to explore around a particular topic. A well-known machinima film, for instance about the French student riots of 2005 gained currency as a useful device to debate the complex reasons for the unrest.[13] But it was the process of producing it which gave the creator a more nuanced understanding of these issues.

Second Life is a sophisticated example of an online, immersive platform – although not strictly a 'game'. Typical of the emerging evolution of Web 2.0-type businesses, it relies on the community and the social networks within to create the content which flavours the collective experience. There, one can experience a tsunami as an avatar (a virtual representation of oneself or 'resident'), while listening to audio explanations of the science, and reading fact cards; residents can fly around armies of rockets from the past and present, and explore the solar system learning about the planets, their position, significance, and chemistry. These are immersive and shared spaces which can be experienced in groups or as individuals at any time and at low cost.[14]

11 *See Nick Yee's 'The Daedalus Project' which features more than six years of MMORG (Massively-Multiplayer Online Role-Playing Game) research, for more context [http://www.nickyee.com/daedalus/].*

12 *Big business sees value in creating 'edutainment' digital games designed around specific learning outcomes, while others are supported by governments and the military to produce Serious Games, those which involve the player directly in life or death decisions in immersive scenarios.*

13 *Machinima describes machine cinema or machine animation, as a collection of production techniques and a film genre. As a production technique, machinima uses computer-generated imagery (CGI) using real-time, interactive (game) 3D engines, instead of high-end 3D animation software used by professionals. [http://www.machinima.com/article.php?article=186]*

14 *There are currently more than 60 universities and education institutes in Second Life experimenting with learning. For an updated list of universities and institutions, see, [http://simteach.com/wiki/index.php?title=Institutions_and_Organizations_in_SL]*

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Teen Second Life is the version of Second Life restricted to 13–17-year-olds.[15] Residents can make friends, learn social and technical skills, and create virtual objects and identities. As in the adult world, teenagers design a resident, allowing them to 'play' with identity, choosing gender, skin colour, height, as well as creating outfits and accessories. It also provides instruction, through live and solo tutorials available in-world on the Second Life scripting language which lets users control avatar behaviour, develop expressions and animations, participate in the world's cultures and economy, in order to create a 3D digital self.

Like the adult version, teen Second Life has its own economy, and some young people have developed businesses generating around $200 a week selling virtual goods.[16] Residents naturally retain the intellectual property rights of what they create in both worlds. This recently led to one adult world resident striking a licensing deal with Nintendo for a popular in-world game, Tringo (CNN, 2006). Commerce is restricted in certain areas for teenagers, for example, in-world advertising by real-world brands is banned. While access to adults is restricted, authorised adults can enter and are labelled within the world as such.

Besides learning about economic and rights, there are several targeted projects there which aim to develop the civic or educational opportunities such a virtual space offers; many of them link up geographically disparate groups of young people.[17] Global Kids Island, part of a long-running real-world project Global Kids, offers a place in-world for teens to learn about complex social and global issues, such as human rights, and global poverty, and social justice, as well as media literacy itself.

As well as encouraging a sense of play and story-boarding of issues which the teenagers can act out in interactive scenarios which they can record as machinima, the project has played host to real-world celebrities who have spoken in-world via their avatars. Mia Farrow joined Second Life in January 2007 to talk about Darfur. The event was streamed by audio from the adult world into teen grid on Global Kids Island. Thousands from Teen Second Life also recently protested against child sex trafficking by completing an interactive maze built by participants, wearing home-made Slavery Still Exists t-shirts.

Perhaps the most compelling lessons are those on the importance of media literacy itself, as one participant explains on the Global Kids blog:

> Media Literacy is an important thing in today's world because having knowledge of media basically empowers us to be able to tell the good advertisements from the bad. That's probably one of the most important parts because, without knowledge...what are we? Naive? People are so affected by media because in this time…media is everything and it is everywhere. I think that's why I had a hard time defining digital media…because I guess I'm so surrounded by it that it makes it harder to understand what is and what is not part of digital media. (Posted by VVP Nafiza, January 2007)

Through participation, a sense of proximity and presence in the 3D world, young residents can practically share cultural understandings and feel connected in different ways to others on their own terms. They can be guided to turn that networking experience and learning into a core social skill and cultural competency.

15 *However, as yet the make-up of Teen Second Life residents is fairly homogenous: 75 per cent are male. The largest concentration of age is around 15 years old, and the majority of residents come from North America, with the UK providing the second largest population group.*

16 *This is in comparison with the $200,000 on average being made by the top ten entrepreneurs in the adult grid.*

17 *Opportunities developed in the adult Second Life, such as universities' virtual campuses, online lectures, and library facilities are also being explored in the Teen version and it clearly offers scope for discussions and debates among young people from different locations and backgrounds.*

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Understanding new media literacies

Second Life is just one example of networked participatory cultures. However, many cultures online in particular are accompanied by shadowy perceived threats which follow in new technologies' wake, especially when young people are concerned. These can often distract policy makers from understanding the real impact of a rising generation's actual practices.

The threats can range from copyright infringements, to internet fraud and identity theft, to violent video games, while features on threats to children from online predators appear regularly. Internet crime and unsuitable content clearly exist, but young people need helpful support about how to protect themselves from harmful approaches. David Buckingham argues that adults too readily construct a notion of children in a networked society as either 'vulnerable, incomplete and inadequate' or self-regulating autonomous agents capable as making decisions about media technologies as individuals, with digital skills which far surpass those of adults. It is a common conception that children are more sophisticated users of new technologies than older users: politicians frequently joke that they have sought the assistance of their offspring to put music on their MP3 player. It is also the case that young people are more likely to learn these skills from their peers and siblings, rather than adults. With this in mind, coupled with the fact that many activities young people undertake at home are banned within schools, it is unsurprising that the enthusiasm for digital or new media within a private or social sphere does not extend to digital media technology teaching in formal education (Mediappro, 2006).

Children (aged 5-9) and new media awareness

- 56% of children using the internet once a week consider themselves average users
- 87% of children are confident in finding information
- 74% of children are aware that the internet can be dangerous
- 48% say they saw something online and they want to purchase it
- 8% of children told their parent/guardian if they found porn emails
- 60% say they would inform their parents

Source: D. Buckingham (2006), *The Media Literacy of Children and Young People: A review of the research literature on behalf of Ofcom*

These stories of fear can be taken to heart by educators, parents and guardians, and responses are not usually positive. The regulatory response in the US is to propose banning access to sites which require a profile page from schools and libraries (boyd [sic.] and Jenkins, 2006). This includes social networking websites such as Bebo and YouTube, but also blogs. This is in response to fears that young people may be networking with others who are not who they say they are. Age verification for such sites is not particularly sophisticated, and young people provide a great deal of personal information in their profiles to attract contacts, which leaves them open to undesirable approaches. Jenkins proposed that this kind of fear is in danger of generating a worrying 'participation gap' which is characterised by unequal access to the experiences, cultures, social contexts, skills, and knowledge that prepare one for full participation in a global economy.

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Beyond fear of online predators, some schools and institutions have reacted to young people's technological habits as more nuisance than anything else. Mobiles and game devices tend to be banned in classrooms and school property because of the disruption they pose to traditional teaching methods and classroom activity. It is difficult to instruct people in WWII history if students are texting or playing on their Nintendo DS. However, handheld devices can be used as part of formal education outside the classroom as an enhancement and extension to learning.[18] Audio learning material can be taken away and consumed at a time and place of students' choosing, for instance. This method of extending learning into a young person's private or personal sphere can give learners more control and ownership over learning.

US research also suggests that Millennials are multi-taskers, juggling texting, talking and other activities in ways which are interpreted more often than not by adults as inattentive (Rainie, 2006). However, multi-tasking and attention should not be seen as oppositional. Instead these might be considered as precisely the kinds of skills that knowledge workers of the future might need. Some suggest that the attention span of teenagers mirrors that of top managers operating in a rapid, context-shifting world.[19]

Many also contend that young people are losing critical skills because they are growing up with a kind of cut and paste culture. They fear the reliance on search (Googling) and collaborative knowledge building (Wikipedia) is introducing new vulnerabilities, gullibilities and a general decline in critical skills. However, there is not yet enough evidence to suggest this has a negative impact on learning and attainment. Indeed, instead of admonishing cut and paste behaviour, young people might be encouraged to create meaningful connections and critically understand what it is they are cutting and pasting, and hence re-producing. Dan Perkel (2006) explores a useful model of literacy which understands literacy practices within their social contexts. This means exploring the different genres and patterns of representation made in these digital contexts, as well as the medium-dependent aspects of them (Perkel, 2006). It means understanding that every medium a young person inhabits is important, socially, politically, economically and culturally.

So, there seems to be a divergence between how young people have adopted and use digital media technologies and devices, and what those in authority – schools, guardians or the mainstream media – allow or wish young people to do under their 'watch'. We are witnessing an educational deficit between new media activity at home, in private, and that which takes place in formal educational and public environments. We know that literacy is not confined to technical processes of reading, writing and numeracy. Being literate is much wider, and has social and cognitive consequences to how individuals think, as well as how societies organise (Perkel, 2006). Indeed, new media or digital literacy should not be about replacing existing literacies: reading, writing and numeracy are crucial skills for full participation in a digital society and knowledge economy. Essentially, new models of literacies suggest that different kinds of digital contexts have different levels of dynamism and participation that can fundamentally change the way one thinks about and understands something.

Technology thus becomes a prop of literacy. Producing a profile page on Myspace, for instance, involves processes of reading and writing – a form of digital quilt-making as 'public displays of connection' (Donath and Boyd, 2004). Practices of copying and pasting code to create a profile page that represents different aspects of one's self are considered as everyday practices in conventional software development, Perkel argues. But now, barriers to do this with simple code are lower and the value one gets out of learning could be significant and an incentive

18 *Indeed, games such as Dr Kawashimas Brain Training - How old is your Brain? for the Nintendo DS are finding wide appeal with children and adults alike, and engage them in basis numeracy and literacy skills in a fun way.*

19 *See Seely Brown (2002)*

to participation. However, it sits uncomfortably in current education practices: to an educator or business, this constitutes plagiarism unless sources are accurately credited or remunerated. A new form of 'networked discourse' is emerging which young people are not yet fully equipped to critically reflect upon themselves, and which educators are not necessarily equipped to understand as part of the process of formal education.

Conclusions - New tools, new challenges

Although there are many good practice examples of educators using new digital media and technologies in exciting and innovative ways, the formal education system may miss an opportunity to provide useful, contextual instruction which would be invaluable to young people's assimilation of new technologies, and their building of digital literacy skills. As we have attempted to show, these are skills which may become increasingly important for full participation in any workplace, further education and life, as we move through rapid technological change.

Through networked cultures young people are learning from peers in more direct ways. They are exposed to and challenged to think about, power and the importance of different cultural practices. Young people are using digital spaces to explore identity, their place in the world, and their understanding of how society and culture works. Yet adults do not fully understand the more deeply complex functions of these spaces, what they mean for young people's sense of agency, what kinds of cultures they are consuming and learning through, and what impact this has on their life chances. Those who excel in a networked world are those who know how to use their networked communities and connections to get at knowledge, take action or communicate at any given moment and context (Jenkins, 2006).

The challenge for educators is much bigger than finding the right game or mobile application for the classroom to learn about WWII, or using a wiki to do homework collaboratively. The challenge is not so much about how to prevent plagiarism via the Web or preventing access to Myspace. Educators and guardians need to ensure every young person, regardless of background and socio-economic position, can access the skills and knowledge to be full participants in the networked knowledge society. Young people should be helped to understand and learn ethical standards that shape their practices as participants in networked cultures. And they must be able to articulate their understanding of how media shapes perceptions of the world.

To meet these challenges, certain conditions have to evolve. To Leadbeater, it requires a cultural rather than physical rebuilding of schools to capture collaborative creativity:

> Schools are factories for learning in an age when we need agility and self-motivation. Learning beyond the school, using new technologies and tools, will become as important as learning at school. Imagine an education system for the generation that grew up with eBay and Google, MySpace and Wikipedia: participative, personalised, collaborative, always available. (Leadbeater, 2006)

For this to happen, new media literacies should be social skills and part of a wider citizenship toolkit for a digital era. The challenge that precedes that is how educators can be supported to approach new digital social contexts and cultures in a way that does not add extra pressure to an already challenging and under-resourced job.

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References

BBC, (2005), 'Gamers in the UK: Digital play, digital lifestyles', [http://open.bbc.co.uk/newmediaresearch/files/BBC_UK_Games_Research_2005.pdf]

Berners-Lee, T, Fischetti, M, (1999), *Weaving the Web: Origins and Future of the World Wide Web*, Orion Business

Boyd, d, and Jenkins, H, (2006), 'MySpace and Deleting Online Predators Act (DOPA)', *MIT Tech Talk,* May 26 2006, [http://www.danah.org/papers/MySpaceDOPA.html]

AP/CNN, (April 2006), 'Virtual game jumps to real world', [http://www.cnn.com/2006/TECH/internet/04/28/gamein.game/index.html]

Coleman, S, (2005), 'Remixing Citizenship: Democracy and Young People's Use of the Internet', Carnegie Young People Initiative, [http://cypi.carnegieuktrust.org.uk/files/Carnegie_v3LRES_0.pdf]

Donath, J, and Boyd, d, (2004), 'Public displays of connection', *BT Technology Journal*, Vol. 22 No. 4, October, [http://smg.media.mit.edu/papers/Donath/PublicDisplays.pdf]

Dutton, W, di Gennaro, C and Millwood Hargrave, A, (2005) *Oxford Internet Survey 2005 Report*: The Internet in Britain [http://www.oii.ox.ac.uk/research/oxis/oxis2005_report.pdf]

Elspa, (2006), 'Unlimited learning: Computer and video games in the learning landscape', [http://www.elspa.com/assets/files/u/unlimitedlearningtheroleofcomputerandvideogamesint_344.pdf]

Gillmor, D, (2006), *We the Media: Grassroots Journalism by the People, for the People*, O'Reilly Media, Inc.

Jenkins, H, with Clinton, K, Purushotma, P, Robinson, AJ, Weigel, M, (2006), 'Confronting the Challenges of Participatory Culture: Media Education for the 21st Century', the John D and Catherine T MacArthur Foundation[http://www.digitallearning.macfound.org/atf/cf/%7B7E45C7E0-A3E0-4B89-AC9C-E807E1B0AE4E%7D/JENKINS_WHITE_PAPER.PDF]

Jenkins, H, (2006), *Convergence Culture: Where Old and New Media Collide*, New York University Press

Leadbeater, C, (2006), 'The Ten Habits of Innovation', Provocation paper 01, Nesta, 1 Plough Place, London EC4A 1DE

Leitch Review of Skills, *Prosperity for all in the global economy – world class skills*, HM Treasury (December 2006) [http://www.hm-treasury.gov.uk/media/523/43/leitch_finalreport051206.pdf]

Margo, J, Dixon, M with Pearce, N and Reed, H, (2006), 'Freedom's Orphans: Raising youth in a changing world', ippr [http://www.ippr.org.uk/publicationsandreports/publication.asp?id=496]

McFarlane, A, Sparrowhawk, A and Heald, Y, (2002), 'Report on the Educational Use of Games', TEEM (Teachers Evaluating Educational Multimedia) [http://www.teem.org.uk/ publications/teem_gamesined_full.pdf]

3

McLuhan, M, (1964), *Understanding Media: The Extensions of Man*, Routledge

McLuhan, M, (1967), *The Medium is the Massage: An Inventory of Effect*, Bantham

Mediappro, (2006), *The Appropriation of New Media by Youth*, European Research Project [http://www.mediappro.org/publications/finalreport.pdf]

Nesta, (2006), 'The Innovation Gap: Why policy needs to reflect the reality of innovation in the UK', Nesta [http://www.nesta.org.uk/assets/pdf/innovation_gap_report.pdf]

Ofcom, (2006a), 'The Communications Market' [http://www.ofcom.org.uk/research/cm/cm06/]

Ofcom, (2006b), 'Media Literacy Audit: Report on media literacy amongst children' [http://www.ofcom.org.uk/advice/media_literacy/medlitpub/medlitpubrss/children/children.pdf]

Owen, M, Grant, L, Sayers, S, and Facer, K, (2006), 'Social software and learning', Futurelab [http://www.futurelab.org.uk/download/pdfs/research/opening_education/Social_Software_report.pdf]

O'Reilly, T, (2005), 'What Is Web 2.0? Design Patterns and Business Models for the Next Generation of Software' [http://www.oreilly.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html],

Perkel, D, (2006), 'Copy and Paste Literacy: Literacy practices in the production of a MySpace profile', unpublished working paper, School of Information University of California, Berkeley [http://www.ischool.berkeley.edu/~dperkel/media/dperkel_literacymyspace.pdf]

Rainie, L, (2006), 'Life Online: Teens and technology and the world to come', speech to annual conference of Public Library Association Boston (March 2006) [http://www.pewinternet.org/ppt/Teens%20and%20technology.pdf]

Seely Brown, J, (2002), 'Learning in the Digital Age', Forum Futures

Sorensen, C, (2006), *The Mobile Life Youth Report 2006: The impact of the mobile phone on the lives of young people,* London School of Economics and Political Science [http://www.yougov.com/archives/pdf/CPW060101004_2.pdf]

Twist, J, (2006), 'The Year of the Digital Citizen', BBC News website, [http://news.bbc.co.uk/1/hi/technology/4566712.stm]

Withers, K, (2006), 'Mobiles have 'key role for young", BBC News website, [http://news.bbc.co.uk/1/hi/technology/6070378.stm]

How to teach with technology: keeping both teachers and students comfortable in an era of exponential change

4

Marc Prensky

Some have opined that earlier technologies that were initially touted with great fanfare for their potential to changing education, such as television, didn't change much at all. I submit that all these technologies – especially television – did change education radically. Just not in our schools.

The twenty-first century will be characterised by enormous, exponential technological change. Our so-called 'Digital Native' generation (that is, our students) is already embracing these changes, creating in the process an 'emerging online digital life' that I have written about extensively.[1]

For education, this explosion of technological change has enormous implications, and is already raising several issues. Technologies such as mobile phones and digital cameras are being banned by many schools. Schools are moving towards one-to-one computing at radically different speeds. In general, students are learning, adopting, and using technology at a much more rapid pace than their teachers, and many teachers are highly fearful of the technologies that the students take for granted. While some teachers do embrace the kids' technological world, those teachers who are fearful of being unable to engage a generation of students used to technological advances often attribute their own failures, such as the loss of control implied in integrating tools that they know relatively little about, to untruths such as lack of attention span and Attention Deficit Disorder on the part of students.

In exchange, students observe their teachers' lack of fluency with modern tools, and view them as 'illiterate' in the very domain the kids know they will need for their future – technology. The very concept of an 'education' is changing for many kids, as they experience self-directed learning, mostly out of school, about things that interest them, and they see how different this kind of learning is from the 'push it on you' and 'test you to death' methods of formal schooling.

I love to listen carefully to what students say, "There is so much difference between how teachers think and how students think," explained a 16-year-old female high school student recently (2006). Today's students see teachers as being from the 'olden days' when you 'actually had to memorise phone numbers' (15-year-old girl, 2006). They see these now useless bits of information as representative of all the knowledge their teachers have that is useless for their future. And the two groups have trouble communicating: "You really have to slow down when you talk to teachers" said a 14-year-old in Liverpool (2005).

Better strategies, please

But this divide, growing larger every day, does not, in fact, have to prevent us from educating our students effectively. There *are* strategies for teaching with technology that can make both students and teachers comfortable, while allowing the students to go as far as they can with the technologies that characterise their age and that they love to use, and that prepare them for their twenty-first century future as well.

In the past five to ten years, we have seen the appearance of scores of new technologies that have strong potential uses in education. They include email, search, texting and instant messaging, blogs, wikis, the Wikipedia, podcasting, polling devices, peer-to-peer (P2P), complex computer and video games, networking, augmented reality, social and community building tools, digital cameras/videocams, phone-based cameras/videocams, GPS, speed enhancers, interactive whiteboards, DVDs, wireless technologies and many

1 *See Don't Bother me Mom, I'm Learning and online at www.marcprensky.com/writing.*

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others. We have also seen older technologies (such as pagers and most wires) increasingly being replaced and leave the field. Given that our technology will continue to roughly double in power every year, based on a combination of Moore's Law for processors, increases in transmission speeds, storage capacity, and other developments, there is every reason to assume that in the next 5 to 10 years we will see even more new technologies appear than we saw in the last decade.

Too fast to master

The key point is that new technologies for education are arriving and changing really fast – too fast for even teachers who *want* to learn to use all of them to effectively do so. (And, of course, there are many teachers who *don't* want to use new technologies at all.) Yet our students are clamouring for these technologies to be used as part of their education, in part because they are things that the students have already mastered and use in their daily lives, and in part because they realise just how useful they can be.

So what should we educators do? Teachers often ask for 'training' in using these various tools, but is that really the answer? I think not, if only because of the speed with which the tools are coming and going. Though we rarely ask our students" opinions, when we do ask about this the students' message to teachers is clear: "Don't even try to keep up with technology – you can't. You'll only look stupid" (High school girl, 2006). I don't imagine any teacher actually wants to look stupid in front of his or her class.

Lest you think I exaggerate, here's an example. Many of our teachers think they have finally 'mastered' Microsoft's PowerPoint. These teachers have worked hard, in many cases, to put their class notes and lectures into the new format, assuming that their students are sure to appreciate their effort to keep up with the technology.

But what do the students say? "Teachers make a PowerPoint and they think they're so awesome," says a high school girl (2006), typically. "Teachers make PowerPoints and think we're so excited to see them," says another in middle school (2006), "but it's just like writing on the blackboard." "And then they read them to us" says a third (2006). "Why should I have to go to hear it read?"

What teachers need to learn

There are, of course, teachers who are passionate about using technology, who strive to learn and keep up, and who are using technology creatively in their classrooms. Some of these enthusiasts have mastered on their own the technologies they use, but the smartest among them have partnered with their students, who are eager to teach them. "Just ask us," says a 15-year-old, "We're happy to help." (2006)

A star among British teachers who use technology creatively is the Becta award-winner Tim Rylands of Chew Magna primary school near Bristol, who uses the Myst, Riven and Exile series of games to inspire creative and descriptive writing in his students. I know of many language teachers who make podcasts for their students. Other teachers are posting homework assignments and accepting student submissions online, which the students love. I have nothing but praise for these teachers, who work hard to keep up with their students' technology preferences. But such teachers are the exceptions.

And, in a sense, that is how it *should* be. Teachers (unless they have a special passion for technology) rarely benefit from learning to *use* (that is, create examples of) the emerging technologies themselves. The reason is simple: excepting a great deal of passion and time devoted, they will always be behind the curve in the use of the technologies – and most importantly, behind their own students, 'looking stupid'.

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The fact is that today's students know more – and will always know more – than their teachers about technology and how to manipulate it. This may be hard for many teachers to accept, because it means letting go of whatever control comes from being 'the only one in the room who knows'. But this really *shouldn't* be so hard, because teachers, being adults, still do have an edge. Our edge is that we understand what the students generally don't – the learning objectives that determine *why* we are using whatever the technology happens to be.

To retain the respect of our students who know more than we do technologically (and to therefore look 'smart'), what we teachers really need to learn to do, I submit, is to 'divide the labour' of learning, to the benefit of all. The answer to 'How do I teach using tools that are unfamiliar to me, tools that I can't fully master, or, even, in many cases, use myself?' is actually simple: Let's each do what we do best.

And how, you many ask, can I, an ordinary teacher, one not ahead of the curve in – or even necessarily attracted to – technology, do this?

My answer – different from the advice of many – is that such teachers don't need to waste even a minute of their limited and precious time learning to use and master any of the new technologies. Why? Because their students can do this – and they want to. What we should do is let them.

If you are a teacher who wants to learn to use new technology tools, go right ahead. Just be sure to get help from your students so you don't 'look stupid'.

But what *all* teachers should learn to do comfortably, though, are those things we can do *without* 'looking stupid'. This (we certainly hope!) is to *evaluate* their students' uses of the new technologies, and *teach our students the important lessons about* those technologies. Teachers can and should be able to understand and teach *where and how new technologies can add value* in learning.

To do this, teachers must learn what these technologies are and can do, and understand them, but without necessarily becoming proficient in their use. (And by 'use' I mean creating with the technologies, not just 'accessing' them.)

Teachers must do this because there are lessons about technology that even the most technologically proficient kids can't learn well on their own. These include evaluating and comparing various uses of the new technologies, as well as specific lessons one doesn't necessarily learn from 'just doing'.

So there needs to be a 'useful division of labour' around the emerging technologies. Teachers need to work with students to understand how the technologies work, what they offer, and to understand how to include them in assignments. Students need to do the work of actually producing things in these technologies and media. Then teachers and students need to work together to create evaluation criteria and rubrics, and to make and understand the distinctions that relate to quality. Teachers also need to help students apply technologies wisely to real problems, and to reflect and search for the deeper issues that the technologies raise, and to bring up and discuss these issues with the students.

Four examples

To illustrate what I mean by a 'useful division of labour' around emerging technologies, let me use four of them as examples. Out of the larger list above, I have picked four 'technologies' as illustrations, choosing them, to some extent because they have been among the most controversial. These are the technologies of The Wikipedia, podcasting, Instant Messaging, and phone-based cameras.

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The Wikipedia

The Wikipedia is an online, collaborative encyclopedia to which anyone who wants to can contribute. Wikipedia is a technology – or more precisely a product enabled by a collaborative technology known as wiki – that has become a thorny problem for many teachers and school librarians. The concern of these people is that students may (and do) use Wikipedia as their sole source of information when doing research, and that the information – not necessarily written by recognised, paid 'experts' – will be wrong. In the most unfortunate and extreme cases, this concern leads educators to ban students from using the technology at all. To me, that 'solution' is just silly, because even medical school professors claim that the Wikipedia is full of useful information not easily found anywhere else. Recently a Harvard Medical School professor wrote in the *New York Times* about being stung by a jellyfish. Everything people did made the pain worse, until he was able to find the 'right' answer – Australian researchers had shown that hot water worked best to alleviate the pain – in under two minutes on Wikipedia. (Jerry Avorn, 'The Sting of Ignorance', *The New York Times*, September 16, 2006)

Let me suggest a different way to approach the issues that the Wikipedia raises. First, we need to let the kids use the Wikipedia (it's useful, and they'll do it anyway.) But we should make them use it not just for searching, but also make our students become contributors, writing articles about, say, local activities, places, or traditions that the Wikipedia does not already contain. (Of course, if students wish, they can contribute to other articles as well.) Teachers can then work with their students to evaluate those contributions. Are they effective? Well written? Do they communicate well? Are they examples of good journalism? Why, or why not? There is a lot of learning here for our students, in a real-life context that is visible to the whole world.

This is what 'using' a technology means to today's kids – not just finding something, but putting something of their own in.

In addition, and very importantly, the teacher can and should raise with students, and discuss with them, some key lessons surrounding the Wikipedia. The biggest of these is the issue of 'search versus research'. What I mean by this is that the Wikipedia is a perfectly valid source when you are 'searching', but using Wikipedia (or anything else) as your sole source when you are doing 'research' is wrong. Research, in an academic setting, comprises a set of tools and traditions that have evolved over thousands of years. One of its primary tenets is consulting multiple sources (yes, that's the 're' in research!)

A second issue for teachers to raise and discuss around the Wikipedia is the concept of Intellectual Property, including the ideas of plagiarism and 'fair use'. Here a teacher's deepest skills are required, because we don't want to only shallowly tell our students that 'plagiarism is wrong', but rather to discuss with them the broad concepts and meaning of intellectual property. Clearly, with the introduction of 'Copyleft', Intellectual Commons and other modern ideas, society's concepts of intellectual property and fair use are evolving rapidly, and need continual re-examination in a time when cut and paste is so easy a first-grader can do it.

So the teacher's job becomes, in fact, far more interesting in our time of emerging technology – not just handing out rules and how-to's, but rather providing evaluation, context and nuance to help the kids truly understand what they are so able to technically do.

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Podcasting

Podcasting is the technology of creating audio (usually MP3) or video files that are then distributed over the internet for others to hear and watch (either directly online or by downloading to personal devices). While teachers often ask for 'a course' to understand how to do this, it's something most high school kids – and even many elementary and middle school kids – already know how to do, or could learn from their peers in under 10 minutes.

So without being taught, or asking a student for help (the easiest way but something that many teachers are reluctant to do), how can teachers use podcasting in their teaching? Simple: treat making a podcast as an assignment. Podcasts can be assigned to individuals, or to a whole class working in teams (which allows those who don't know how to make them to learn from their peers), or they can be allowed as an alternative way to do written assignments.

What does the teacher have to do? Nothing more than use a skill that hopefully they are already good at: listening. Teachers should listen to the podcasts with the students, and help the students decide on the criteria for evaluation, and evaluate how well their own work and other students' submissions meet those criteria.

And what is a deeper issue to 'teach' regarding podcasting? I'd suggest oral versus written communication – how do the two forms differ and why?

Instant Messaging

Instant Messaging (IM) is something many kids do so well and easily – and most teachers do so poorly – that it has effectively opened a private communication channel, both between the kids in the class and between the kids and the world. Obviously the knee-jerk educational response has been to just close the channel off. But what it we were to ask instead 'How can this be useful in our teaching?'

After hearing one of my talks about using mobile phones in education, a teacher actually put this question to her primary school class, and, in one class period, they came up with several useful ideas. These included interviewing experts using standard English, practising business etiquette and conversational skills, doing research on the health risks of mobile phones, text messaging ideas such as to speakers while they are debating, reviewing silently for quizzes, and taking pictures of notes and assignments on the board.

I submit it is *always* better to get the ideas for how to use new technologies from the students, and to assign the use of the technologies to them. If we don't do this, and if we don't teach the kids to use these technologies responsibly, they will just use them to beat us. "I can look you right in the eye and still be texting," said one student.

So what if we *allowed* the use of mobile phones and IM to collect information during exams, redefining such activity from 'cheating' to 'using our tools and including the world in our knowledge base'? Our kids already see this on television. "You can use a lifeline to win $1 million," said one. "Why not to pass a stupid test?"

I have begun advocating the use of 'open phone' tests similar to the 'open book' tests I often had in college, in which being able to find and apply the right information becomes more important that having it all in your head. Teachers who have implemented such tests report an added benefit as well: once the students have a bigger information base to draw from, teachers can ask harder questions. Of course, as usual, the students are way ahead of us. "The truth is that all our tests are 'open phone,'" said a high school senior to me recently. "It's just that the teachers don't know it."

Once we accept IM as having educational value, then we can, as above, begin to search for, discuss and evaluate with the students the most effective procedures, the most interesting methods and ideas, and the most

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creative thinking for using it. And we can address and teach the key stumbling block about IM for many teachers – the issue of spelling. The lesson students should be taught is not that IM destroys spelling, but rather that IM is an informal language, and has its own rules, which are different from those of formal writing. Students need to learn both, and use each when appropriate.

Mobile phone cameras

Except for the research possibilities of the internet, it is hard for me to imagine a tool better able to help education than each student having in their hand a camera, especially one that can transmit the pictures they take anywhere. Students can collect evidence and scientific data, do photojournalism, visually express ideas, identify things and people, and do hundreds of other useful learning tasks, depending only on the imagination of the students and the teachers. The pictures students take can, in addition, be manipulated by them with photo editing software or other programs, creating even more expressive and useful possibilities.

But what typically happens in our schools? A student takes a picture in the girls' locker room and posts it, and, before you have time to turn around, or have time to talk about it, this incredibly useful tool is banned from use forever. From the point of view of education, this is insane. Do we ban skirts because some are too short? No, we teach kids to act appropriately. It is our job to teach responsibility and the responsible use of tools.

Just think, for a minute, of everywhere in education a camera could be useful. It could be used in English classes for creating (and later writing about) expressive images. It could be used in literature classes for collecting potential illustrations of word images and ideas. The camera's usefulness in science classes goes without saying. In maths kids could seek out and photograph mathematical principles in nature. In rhetoric, photos (and videos) can allow us to see ourselves as we are when we talk, and get useful feedback. Photo contests, photo-editing contests, caption contests, and other picture-based educational activities already exist all over the Web. They engage kids terrifically. They could and should be part of every class.

And the key issues to be teaching here? Words versus images. Responsible use. Truth versus manipulation.

You get it.

Whenever I hear pundits opine that earlier technologies that were initially touted with great fanfare for their potential for changing education, such as television, didn't change much at all, I truly bristle. All these technologies – especially television – did change education radically. Just not in our schools.

It would be foolish of us to let the same thing happen with all the newly emerging digital technologies. This time the learning is much more direct and important, and the kids already know it. Perhaps the main educational battle of our time will be between 'School' (the keeper of the credentials, yet with past-oriented learning and fear of new tools and methods) and 'After-School' (a catch-all term for all the ways kids are learning today using technology). In my view school will have to fight very hard to win this battle, as formal learning becomes, in a time of hyper-rapid change, more and more irrelevant to our students' preferences and needs for the future. If teachers do not focus on teaching the students the key lessons necessary for our future technology users to know –quality, meaning, value, relevance – school has very little chance. And if IT stands in the way of technology use rather than facilitating it, school's chances will be even worse.

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Remember, technology tools are coming at us at enormous speed, and they will only come faster in the future. 'Email Is For Old People' cried a recent headline in the *Chronicle of Higher Education* (Volume 53 Issue 7, October 6, 2006). YouTube videos, hot today, will be replaced by something even better tomorrow. Our kids are already moving beyond MySpace. Flash, the programming language of the moment, will be a 'flash in the pan' as soon as something better is invented. The futuristic GPS, gyroscopes, motion sensors and other haptics of our latest game consoles will seem old in a few years. More appropriately engineered materials will be invented to replace the largely 'found' materials of today. The use of our senses of smell and taste for learning have hardly begun to be explored. And although we still know relatively little about how the brain works (for learning or anything else), technologies for direct mind control of objects are already in use.

For technology and our kids, it is absolutely a New World ("Brave" remains to be seen). And while it is a huge one-time leap from the analogue world of our past to the digital world of our hyper-changing future, because of the speed of continuous change, future teachers will *always* be behind the technological know-how of their students. And the gap will always be greatest in the lower grades.

But whatever the technologies of the future turn out to be, creative, intelligent use of them, in service of real, important societal goals such as communication, education, and greater understanding, will still remain the thing that counts. And in those realms good teachers – whatever the technology – should be able to help and add value.

In my view, the only way our schools will ever adopt and benefit from the *new* technologies that the students want and need is if everyone, students and teachers, remains comfortable (or at least reasonably comfortable) in the process. That can only happen when each group acknowledges the strengths of the other, requiring from them that they employ their strengths as fully as possible, while learning simultaneously and gradually about the areas where they are weaker.

Our students' strengths lie in their ability to quickly master, use and apply technology, and in their fearlessness to try new things. Our teachers' strengths lie (or should lie) in their ability to distil and teach lessons about and with technology, and to engage their students in discussions that help them see and understand issues that they are likely to miss on their own. In order to figure out ways to use the technologies in service of learning, both groups must work together, because today the 'right answers' and 'best practices' exist only as ideas and experiments, or do not exist at all.

To use the twenty-first century's rapidly emerging technology effectively for education, we must invent best practices together. In an era whose often unbelievable technological changes we are all struggling with, the mantra – for both educators and students -- must be this:

We are all learners. We are all teachers.

Computer games in education

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Can computer games go to school?'

Keri Facer, Mary Ulicsak and Richard Sandford, Futurelab

Why the interest in using computer games for learning?

Educators have been interested in the potential of computer games to support learning for at least twenty years[1]. The 1970s saw experiments in games-based learning at Palo Alto; the 1980s saw Harvard professors asking whether educational practice should be radically reconfigured in the light of five-year-olds' facility with computer games; the 1990s saw the emergence of ideas of a 'digital generation' confident in the practices of the new 'information society' as a result of their regular use of computer games. J.C.Herz, for example, argued in 1996 that:

> Video games are perfect training for life in fin de siècle America, where daily existence demands the ability to parse 16 kinds of information being fired at you simultaneously from telephones, televisions, fax machines, pagers, personal digital assistants, voice messaging systems, postal delivery, e-mail and the Internet. (Herz, *Joystick Nation*, 1996)

The new millennium saw the culmination of this interest in games with the argument that computer games not only taught young people new skills and competencies, but that they could, in themselves, be considered 'little learning engines' (Henry Jenkins, MIT) and as 'designed to be learned' (Jim Gee, Wisconsin Madison). Computer games, this argument went, not only taught new skills but were, in themselves, exemplars of powerful learning environments. In theory at least, they offered an educational 'holy grail': not only, many commentators suggested, could these games support learning, but they did so in a way that young people enjoy and actively want to take part in.

The implication of much of this research, at least as far as policy makers may be concerned, is that computer games can be easily appropriated and used in school settings. What is missing from this interpretation, however, is a sustained examination of what actually happens when commercial off the shelf (COTS) games, designed for use in bedrooms and living rooms, are transplanted for use, by non-specialist teachers, with limited support, in mainstream curriculum contexts with pupils in classrooms today.

This paper seeks to outline some of the challenges and tensions that arise when 'computer games go to school' – it does not look at the learning achievements of the students when the games have arrived. It is based upon a number of studies of games and learning both in and out of school, and draws particularly upon the Futurelab/ Electronic Arts (EA) 'Teaching with Games' project which ran from 2005-2006 **[http://www.futurelab.org.uk/ research/teachingwithgames.htm]**. In this article we focus specifically on PC-based commercial games (see next article for a discussion of console-based games).

Does anyone really want computer games at school?

While academics and policy makers may be interested in the potential of computer games in school settings (see, for example, the recent DfES/ELSPA publication on games and learning), until recently we have known relatively little about whether teachers and young people themselves are interested in using these games in school. To what extent do teachers see computer games as a frivolous distraction? To what extent do children want their leisure cultures appropriated and used in classrooms?

1 *Malone (1980), Baugham and Clagett (1983), Herz (1997), Gee, (2003), Jenkins, (2005)*

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Ipsos MORI polls conducted for Futurelab and EA shed some light in this area. In surveys of 924 primary and secondary school teachers in 2005, and 2,334 secondary students in England and Wales in 2006, there was a surprising level of interest in the use of games for learning. Some 59 per cent of all teachers reported that they would be willing to use them in classes, and an average of 62 per cent of students said that they would like to use games for learning in schools. There are also differences between different teacher and student populations. Younger students were most likely to want to use computer games in school: 66 per cent of 11-year-olds compared with 49 per cent of 15–16-year-olds, for example. Similarly, teachers aged 25 to 34 with less than five years' teaching experience were more likely than older, more experienced teachers to consider a role for games in the classroom (67 per cent as compared with 59 per cent overall). These figures suggest that while there is interest in the use of games for learning, it is by no means universal even amongst young people; and a significant number of teachers (37 per cent) and students (22 per cent) are opposed to using games in school.

There is also some debate amongst teachers and children as to what they might expect games to 'teach' in lessons: both teachers and children were likely to believe that games play improves computer skills and general problem-solving abilities; teachers were more likely to believe that students could gain subject knowledge from computer games than children (62 per cent compared with 24 per cent); while more children believed games play improves social skills (24 per cent compared to 17 per cent of teachers). This difference in expectations of the potential role of games in learning may be explained by the generation gap in games play that still prevails today: 72 per cent of teachers surveyed reported no use of games in their leisure time, compared with 85 per cent of children who reported playing games outside lessons at least once a fortnight.

What happens when games meet curriculum constraints?

A range of academic and practitioner experiments have begun to generate an emerging 'canon' of computer games for learning. In this canon we might list Myst, Sim City, Age of Empires, Civilisation, Rollercoaster Tycoon and Animal Crossing – the list will vary, but what is key to these games is that they are rich, complex environments that allow immersive exploration of numerous strategies for action and decision. What we see much less of in this research are studies of fighting games such as Tekken or puzzle games such as Puzzle Bubble or Tetris. A key factor which seems to inform the way in which computer games are being incorporated into schools, then, may be the perception of their ability to offer a rich and complex world which allows the player(s) to experiment, test actions against the models offered in the games world, and develop progressively more complex understandings of the environment.

Beyond this general observation, however, it is impossible to specify the features of a computer game that will allow it to be incorporated into school. This is because not only are there are wide variety of computer games, with different features and approaches to games play, but the educational contexts into which they are brought diverge widely and have radically different educational goals, teaching practices and subject knowledge. For some teachers, for example, the absolute accuracy of the underpinning games engine (its fidelity to real life) may be essential if they are wanting to encourage children to use the game as a simulation to explore certain natural phenomena. For other teachers, however, the game may need to be only relatively accurate and internally consistent, as the teacher intends to use it for stimulating debate, discussion and generating an understanding of certain key principles.

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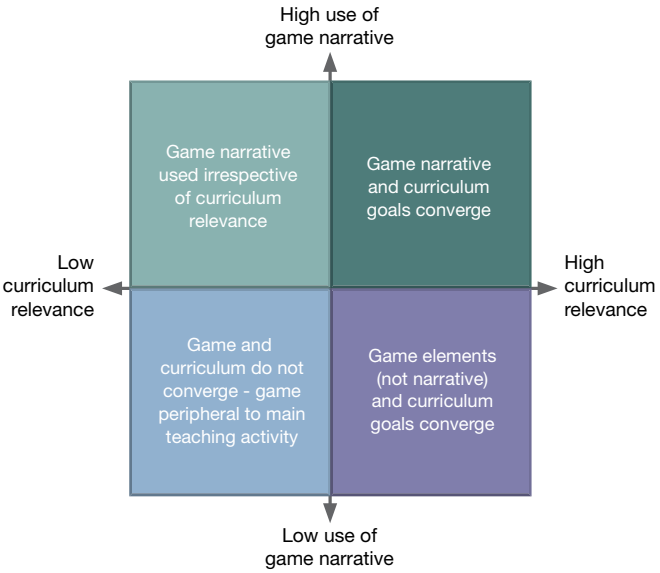
From our research with teachers and children, and our review of the literature, we suggest that there are four ways in which games are used in schools and that these are organised around a careful balancing of the tension between the narrative of the computer game and the demands of the curriculum. This is mapped out in the figure below.

Hypothetical approaches to balancing curriculum relevance and games narrative (for more detailed discussion of this framework see **www.futurelab.org.uk/research/teachingwithgames/report**)



The figure provides a model of the different ways in which the tension between game narrative (the 'ideal' route through the games play (mission structure) as intended by the games designer) and the curriculum, may be managed by teachers in the classroom.

In the top right-hand quadrant we have the 'holy grail' of computer games based learning, in which playing the game as the designer intended is the means by which children will achieve the learning objectives of the lesson. Common to this approach is the suggestion, for example, that playing a computer game in a foreign language will support the acquisition of language skills, or that playing strategy games will encourage practice of problem solving, team working and thinking skills.

In the bottom right-hand quadrant, we have the appropriation of elements of computer games for learning, in which discrete parts of a game are taken out of the overarching games context and used to achieve specific goals. In this approach, for example, we might include using the 'sandbox' element of Rollercoaster Tycoon as a simulation environment for physics which ignores the narrative of the wider game which allows players to create entire theme parks and keep visitors happy.

In the bottom left-hand quadrant, we have what seems to be a complete mismatch and disconnect between the game and the educational goals. In this instance, we would rarely expect to see games used in lessons, instead, we would see them mainly used as a stimulus to set the main activity of lessons going. In this setting, the game is neither seen as an integral educational resource to the activity of the lesson, nor is it played as intended by the designer.

In the top left-hand quadrant, we have the use of games as an additional resource for teachers – as a perk or reward for behaviour, as a means of enabling some children to fill in time while others are involved in other activities. In this context, the game is effectively fulfilling its entertainment remit and so is played as intended by the designer, but fulfils little or no educational objectives in relation to the chosen curriculum. Moreover, the game could be replaced in theory, by any number of other motivational activities.

From our studies of what happens when games 'go to school', this balance between games narrative and

curriculum relevance is a profound tension which is managed by teachers on an ongoing basis. It is a tension which emerges as a result of using software that is designed neither for schools' educational objectives, nor for classrooms. In certain circumstances, this tension is managed in such a way as to achieve a powerful new learning experience, in others the danger is that 1) either the game no longer functions as a game and thus loses its motivational value or 2) the curriculum becomes marginalised.

The strategy of managing the tension between games narrative and curriculum relevance by disaggregating games content into discrete elements raises two important questions. First, can the game still be considered a 'game' in this approach to its use, and thus, does it still maintain its motivational features? Second, is there a benefit in purchasing expensive and complex games if only small elements of that game will in fact be used in lessons – would bespoke, customisable and modular resources for learning not, in fact, be more appropriate and cost effective?

Of innocence and experience…

Futurelab's recent Teaching with Games study identified a third set of challenges faced when introducing COTS games into mainstream educational settings. These relate specifically to the question of negotiating different models of 'expertise' in games play. Schools are fundamentally designed around a premise of age-related and uniform development of expertise amongst young people. For example, a child is expected to progress at the same rate at maths, English and science and to move systematically through the grades. This underlying assumption informs how we expect children to demonstrate expertise in games play – from an initial position as 'novice' working through different levels of task complexity until they achieve 'expertise'.

In contrast, however, this study highlighted the fact that children's games play seems to be characterised by a very different model of expertise. Rather than children acquiring 'basic games skills' and gradually progressing through these until they become games experts, it is clear that children can demonstrate high levels of competence in games activities seen as particularly challenging by teachers (for example, exploiting some cheat facilities), while at the same time, being unable to navigate basic functions (such as certain character controls). This means that the 'novice' vs 'expert' model is no longer tenable in these contexts, or at the very least that teachers and students have differing views of the novice to expert continuum. What 'counts' as hard for students and teachers may be very different.

Without a shared model of progression in games literacy, and without a set of tools that allow teachers to gauge innocence and experience in using games,

there are significant challenges for teachers in designing and implementing games-based lesson activities. This matters little for the child playing the game at home for leisure purposes – indeed, expert specialisation in certain areas may, one could conjecture, form a basis for social exchange of ideas and knowledge amongst peer groups. For the school setting, however, this flags up a basic problem of how to assess pupils' abilities and competencies in order to understand how to shape the learning environment to their needs.

Learning through play or reflection on play?

Finally, one of the major tensions involved in introducing games play into formal classroom settings is that games-based learning and traditional classroom practice offer radically different models of learning. Where classrooms remain characterised, even today, by teacher-centred 'delivery' of content information, heavily reliant on talk and reflection; games-based learning is characterised by immersion in practice, problem solving and participation in community knowledge building and sharing. Indeed, it is the distinction between these two models that has led some commentators to suggest that games offer a more adequate and appropriate model for learning in the 21st century. Indeed, some have suggested that games-based learning offers a model for 'personalised' learning in the agency it offers to learners, and the responsiveness of the environment to their actions.

These two approaches to learning, however, are potentially brought into conflict when games are introduced into the classroom. As many have commented, for example, classroom practice in the UK is heavily influenced by an assessment system that rewards declarative knowledge (knowing that) rather than procedural knowledge (knowing how). In this assessment context, it is not enough for children in classrooms to learn how to play games nor to acquire a tacit understanding of the principles of the game. Instead, it is incumbent upon teachers to ensure that children are enabled to articulate and reflect upon the knowledge and principles they have developed through games play.

In this context, just 'playing the game' is unlikely to be a successful strategy for encouraging the sorts of learning required by formal education settings. Instead, teachers have to create opportunities for reflection upon action, have to develop strategies for enabling children to 'distance themselves' from the game, need to establish ways in which children can step out of the immersive environment of their games identity and adopt a new identity as learners. The incorporation of games for learning, then, requires both teachers and learners to balance the tension between different 'identities' in the classroom – between acting as games players (Medieval Knights, Rollercoaster Tycoons, Gods and City planners) and as learners in history, science, religious education or geography. This requires a complex balancing of multiple discourses and languages – the language and strategies of the game, and the language and objectives of the classroom.

More importantly, however, this need to balance the dual discourses of games and formal educational objectives, means that the teacher necessarily has to play a major role in supporting learning with games in school. Even where games narratives and curriculum objectives may be congruent (as, for example, in the use of strategy games to support competency curricula such as Opening Minds) it is clear that the teacher continues to play a significant role in orchestrating practice in the classroom, and that this role is often one of translation – between immersion and reflection, between implicit and explicit knowledge, between the games world and the world of formal, summative assessment. This is a far from a trivial task.

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Alternative futures for games and learning?

From our studies of COTS games use in classrooms we would argue that their benefit for learning is reliant upon the presence of highly motivated and expert teachers, able to appropriate precisely those elements of the game necessary to support the achievement of their learning objectives. Arguably, these teachers would make a success of any number of different resources – critically, it is the person, not the technology which defines success in this context.

If we were to imagine the future of games-based learning, then, we might turn our backs on the attempt to incorporate existing commercial games into the classroom, and instead explore how principles of games-based learning might inform the creation of radically new learning environments. This, indeed, is what Gee (2003) argued in his study of games-based learning outside school in which he identified 36 principles that could be appropriated from games play for the design of educational environments. In this spirit, then, we would suggest that the future of learning environments premised upon games practices should be built on some or all of the following principles:

1. That learners should be able to control the time, pace and location of their learning
2. That learning environments should respond to learners actions and provide rapid feedback and gradually increasing challenge
3. That learning environments should be characterised by challenges which are perceived by young people as authentic and engaging
4. That learners should be able to explore multiple identities and explore the interplay between immersion and reflection
5. That learners should be able to explore environments that require them to grapple with complex challenges and the inter-relation of multiple variables, representations and modalities
6. That learners should be able to collaborate in communities of practice –sharing ideas, cheats, hints and tips and encouraging progress to higher levels of skills.

The future vision of learning that games offer, therefore, may be a vision premised not only upon the affordances of emerging technologies, but upon a much more radical vision of a transformation in the relationships between adults and children, between learners and educational institutions, between curriculum and knowledge, between identity and learning in the 21st century. As we are demonstrating in our prototype development research at Futurelab (see for example, Fizzees), it is in combining the principles of learning that games offer, with the affordances of emergent technologies and a radical transformation of pedagogy, that very new educational practices will emerge, practices which promise to fulfil the goal of achieving a fully personalised environment for learners.

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The Fizzees project

The Fizzees project aims to encourage young people (aged 10 and 11) to undertake greater amounts of physical activity whilst developing a better understanding of the constituent parts of a healthy lifestyle. This will be attempted through the use of a dual sensor device that accurately measures heart rate and accelerometer data, and a complex scoring system that equates the maturation process of the digital pet with the recommended levels (and types) of physical activity for young people. The prototype accurately measures the player's physical activity, which is then represented visually in the form of a virtual pet (a Fizzee) 'living' on a wrist-worn device. The digital pet's appearance changes depending on the activity levels of the player, and as they investigate the best way to nurture their digital pet, they discover how to best nurture their own physical wellbeing. In addition to the wearable technology, a website provides the opportunity for players to compare their Fizzee with others, to swap suggested activities and to find out about other aspects of healthy lifestyles, such as healthy eating. A further important part of the website is for players to interrogate their health data in a variety of forms to investigate their past activity rates and to see how they have developed over time. This project draws on games' principles of rapid feedback, personalised development rates, communities for sharing ideas, hints and tips, space for immersion and reflection. See **http://www.futurelab.org.uk/showcase/fizzees/index.htm**

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Acknowledgements

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References and further reading

Baugham and Clagett (1983), *Video Games and Human Development*: A research agenda for the 80s, Harvard Graduate School of Education

Egenfeldt-Neilsen, S (2005), Beyond Edutainment: Exploring the Educational Potential of Computer Games, PhD dissertation **[www.itu.dk/people/sen/egenfeldt.pdf]**

Facer, K, Joiner, R, Stanton, D, Reid, J, Hull, R, Kirk, D, (2004), 'Savannah: mobile gaming and learning', JCAL Vol. 20

Gee, J (2003), *What video games have to teach us about learning and literacy*, Palgrave Macmillan, New York

Herz (1997), *Joystick Nation: How Videogames Ate Our Quarters, Won Our Hearts, and Rewired Our Minds*, Abacus: New York

Jenkins, H (2005), Keynote, Computers and Learning Conference, Bristol University

Kirriemuir, J (2002), *A survey of the use of computer and video games in classrooms*. Internal report for Becta

Kirriemuir, J and McFarlane, A (2003) 'Literature review of games and learning', Futurelab

Malone, T (1980), 'What makes things fun to learn? A study of intrinsically motivating computer games', Xerox, Palo Alto

Prensky, M (2001), *Digital Games Based Learning*, McGraw Hill

Sandford, R, Ulicsak, M, Facer, K, Rudd, T, (2006), *Teaching with Games: Using commercial off the shelf computer games in formal education*, Futurelab

Squire (2004), Replaying History: Learning World History through playing Civilisation III, PhD Dissertation[website. education.wisc.edu/kdsquire/dissertation.html]

Williamson, B and Facer, K (2004), 'More than Just a Game: the implications for schools of children's computer game communities', *Education, Communication and Information*, Vol. 4, No. 2/3

Williamson, B and Sandford, R (2005), *Games and Learning Handbook*, Futurelab

See also the following websites:

Becta Computer Games in Education project: **www.becta.org.uk/research/resesarch.cfm?section=1&id=2835**

Tim Rylands: **www.timrylands.co.uk**

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Games to entertain or games to teach?

Tim Dumbleton, Becta

Games are incredibly popular, and no more so than with those most likely to be in full-time education – children and young people. They cost not insignificant amounts of money and they demand, and get (in most cases), players' attention again and again.

Computer and console games are big business. The global market for digital games is estimated to be worth $11bn. The launches of two new games consoles, Microsoft's Xbox 360 and Nintendo's Wii, saw UK sales records broken in 2006. An Ofcom survey of media literacy amongst children found that 50 per cent of children reported 'owning' a games console and a further 34 per cent use one available in their household [http://www.ofcom.org.uk/advice/media_literacy/medlitpub/medlitpubrss/children/]. Development of an average console game has been estimated to cost £5.7m per title, with some titles needing over £10m [http://news.bbc.co.uk/1/hi/technology/4442346.stm].

Many educational researchers and theorists have commented on the powerful draw that games can have on players, how they engender high levels of engagement and motivation and how they can turn failure into a valuable learning experience. If the hours players spend absorbed in the latest console game could be bottled and transferred to education, we would have classes of engaged, motivated learners who bring self-direction and enthusiasm to every learning objective.

Unfortunately, games designers don't have the National Curriculum in mind when working on their next blockbuster; games are not a natural fit for the requirements, structures and established practices of formal education. So, to date, it has been mainly down to those in e-learning design and research to attempt to 'bottle' the advantages of games by marrying educational objectives, pedagogical theory and game-like designs. However, we are still waiting for the 'killer app' and, as Professor Richard Van Eck describes below, experiences to date have been highly variable.

> [T]he result of our experiences with the edutainment software of the last decade or so, which instead of harnessing the power of games for learning, resulted in what Professor Seymour Papert calls "Shavian reversals": offspring that inherit the worst characteristics of both parents (in this case, boring games and drill-and-kill learning). Many argue that this happened because educational games were designed by academicians who had little or no understanding of the art, science, and culture of game design. The products were thus (sometimes!) educationally sound as learning tools but dismally stunted as games. [http://www.educause.edu/apps/er/erm06/erm0620.asp?bhcp=1]

Something crucial is often lost in translation from games design to digital learning resource design and use. The potential benefits of using games-based approaches are increasingly being acknowledged and recognised in education at large. However, what actually makes games popular, engaging and motivating is far less well understood. The factors that make a game popular are what is most often missing from digital learning resources which are intended to be 'games-based' or 'serious games'.

The following sections explore what makes a popular game, beginning by looking at how games have been analysed as discrete 'pieces' of software. However, this article will argue that games need to be understood as an entertainment medium which draws on many other media and cultural influences to successfully

engage players. Games also need to be understood in the context of how they are delivered to players through computers and consoles in the home and through handheld technologies. By developing a better understanding of how good games design links existing cultural reference points and combines features offered by their delivery platforms, we may be in a better position to understand how they engage players.

The popularity of games and games consoles also raises some interesting questions about the expectations of children and young people and about new opportunities to deliver educational content into the home. There also needs to be serious consideration of what factors that affect the popularity and interactivity of games are replicable or desirable in an educational product. Perhaps we need to narrow our view of what an effective games-based learning product could deliver and how far it can really be 'games-based'.

For the most part, this article focuses on the commercial off-the-shelf games produced for home computers or consoles and handheld devices (produced by 'the big three' – Microsoft, Nintendo and Sony) which make up the mainstream market. It also touches on some developments from games sectors outside this mainstream market. Game-based products designed specifically for educational purposes will not be considered.

Games as software design

Despite the seeming wealth of research literature and discussion about how games could be used to inspire better design and use of digital resources in education (such as Futurelab's *Games and Learning* handbook [http://www.futurelab.org.uk/research/handbooks.htm] or ELSPA's recent research review *Unlimited Learning* [http://www.elspa.com/]), little is known (at least outside the games industry) about how games designers actually create products which can achieve high levels of engagement and motivation.

A few games companies have positively engaged with research and debate about educational uses of their products, but these have mainly been major games publishers such as Electronic Arts and Microsoft (see for example Futurelab's Teaching with Games project [http://www.futurelab.org.uk/research/teachingwithgames.htm]). Many of the major publishers also develop games through dedicated divisions or subsidiary companies that they own. Independent companies that are directly involved in designing and developing games tend to be much smaller and are under very different financial and contractual pressures from the major publishers. To date, there have been few development companies or divisions that have shown any interest at all in educational uses or links with the educational digital resources sector. Notable exceptions are Blitz Games [http://www.blitzgames.com] (who have set up TruSim as their 'serious games' division) and Relentless Software, developers of the award-winning game Buzz: The Big Quiz [http://www.relentless.co.uk/].

We have the evidence that games can offer something, but we do not have a clear understanding of how this evidence should be reflected in the design of educational resources. To put it simply, there is a major gap between the positive research about the potential of games in education and understanding of the reality of how games are created. The alternative of not taking the time to understand how games development happens can result in poorly balanced designs which can, as Van Eck puts it, be 'dismally stunted as games' (ibid).

To start understanding design from the games developers' perspective, in 2005 Becta commissioned a study which included interviews with representatives of four games development studios.[2] The aim was to speak directly to those involved in the design and creation of games and explore what they knew about how to engender engagement and motivation in the final product.

2 *The report, 'Engagement and motivation in games development processes' is available from the Becta website [http://partners.becta.org.uk/index.php?&rid=11211].*

Although the sample size was small, so care should be taken in applying any findings more widely, the study did highlight some key features of games design processes and the culture that surrounds it.

Firstly, the project management approaches and design processes used by most of the games developers would be recognisable to most other digital content developers. There was also no sense of games design and development being a secretive 'black art' – specific design techniques that are often employed in games were discussed, such as imaginative uses of 'goal and reward' loops and enabling players to easily gain new items/abilities early in the game were seen to be important factors in fostering engagement and motivation. Again, understanding what the interactions can do and how to replicate them would be fairly straightforward for many content developers. Educational researchers and commentators do offer insights into how games design offers structures which can support learning, for example as described in Professor James Paul Gee's article 'Learning by Design: Good video games as learning machines'.[3]

The list below suggests some design factors without which a game is highly unlikely to maintain a player's interest time after time. Few games (if any) will demonstrate all the factors below and they are not all necessary to foster engagement and motivation in one game (compare, for example, the enduring popularity yet fundamentally different designs of SimCity and Tetris):

- **Engaging narrative**: this can be a good (and complex) storyline expounded through the game (such as Fahrenheit) at one extreme or a very simple scenario that is immediately obvious to the player at the other (for example Pac man).
- **Graduated challenge**: the best examples provide a relatively easy learning curve initially, allowing players to familiarise themselves with the game's interface and environment. After this initial point the learning curve becomes steeper and begins to challenge the player to develop more complex strategies and to analyse their own performance.
- **A consistent game world**: the 'playing field' offered by the game provides all the necessary interactions and cues to enable the player to engage with and address the challenges offered. It does not 'change the rules' without warning (for example, physics within the game do not change for no apparent reason) and does not undermine player agency (see below).
- **Intuitive interface (including audio)**: the interface includes visual and auditory information and intuitive controls which enable the player to both understand what they need to do within the game and to act without being distracted by awkward controls. Good examples are highly economical with the interface, providing only those cues and ranges of actions most relevant to particular points within the game.
- **Player agency (and clear feedback)**: what the player does matters within the game environment and has a clear impact. There is a logical feedback loop which enables the player to quickly understand how their actions in the game affect the game environment (whether through the interface or through changes in narrative). Feedback may be very clear and simple (for example, Space Invaders) or may challenge the user to analyse more complex sequences of cause and effect (such as SimCity), but the player should not be left stumped.

3 *http://www.wwwords.co.uk/pdf/viewpdf.asp?j=elea&vol=2&issue=1&year=2005&article=2_Gee_ELEA_2_1_web&id=88.106.6.23*

4 *http://www.spore.com/*

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From the findings of the Becta study and from other sources such as the International Games Developers Association (IGDA) [http://www.igda.org/], the games design professionals' website Gamasutra [http://www.gamasutra.com/] and the Games Developers Conference [http://www.gdconf.com/], it's clear that games developers are willing to share ideas and experience (to an extent) and these ideas are accessible to others outside the games industry (see box on previous page for a summary of other games design factors). Yet, despite the availability of information, examples and insight about games design, there remains very often a gulf between the levels of engagement and motivation seen in users of games-based educational products when compared to most games.

The reason for this stubborn gulf could perhaps be because 'games design' is being treated as synonymous with 'software design'. This should make perfect sense – after all, a computer game is digital, it has structure, parameters and a pre-defined design. All of these elements are replicable in an educational product in some form. By analysing and disassembling a game, it would make sense that one should be able to identify those elements and techniques that work and those that don't.

This results in a view of games as 'pieces' of software, as self-contained items of software that can be explored in isolation. Unfortunately, this approach does not address what makes games design fundamentally different from other approaches to software design – they are entertainment first and software second. A good example of how games can owe more to other entertainment industries than to IT industries is provided in Don Carson's series of articles, Environmental Storytelling: Creating Immersive 3D Worlds Using Lessons Learned from the Theme Park Industry (parts I & II) [http://www.gamasutra.com/features/20000301/carson_01.htm].

Games as entertainment

Good games often provide more than just a package of missions, challenges, power-ups and characters. They will also draw the player in with the right mixture of visual and aural stimuli (compare the very different atmospheres of the games Medal of Honor and Ico, for example). They also take advantage of the high-end technologies that they can be delivered on, for example the graphical fidelity of Gears of War on the Xbox 360 and the intertwining of online and offline game play in the forthcoming Spore by Will Wright, creator of the Sims.[4]

Crucially, they will also plug into the wide cultural and aesthetic landscape of their target audience by, for example, offering the 'right' celebrity endorsement or, with more subtlety, by sharing the player's visual language and cultural reference points (as demonstrated by Rockstar Games' GTAIII series). Ways in which games link outwards to entertainment and other media include:

- *High graphical fidelity and performance*: this can be as simple as shallow 'eye candy' to attract attention, or may offer deeper engagement through greater authenticity and freedom of exploration in a game's environment (for example FarCry).
- *High-quality audio and music*: where audio and particularly music is intelligently used, it can further immerse a player in the game environment and heighten emotional engagement (for example Medal of Honor).
- *Celebrity licensing*: often, this is confined to a celebrity face on the game's box or the rights to use real-world names and likenesses in the game. However, some games have used famous actors both to act as an initial draw and to bring real skill and experience to the 'role' (the Grand Theft Auto series is a prime example in which actors such as Ray Liotta and Samuel L Jackson have used their talents – both actors bring real talent to the voice-overs, but they can also associate the game in the minds of players with gangster movies they have starred in).

- *Cultural references*: games often build upon existing cultural interests including periods of history such as World War II or underground cultures such as street racing and gang warfare. These may not always be educationally desirable, but they often reflect wider output from Hollywood and TV (for example, Saving Private Ryan or Brian De Palma's Scarface).

It must also be noted that these features can also often hide (for a short time at least) the faults of many poorly designed games. High investment in a game's development, investing in a high-profile licence and high sales of a title are not necessarily signs of intrinsic quality, as the GamesIndustryBiz columnist MMS Cooray dryly comments:

> Bad licensed games are worse than bad ports or useless shooters or idiotic puzzle games. The reason is that they have a profile and a market penetration that your average bad game can never have. They get bought by parents and kids who don't know better and casuals who're tempted by the shiny logo. And they get bought in their millions. [http://www.gamesindustry.biz/content_page.php?aid=20307]

Good games designers are those that can balance both the 'intrinsic' elements of games as software with links and references to the right mixture of entertainment elements such as music, art and strong narratives. The responses of the developers interviewed as part of the Becta study reinforce this as they identified other factors such as a celebrity or sports licence, cutting-edge graphics and high-quality audio as very important (and in some cases more important than other elements) in achieving high levels of engagement and motivation. The Futurelab research report *More than 'just a game'*, which examined children's communities focused around computer games, also comments on this from the players' perspective:

> ...many games today are the product of cross-marketing exercises. Children are likely to have, as resources to assist their games play, not only the manuals and magazines that provide 'games play' information, such as cheats and information about levels, but a wider cultural frame of reference that is able to guide expectations about games play. The latest Star Wars games, for example, are modelled on particular sequences within the films (some would argue the films were modelled on the computer games) and even Harry Potter has now become a computer game, bringing with it the resources of books, films, and merchandising as frame of reference for players.
>
> Facer and Williamson, *More than 'just a game'*, Futurelab, 2003 [http://www.futurelab.org.uk/download/pdfs/research/other_pubs/More_than_a_game.pdf]

Picture courtesy of TruSim, a division of Blitz Games Ltd and the Human Factors Integration Defence Technology Centre, University of Birmingham

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The importance of linkages with other entertainment forms and references to popular culture in games (subtle or otherwise) have perhaps been underestimated in many attempts to bring games design features into education. It is also difficult for many of these linkages to be replicated in educational products for a number of reasons:

- The finance available to educational content development (particularly commercial products) simply could not support expensive licences for celebrity endorsement, use of popular music and licensed iconic brands and images as a matter of course. This is sometimes off-set by some celebrities' and entertainment companies' willingness to support educational causes, but this is the exception rather than the rule.
- Educational developers need to create products that will operate properly on the ICT infrastructure available in educational institutions – dedicated graphics cards are not the norm in school and college computers.
- Some of the features and references that games can take advantage of (such as gang violence as noted above) simply wouldn't be desirable in educational settings in the form they are presented in games.
- Educational products are not normally bought by the end-user; they have to address the needs of a range of stakeholders – national policy in terms of curriculum relevance and assessment, teachers' requirements for clarity, subject focus and relevance to classroom practice and wider social requirements such as inclusion and cultural sensitivity.

The impact of the extrinsic entertainment and cultural factors on players, and particularly young people, needs to be acknowledged by the education sector if the engagement and motivation fostered through games is to be properly understood and we are to avoid 'Shavian reversals'. The Futurelab Teaching with Games research project raises the issue of our lack of in-depth understanding of what makes games popular: 'We need to move beyond the generalisation that children 'are motivated by' playing computer games, towards a more nuanced understanding of exactly what in games play is motivating in order to best understand how to engender such engagement in the classroom.' [http://www.futurelab.org.uk/research/teachingwithgames/findings.htm]

If we are to succeed in translating features of games design into educational products effectively and repeatedly, then games need to be understood as entertainment products that engage their audiences in a wide variety of ways. Some will be desirable and replicable in educational settings; others simply won't be appropriate, affordable or relevant. Games must also be understood as products which benefit from other popular media – good games can engage by tapping into the culture of their players rather than only through 'pure' gameplay elements.

Games platforms and the context of gameplay

Today, games platforms are broadly divided between personal computers (Mac and PC) and dedicated games platforms such as consoles (including handheld devices for games). This section focuses on recent developments within the console sphere – the availability of personal computers is also a significant area but it is a relatively stable area of technology and the role of personal computers is already well understood in education.

Over recent years, Sony has come to dominate the console market through its PlayStation and PS2 products with millions of units in homes. Nintendo's place in the home console market has been somewhat reduced over recent years but it has had great success with the Gameboy and the more recent Nintendo DS and Wii platforms. Microsoft has been the first to enter the 'next generation' console market with its recent Xbox 360 console and is seen as a possible challenger to Sony's dominance.

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The computing power and functionality offered by the most recent versions of consoles (the Xbox 360, the PS3 and Nintendo Wii) are also worth considering. Broadly, the new generation of consoles offers multimedia capabilities beyond just games use, they are utilising broadband and wireless connectivity both to offer value-added services and to provide new opportunities for gameplay, and they are beginning to challenge high-end personal computers in their processing and graphics capabilities. Handheld devices (principally Sony's PSP and the Nintendo DS) are also offering interesting new social and collaborative gameplay opportunities through wireless connectivity and can support a greater range of functions such as internet access, chat and multimedia playback.

As well as the technical capabilities of these devices, the marketing strategies taken by the console manufacturers are also worth noting. Microsoft and Sony are positioning their consoles as high-end, multi-purpose entertainment platforms which can sit comfortably under the TV in the living room. By offering more than 'just games', the approach taken by these companies appears to focus on presenting games as a legitimate part of a wider entertainment choice alongside (and increasingly with links to) film, digital TV, music and internet use. Nintendo are taking a different tack, focusing almost wholly on re-inventing gameplay and opening games up to new, largely untapped audiences such as people over 30 and women. They are offering more intuitive ways to interact with games through a kinaesthetic, position-sensitive controller (which it is hoped will remove the barrier of 'button bashing' controls) and by supporting the development of more collaborative, social and imaginative games which do not only appeal to the existing demographic of game players.

Games design has always been intrinsically linked to the availability of relevant technology from the earliest days of popular computing – in fact many of the games industry's leading lights got started because platforms such as the Sinclair Spectrum offered not only the platform to play games, but also to create them with relative ease. These 'hobbyist' opportunities faded over time but have been re-emerging significantly through 'modding' communities for PC games (now often supported by commercial developers) and through Microsoft's XNA development toolkit available to players through the Xbox 360. These developments are explored further in the next section.

All of this should be of interest to education because of the directions in gameplay that consoles are fostering, the challenge that they are making to the personal computer as the 'traditional' internet access and digital platform of choice and also because they are proprietary devices, each of which requires different (and potentially very costly) technological and development approaches for content designed to be delivered on them. We are already beginning to see significant interest in the educational applications; Sony has recently begun to market their PSP platform to the education sector [http://www.playstation-ed.co.uk] and Learning and Teaching Scotland are establishing the 'Consolarium' to explore the potential benefits for education[5].

These technologies should be taken account of in future planning around ICT provision and use in education. They could offer a route for increasing access to educational resources in the home and they are an important element in understanding the different sorts of digital literacies and expectations of technology that children and young people are bringing into educational institutions. There may also be real opportunities in exploring how wireless and internet delivery of educational resources ('through' rather than 'on' consoles) could take advantage of new types of interaction supported by consoles and handheld devices.[6]

5 *http://www.ltscotland.org.uk/ictineducation/connected/articles/16/embracinggamingculture/index.asp*

6 *More detailed discussion and links to some relevant articles by games developers are available in the Becta article 'Learning lessons from digital games: What can games teach us about narrative?' [http://industry.becta.org.uk/display.cfm?resID=15498].*

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Wider developments in games

So far, we have focused on the mainstream games market. However, there are some relatively recent developments in other approaches to game design and online collaboration and communication.

Firstly, the high-entry barriers to mainstream games development are being increasingly offset by the growth in interest in casual games and 'indie' games development (that is, not dependent on the support of large mainstream publishers). Casual games are often fairly simple browser-based applications that are intended to be played in short bursts and are intended to appeal to wide audiences. These are usually internet based or available for download onto mobile phones – games for both of these platforms are expected to see major growth in the near future.

Indie games are seen as an area of greater creative freedom as the cost of development is kept much lower through Open Source tools development approaches, collaborative design and support networks and online publishing, which enable professionals and enthusiasts to engage in games design. One focal point of indie games is GarageGames [http://www.garagegames.com/] which sells the Torque game development tools at a relatively very low cost. This more open approach to games design is being recognised by some in the public sector (such as NASA) and in the mainstream games market. Microsoft is working with GarageGames to offer some of the Torque development tools as part of the XNA toolkit to enthusiasts via the Xbox 360 and the PC.[7]

There has also been a major shift in the popularity of massively multiplayer online role playing games (MMORPGs) and persistent online worlds. MMORPGs are often distant cousins to table-top wargames or pen and paper fantasy role-playing games. Examples include Sony's Everquest and Blizzard's World of Warcraft. There is not usually a 'winner' or a defined outcome in MMORPGs – the primary attraction is in developing an avatar and exploring the environment, challenges and opportunities for collaboration that the online world offers. Persistent world approaches focus solely on the communication and exploration aspects without any predefined gameplay elements, such as Linden Labs' Second Life and A Tale in the Desert II. Both of these virtual worlds offer creative spaces for users to socialise and collaborate with others.

All of these online environments provide players with stable online environments which they can revisit and interact with over an extended period of time. Each 'player' can create a character or avatar which can evolve by completing quests and challenges or through social interaction and gaining new items. They can also have complex economies through buying and selling items within the online world, and increasingly these virtual items are attracting real-world financial value.

MMORPGs and persistent worlds are gaining more interest from education and training sectors. For example, the Alliance Library System with partners is developing a library within the Second Life online world [http://secondlifelibrary.blogspot.com/]. Forterra Systems [http://www.forterrainc.com/] develops virtual online environments to enable 'first responders' across the USA to collaborate and practise responses to different emergency situations. With both of these examples educators are taking advantage of online communication to either reach an existing audience or overcome geographical barriers to effective communication.

All of these developing areas could provide a rich seam of opportunity and inspiration for digital resources and services in education. The lower barriers to entry in the casual and indie games areas offer the potential of collaboration with experienced games designers and access to new tools at a much lower resource and investment risk than with the mainstream games

7 *http://www.microsoft.com/uk/press/content/presscentre/releases/2006/08/pr03685.mspx*

sector. The growth of persistent online worlds could offer insights into new approaches to interface design that focus on communication and collaboration, intelligently combining a control interface with visual and auditory cues that support communication and can augment text-based approaches.

Used with permission of West Nottinghamshire College, www.alteredlearning.com

Conclusion

There is no doubt that the potential role of games is being recognised and that we are becoming clearer about where aspects of games contribute to education. For example, the power of games to engage and motivate has been demonstrated through West Nottinghamshire College's Altered Learning project [http://www.alteredlearning.com/] and through the work of the award-winning teacher Tim Rylands with the Myst series of games [http://www.timrylands.com].

However, examples of successful and sustained use of games in education are still very limited (the possible reasons for this have been documented by Becta [http://partners.becta.org.uk/index.php?&rid=11211], TEEM [http://www.teem.org.uk/publications/] and Futurelab [http://www.futurelab.org.uk/research/teachingwithgames.htm]). The use of games design approaches in products developed specifically for education is also still very much developing with a fledgling 'serious games' sector gradually emerging. Experiences of games-based learning across the board are still very mixed with only pockets of good design and practice.

If real lessons for the development of engaging, innovative digital resources for education are to be clearly identified and embedded in design and use, then games themselves must be understood at a much deeper level. It could be argued that in many cases the lessons taken from games design have focused too heavily on games as 'pieces' of software first and foremost (rather than as an entertainment medium) and so the results do not capture the imagination as much as might be hoped.

However, by broadening our view of what games design means to include consideration of the entertainment linkages they build on and the importance of their delivery environment on dedicated and available platforms, then we may be able to develop a more rounded view of how games really do engage and motivate. The improving profile of and increasing big business support for 'amateur' games development which can actively involve the end-user also suggest that there may be greater opportunities in future for collaboration across the sectors at a range of levels. Perhaps the combination of a better understanding of mainstream games and revitalised access to games development tools for users could steer us away from going down the path of edutainment again.

Ubiquitous Computing

David Ley, Becta

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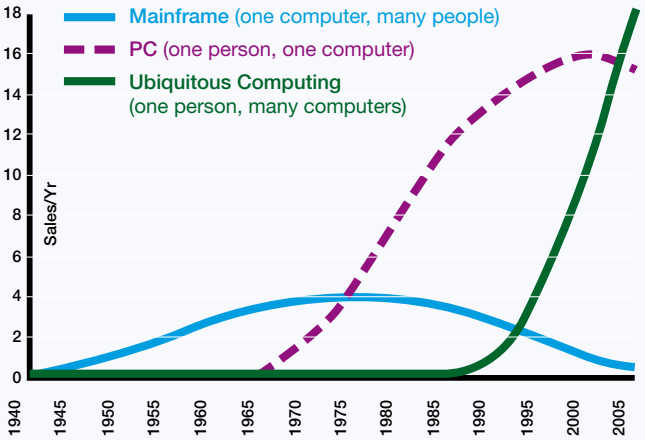
The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

Mark Weiser[1]

Ubiquitous computing is a vision of computing power 'invisibly' embedded in the world around us and accessed through intelligent interfaces: 'Its highest ideal is to make a computer so embedded, so fitting, so natural, that we use it without even thinking about it.'[ii] This is about a shift to human-centred computing, where technology is no longer a barrier, but works for us, adapting to our needs and preferences and remaining in the background until required. This implies a change in our relationship with ICT to a much more natural way of interacting and using the power of networked computing systems which will be connected not just to the internet or other computers, but to places, people, everyday objects and things in the world around us.

If achieved, such a vision would be transformational and have profound implications for how we live, work, interact and learn. When Mark Weiser wrote about ubiquitous computing in 1991, his vision of computing power deeply embedded in objects, places and devices seemed some way off. Today, various elements of ubiquitous computing are beginning to appear and be useful in their own right, as increasing numbers of devices and objects become addressable (have a unique ID) and connected (usually wirelessly).

Just as with the rapid development of the internet and web technologies, many applications of ubiquitous computing cannot be predicted today and rely on these technologies reaching a critical mass. Weiser saw three waves of computing: the mainframe age when many people shared a computer; the personal computer wave when one person has one computer (the focus of many initiatives); moving to the ubiquitous computing wave when each person shares many computers. The current internet age is seen as a transitional phase between the PC and ubiquitous waves.



The three waves of computing [Source: http://sandbox.xerox.com/ubicomp/]

Implications

The increasing maturity, performance and miniaturisation of processors, networking technologies, memory, displays and sensors is enabling a move towards pervasive computing, ubiquitous connectivity and more adaptable interfaces that are sensitive and responsive.

Many objects and devices already have embedded processors and sensors. Some cars, for example, use sensors to monitor wheel slippage and apply the brakes to stop us skidding. Radar-controlled cruise control will automatically keep the distance with the car in front. However, these systems tend to be stand-alone and do not necessarily interact with other connected objects and devices. Washing machines have sophisticated electronic programmes, but we need to explicitly control them. In the ubiquitous computing world, the washing machine would automatically interrogate tags embedded in our clothes and adjust the wash cycle accordingly.

Increasingly then, connections are not just people–people or people–computers, but between people–things and most strikingly, things–things.[3]

1 Weiser, M. (1991): *The Computer for the 21st Century.* In: Scientific American 265, Nr. 3, S. 94-101.

2 Weiser, M **http://sandbox.xerox.com/ubicomp/**

3 'Things' here means objects and devices that are not computers

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This is what the International Telecommunication Union (ITU) calls the 'internet of things'[4]. These new connections create the possibility of new interactions and access to enormous amounts of information. This changes the web from being a purely virtual, online space to a system that can provide appropriate information, help and services in the real world. If properly harnessed this information will make us better informed and enable smarter decisions by both people and machines.

These technologies have modes of use that can be implicit or explicit. Explicit interactions are those where a conscious action by a user enables an interaction. Implicit interactions are automatic and can happen without any direct user intervention. Our opportunities for explicit interactions with the real world are increasing, but it is the implicit, unseen interactions that will provide a real shift in how we use and gain benefit from computer systems.

Ubiquitous computing encompasses most areas of IT and achieving the vision will rely on several factors coming together:

- Miniaturisation (smaller, lower power processors, sensors and wireless technologies.)
- Ubiquitous connectivity
- Interoperability (standards for networks and devices; identification; network and device discovery; self-configuring, seamless networks etc.)
- Improved intelligent interfaces (natural interfaces; intelligent agents; display technologies etc)
- Intelligent systems (including sensor networks; context awareness; location; semantic networks; data handling; and search etc.)
- Security and reliability (reliable, secure systems; and privacy features)

Many parts of ubiquitous computing are still in development and many of the possible uses and implications of the technologies are still unknown. However, there are already clear possibilities for improving learning both through individual technologies and increasingly through using these technologies in unison. As will be explored, ubiquitous computing technologies can lower the barriers to using the power of ICT, enable much more personalised, context-aware interactions and help with a move to more experiential learning: learning by doing, interacting and sharing.

Key elements of ubiquitous computing

The key elements that devices/objects/nodes in a ubiquitous computing environment need are: identification, location, sensing and connectivity

Identification

In order for objects and devices to usefully become part of a wider intelligent, information sharing network, it is vital that each one has a unique identity. This not only enables more things to be interconnected, it also means that objects that surround us can become resources and act as interfaces to other resources. Two important technologies used to provide identity are Radio Frequency Identification (RFID) tags and visual barcodes.

RFID

Radio Frequency Identification (RFID) is a type of auto identification system and refers to technologies that use radio waves to identify objects, locations or people. RFID is a generic term and does not refer to a particular technology. However, more recently, the term

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has become associated with a form of the technology called RFID tags. These are tiny microchips attached to antennae (transponders). The data on these chips can be read by a wireless reader (transceiver) and the data passed back to computer systems. There are two main types of RFID tags: passive (energy harvested from the reader) and active (with their own power supply). The more sophisticated tags offer read/write capabilities. RFID chips can be as small as 0.05 mm^2 and can be embedded in paper. More recently, printable tags have been developed. RFID systems do not require line of sight and work over various distances from a few centimetres to 100 metres depending on the frequency used and type of system. Standards for tags and electronic product codes (EPC) are being overseen by EPC Global **[http://www.epcglobalinc.org]**.

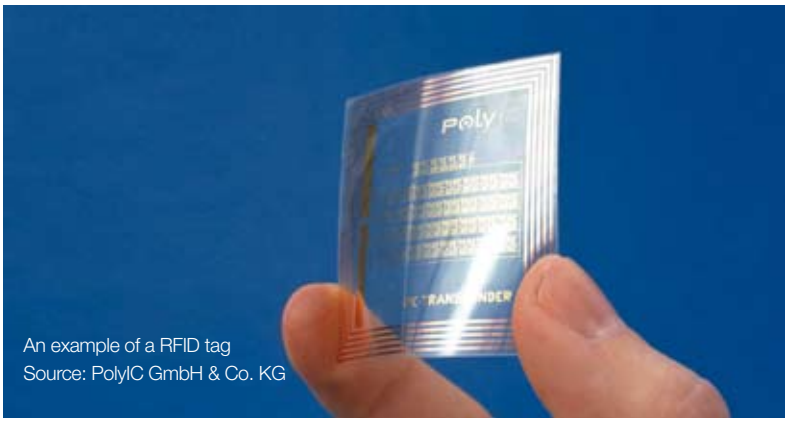
The ability to identify, locate and track RFID tags is seen as a transformational technology, potentially allowing any object to be interrogated by computer systems. However, high costs, technical issues and concerns about privacy will need to be overcome before RFID tags become widespread. Currently, the main area of use is in the retail supply chain, but analysts predict that 50 per cent of the uses for RFID in 2012 have not even been thought of yet.

The retail/supply sector is only one area of use for the technology. Some examples of other uses are: security, authentication of goods/banknotes **[http://networks.silicon.com/lans/0,39024663,39122553,00.htm]**, asset tagging, document tagging, library book tagging, road tolls, safety systems, and payment systems. RFID is already in use in contactless card systems for door entry and on public transport such as the London Underground **[http://www.rfida.com/nb/oyster.htm]**.

ABI Research[5] believes that by 2009 50 per cent of mobile phones will have embedded RFID chips to access services and pay for goods. This technology is already being used in Japan **[http://www.nttdocomo.com/presscenter/pressreleases/press/pressrelease.html?param[no]=474]**.

In education the main use of RFID tags so far has been in library management systems, for asset tagging and ID/tracking purposes. However, a number of more innovative education projects have shown the value of learners being able to interact with tagged objects in the real world. For example, an object's ID could trigger information or sounds to be sent to a learner's device. Such systems are increasingly being used in museums **[http://www.rfid-weblog.com/50226711/rfid_in_museums_another_growing_market.php].**
RFID tags can also play a part in creating intelligent classrooms (see below).

RFID readers can now also be included in mobile phones, potentially making the readers as ubiquitous as the tags are expected to become. However, RFID tags can operate without user intervention, automating many applications and providing huge amounts of data, which creates a need for more sophisticated systems to support them (see data handling).



An example of a RFID tag
Source: PolyIC GmbH & Co. KG

5 ABI Research **http://www.abiresearch.com**

Visual bar codes - hyperlinking the world

A simpler way of giving an object an identity and allowing a user to interact with it is through a visual or 2D 'bar code'. These are printed 'pictures' containing data, which when photographed by a cameraphone will provide information about the object or, more often, act as a 'smart URL' taking the user to a particular web page. Examples include Semacode, Bango spots and Shot codes. Software for creating these 2D barcodes can be downloaded from the relevant websites. Newer versions such as those from Fujitsu (Fine Picture code) allow the 'barcode' to be invisibly embedded into photographs or pictures. NTT DoCoMo has also developed a system that allows URLs to be embedded in sounds or music, which can be interpreted by some mobile phones.

In Japan, a type of 2D barcode, called QR (quick response) codes, is widely used to save having to enter information such as addresses into mobile phones or even to purchase goods. They are found in advertising, in the print media, on business cards, products, websites and vending machines. Some teachers in Japan are using QR codes to distribute resources to learners **[http://delivery.acm.org/10.1145/1190000/1181244/p123-fujimura.pdf?key1=1181244&key2=6214984611&coll=ACM&dl=ACM&CFID=15151515&CFTOKEN=6184618]**

or in more innovative projects to allow interaction with real world objects (as with RFID) – see for example, *Future Experience Workshop,* Takeyama Laboratory, Keio University **[http://www.childresearch.net/RESOURCE/RESEARCH/2005/TAKEYAMA.HTM].**

An example of a QR code. This QR code is a link to the Becta website (Source: http://qrcode.kaywa.com/)

The BBC/Open University used a similar system for their Coast project. Data Matrix 2D barcodes were placed on signs around the coast allowing walkers with cameraphones to connect to related text, directions, images and audio **[http://www.gavitec.com/fileadmin/template/main/downloads/CaseStudy_EN_BBC_CoastMobile_F0608.pdf]**

The drawback of visual bar codes is that they are not wirelessly linked, so rely on explicit user interaction rather than the automatic, implicit use that is the real vision of ubiquitous computing.

IPv6

An alternative technology that could be used for identification is Internet Protocol version 6. IPv6 is the next generation protocol designed by the IETF[6]. Currently the internet and most networks rely on IPv4 addresses which have a limit of 2^{32} addresses. IPv6 provides 2^{128} potentially allowing billions of unique IP address. IPv6 also offers other advantages over IPv4 such as support for auto-configuration of devices, Quality of Service (QoS), mobility and security. However, adoption of IPv6 is expected to happen relatively slowly, with most interest currently coming from government/military and research organisations.

Location

The ability of objects and devices to have location information adds another important level of intelligence, allows the discovery of people, objects and resources and enables location based tools and services. Indeed, location services are expected to be increasingly important over the next few years. It is predicted that there will be 70 million GPS enabled phones in Europe by 2010 (IMS Research[7]). Tim O'Reilly, who coined the term Web 2.0, has now started a new annual conference called Where 2.0[8], underlining the potential for innovation in this area.

Devices and objects can establish their location in a variety of ways and to varying levels of accuracy. At a basic level an RFID tag can be recognised as it passes a fixed wireless reader. Devices with accelerometers can detect motion and know their orientation. Wi-Fi enabled devices can be tracked to a reasonable degree of accuracy (for example Ekahau[9] systems). Mobile phones can also be pinpointed, but the accuracy can vary considerably. It is with the advent of inexpensive satellite positioning technologies that location can be determined to within a few metres and absolute geographic locations can be accurately established. Global Positioning System (GPS) chips now provide better coverage and can be found in many consumer devices such as PDAs, mobile phones and even school bags **[http://ubiks.net/local/blog/jmt/archives3/2004/10/index.php]**. GPS can be coupled with navigation and personal locator services (likely to appear in UK in 2007 according to ABI Research**[http://www.abiresearch.com/abiprdisplay.jsp?pressid=766]**). An alternative European satellite positioning system, Galileo[10], is also in development and should provide greater reliability and accuracy

Proximity devices like RFID chips rely on a user or device coming near to them before an event is triggered. This 'event' could be relevant learning materials downloaded to a users' device, or automatic connection to a large display, for example. Other location services are about knowing your relationship to other people or devices. MIT's iFind service allows students and staff to let other people know their location on campus **[http://ifind.mit.edu/]**. Mobile location based services are increasingly combining presence (information about the status of a user) with location information **[http://www.mologogo.com/]**. Some countries are using these technologies to track students for safety and control reasons, but these raise concerns over privacy (see issues). For example the Japanese government is piloting a system using RFID, GPS and mobile phones to track students and keep parents informed of their whereabouts **[http://ubiks.net/local/blog/jmt/archives3/005856.html and http://www.sankei.co.jp/seiji/seisaku/070103/ssk070103000.htm]**

Real world search

More recently, location systems allow the user to point cameraphones at an object or location and receive back relevant information from a database. Nokia researchers have developed a Mobile Augmented Reality Application (MARA) that is able to overlay digital information onto cameraphone feeds of the real world. It uses GPS, an accelerometer, digital compass and database of locations **[http://research.nokia.com/research/projects/mara/index.html]**.

Japanese mobile phone networks offer a similar system developed by GeoVector Corporation. It enables users to point their devices at buildings or other locations in order to retrieve information and services related to that place. A variety of innovative uses from mapping, tourist information, local search, mobile commerce, entertainment/shopping guides and advertising are envisaged **[http://www.geovector.com/appdemos/]**.

7 IMS Research **http://www.imsresearch.com/**

8 O'Reilly Where 2.0 Conference, **http://conferences.oreillynet.com/where2007/**

9 Ekahau **http://www.ekahau.com/**

10 Galileo European satellite navigation system **http://ec.europa.eu/dgs/energy_transport/galileo/index_en.htm**

Tagging the world

Location based and visual recognition systems have also been used in educational projects to allow learners to access context related content (text, sounds, photos, video and websites) about objects and places in museums or in especially created learning environments (see for example EQUATOR projects such as Ambient Wood **[http://www.mrl.nott.ac.uk/]**). For more information on innovative projects in these areas see Bill Sharpe's article in *Emerging technologies for learning* (Becta, 2006).

These 'mediascapes' or learning trails are relatively straightforward for teachers to create, for example **[http://createascape.org.uk/]** or CAERUS **[http://portal.cetadl.bham.ac.uk/caerus/default.aspx]**. Students then navigate and interact with these learning environments using mobile devices. Often a record of the learner's route and interactions can be recorded. It is also possible for learners to tag their own content to particular locations so that others can access it when they are at that location, or it can be explored in more detail in the classroom. This 'digital graffiti' (such as photos, text, video or audio files) is 'geotagged' data that can be uploaded to the web and shared. Mappr **[http://www.mappr.com]** is one website that combines tagged photos from Flickr with Google Earth maps. This is part of Web 2.0, using the power of communities to add value to data. Indeed, combining location-based information with digital maps can be a powerful learning tool. For example pollution levels could be tracked and overlaid on maps. By adding sensors to the environment, this could be done in real-time.

Sensing

Having an identity and location information enables a variety of applications and uses, but adding a sensing capability can give systems 'eyes and ears' creating intelligent networks that can collect a range of data and even respond to events.

Sensor networks

Attaching sensors to RFID tags or other wireless nodes enables much more information to be gathered and analysed as well as adding more 'awareness' to ubiquitous networks. This awareness means that the network can detect and respond to the environment, often without any human interaction. Typically sensors can measure things like pressure, temperature, speed, air/water quality, stress, humidity, or acceleration. Wireless sensors consist of sensor(s) connected to micro-controllers, memory, batteries and radios. Each wireless sensor node usually forms part of peer to peer, mesh network (routing data through other nodes) that is self-configuring and has inbuilt redundancy. These autonomous networks are very scaleable and flexible, allowing self-discovery of new nodes and can cover large areas without the need for extensive fixed infrastructure (for example a sensor mesh network monitoring island weather conditions off Korea covers 80 square miles). Sensor networks can now be deployed very quickly and can use web services to integrate with other IT systems. Many sensor networks require little power and could potentially be deployed for a number of years.

MEMS

Micro Electro-mechanical Systems (MEMS) are moving parts on chips that are used to sense the environment and potentially to initiate an action, allowing systems to respond to the real world around them. For example these are already used in cars to detect collisions and deploy airbags. Inertia sensors have been embedded in some mobile phones and games controllers (such as the Nintendo Wii) to allow users to interact with the device through movement.

Research from InStat suggests that MEMS in mobile handsets will be worth $1 billion by 2010 **[http://www.instat.com/newmk.asp?ID=1671&SourceID=0000036 6000000000000]**.

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Motes/smart dust

A development of sensor networks variously known as motes, smart dust, and speckles, involves extremely small sensor nodes, potentially the size of a grain of rice. These 'smart dust' networks are very robust and can be scattered or sprayed into an environment or on an object. These systems are still very much in development, but are being researched by various organisations around the world **[http://www.specknet.org/publications/Steven4_ICSE04.pdf]**.

Connectivity

Wireless connectivity is key to enabling ubiquitous computing, but the increasing range of technologies is beyond the scope of this article. You can keep up with developments in wireless technologies through Becta's TechNews **www.becta.org.uk/technews**.

Potential for learning

In education the ability to receive and manipulate real-time data and interact with objects and devices in the real world has a range of benefits. Science, for example, involves measuring the world, analysing data and testing hypotheses. By accessing sensors embedded in the environment, learners have the opportunity to conduct their own investigations, develop analytical/critical thinking skills and model concepts. The Coastal Ocean Observation Laboratory based at Rutgers University (USA) can be accessed online by schools enabling learners to use and manipulate real time data collected from sensors in the ocean **[www.coolclassroom.org/home.html]**. In this experiential learning learners have the opportunity to use exactly the same data as professional researchers. This is part of what Bruner calls 'learning to be'[11] rather than 'learning about'.

Context awareness

One of the main goals of ubiquitous computing is to provide relevant information, in the right form, at the time and place it is needed. If objects and devices can recognise you and know about their location and environment and automatically discover other devices and resources (multi-sensorality), then the potential for delivering the appropriate, 'just in time' information increases. Learning systems would be able to adapt their output based on a range of unique characteristics. This is key to customised and personalised information systems that remain invisible until needed.

Already, our attention is being taken up by streams of often unmediated information. Context- aware systems should help filter information and make IT work for us without us having to actively interrogate systems. This allows learners to concentrate on the task rather then the technology.

Intelligent agents

Intelligent agents are proactive, autonomous, software tools and systems that can determine appropriate actions based on a range of data from multiple sources. Often they can 'learn' from experience. They enable systems to become 'aware' and respond intelligently to events. Sometimes this will mean informing or alerting a human user, but in other cases the system will make decisions. These systems may respond to environmental data (much as the thermostat in your home controls the central heating), but for learning it means systems that know who you are, what your preferences and learning styles are, where you are, what device you are using and what you are doing. This allows systems to become much more human/learner centred. **[http://agents.umbc.edu/]**.

11 Bruner, J. (1969) *The Process of Education*, Harvard University Press, US

Service discovery and follow me services

Increasingly, devices and systems will be able to discover tools and services automatically. At a simple level this could mean being able to locate and use nearby printers, or large-screen displays, but increasingly this will allow content to recognise and follow the user (rather then the device), seamlessly moving from device to device or display to display as a user moves from home, to a car to a classroom or office. Some of this is already beginning to happen: automatic connection to Wi-Fi hotspots; the ability to access remote content/devices through any device with a browser; follow me phone services; presence capabilities in instant messaging applications. However, it is not yet seamless or personal enough and usually relies on some user action.

Emotional/social awareness

Initial applications are likely to make interfaces behave more socially by knowing where you are or what you are doing. This could mean, for example, that your phone won't ring during an exam or while you are in the cinema, and devices will switch on when you pick them up and off when you put them down.

Research is also looking at 'affective computing', through detecting the emotional state and attention of the learner. Voice analysis (already used in call centres), gaze tracking, skin conductivity, facial expression analysis (machine vision) **[http://web.media.mit.edu/%7Ejackylee/publication/p1007-lee.pdf]**, location and the way a user interacts with a system can all give clues as to the state and receptiveness of the learner. Research such as the EU-funded Learning in Process[12] project has already looked at delivering context-sensitive resources to the learner **[http://www.andreas-p-schmidt.de/publications/abis05_aschmidt.pdf]** Over time developments are likely to allow educational applications to tailor outputs more appropriately to how receptive to learning the user is at any given time and not just to a more fixed profile of preferences and learning styles.

The acknowledgment of the user's affective state might play an important role in improving the effectiveness of e-learning. The emotional unawareness has been considered one of the main limits of the traditional e-learning tools (especially the ones where learning takes place mostly individually). In fact, while skilled teachers can modify the learning path and their teaching style according to the feedback signals provided by the learners (which include cognitive, emotional and motivational aspects), e-learning platforms cannot generally take account of these feedbacks resulting often too rigid and weakened.

The Potential of Affective Computing in E-Learning: MYSELF project experience (Centre for Research in Communication Science, University of Milan paper for INTERACT 2005 Conference) **[http://images.1-to-x.com/acse/artMySelf02.pdf]**.

Human Computer Interaction (HCI)

We have seen how location- and context-aware technologies can help provide the right information in the right place and at the right time, but for this to be truly transformational it also requires a shift in the way that we interact with computer systems themselves.

Despite major advances in computer technology, human computer interaction is still largely based on mice, keyboards and the monitor. Interacting with computers and the skills needed to do this effectively can present a barrier to using the potential of connected information systems and the real world web of connected objects and locations.

There have been developments in voice recognition, gesture recognition, haptics, eye-tracking, handwriting recognition, display devices and a range of other technologies (see Paul Anderson's piece on HCI in ETL 2006 for an exploration of how these technologies may develop and be used in education). However, these have

12 Learning in Process (EU Framework 5) **http://www.learninginprocess.com/**

largely remained niche technologies, prevented from becoming more widely used due to usability issues or the fact that they don't necessarily improve productivity.

In ubiquitous computing the traditional computer and display no longer provide the only window on the virtual world; the computer will have become embedded all around us in a variety of devices, objects and locations. These non-PC end points (smart objects) often benefit from non-PC interfaces involving touch and movement (tangible interfaces). This is not to say that in a few years we will no longer be staring at computer monitors, but that there will be increasingly more intuitive and natural ways of receiving information from computer systems and interacting with them. This has been likened to the role of electricity and writing in our environment, both of which are fairly ubiquitous, but which largely go unnoticed until needed.

Ambient Information

Information is increasingly available in ways that do not require our permanent attention. Already, RSS feeds push relevant news and other web content to us, saving the need to actively visit the websites to see if anything has been added. That idea is now being taken further with the relevant information been presented 'ambiently' through everyday objects and devices in our environment, without the need for explicit user action or continuous attention. This lowers the barriers to accessing digital information and makes the increasing amount of data vying for our attention more manageable. Ambient display devices can use audio/sound, light, vibration, colour or movement. This is part of a move to more natural, multi-modal interfaces.

Some ambient display devices with glanceable interfaces are already available in the consumer market. For example the Nabaztag (Armenian for rabbit) connects to the internet via Wi-Fi and through sound, light and movement can provide its owner with emails/messages, information from RSS feeds (such as news or weather updates), inform the owner when friends are online and even teach TaiChi.

[http://new.nabaztag.com/en/index.html]

Nabaztag/tag by Violet

http://new.nabaztag.com/en/index.html

The Ambient Orb changes colour to present information relevant to the user such as share prices and the weather. **[http://www.ambientdevices.com/cat/orb/orborder.html]**.

Source: Ambient Devices

Ultimately, HCI may not be about how we interact with particular devices. As the environment around us becomes the 'computer', HCI could become a separate layer for interacting with multiple computers, nodes and systems.

Smart classrooms

Commercial products can already automatically capture audio, video and digital resources from lessons and publish them to the web; several research projects have looked at how classrooms could benefit from the use of embedded technologies (see examples below). These intelligent classrooms are able to track and respond to the needs of learners and teachers and allow the use of technology to become much more seamless. This not only reduces the burden of managing and operating technology in the classroom, but ultimately allows the classroom to add to the learning process. Intelligent environments make use of sensors, cameras, microphones/speakers and actuators and are controlled by intelligent agents (see above). At a simple level these technologies allow automatic environmental control (such as appropriate lighting for a particular task and automatic switching on of devices), but as the room can recognise the learner or teacher more sophisticated interaction is possible, enabling user/context sensitive actions and a seamless link between school and home.

> At the front-end of an AmI [ambient intelligece] system are a variety of tiny devices that can hear, see, or feel an end-user's presence. At the back-end, wireless-based networked systems make sense of these data, identifying the end-user and understanding his/her needs.
>
> *Ambient Intelligence: Changing forms of Human-Computer Interaction and their social implications*[13].

Some examples of intelligent classroom projects include the MIT Project Oxygen (E21 Intelligent Spaces) **[http://www.oxygen.lcs.mit.edu/E21.html]** and Intrinsically Motivated Intelligent Rooms

[www.arch.usyd.edu.au/~mary/Pubs/2005pdf/Ubiq_Comptg_Macindoe.pdf]

(Owen Macindoe and Mary Lou Maher, December 2005).

This paper describes classrooms that respond and adapt to human occupants and the technologies that can be used to create them.

Tangible interfaces and learning

The use of smart objects and ambient/tangible interfaces in education can have many benefits, including helping kinaesthetic learners. They allow students to learn by doing and remove the barrier of the standard computer interface so that learners can concentrate on the task rather than how to do it. However, although the more physical learning which is possible through smart objects/tangible interfaces can improve performance, there is a risk that if not used well, they will prevent more theoretical understanding of concepts

> *…research has shown that it is important to build in activities that support children in reflecting upon the representational mappings themselves. DeLoache's work suggests that focusing children's attention on symbols as objects may make it harder for them to reason with symbols as representations.*
>
> *Literature Review in Learning with Tangible Technologies,* O'Malley, C, Fraser, D, Futurelab, 2006

Telepresence/robots

Telepresence refers to technologies that allow a user/learner to act remotely as if they were actually at another location. Telepresence technologies are developing in two ways. Firstly, high-definition, life-size video conferencing facilities are now available from a variety of companies (see for example HP's Halo system: **http://www.hp.com/halo/index.html**).

Secondly, a range of technologies allow users to control cameras, robots and other devices equipped with sensors at remote locations. Here, intuitive, immersive interfaces using video, haptics, and/or virtual reality are being developed (see **http://www.chattenassociates.com/** (a head-aimed remote viewer) and **http://telepresence.dmem.strath.ac.uk/technology.htm**).

13 Mahesh S. Raisinghani*, Ally Benoit, Jianchun Ding, Maria Gomez, Kanak Gupta, Victor Gusila, Daniel Power and Oliver Schmedding, *Ambient Intelligence: Changing Forms of Human-Computer Interaction and their Social Implications* Journal of Digital Information, Volume 5 Issue 4 Article No. 271, 2004-08-24 **http://jodi.ecs.soton.ac.uk/Articles/v05/i04/Raisinghani/**

Source: http://www.hp.com/halo

> …I can envision a future in which robotic devices will become a nearly ubiquitous part of our day-to-day lives. I believe that technologies such as distributed computing, voice and visual recognition, and wireless broadband connectivity will open the door to a new generation of autonomous devices that enable computers to perform tasks in the physical world on our behalf. We may be on the verge of a new era, when the PC will get up off the desktop and allow us to see, hear, touch and manipulate objects in places where we are not physically present.
>
> Bill Gates, *A Robot in Every Home*, Scientific American, January 2007

These sorts of technologies are already being used in scientific and military work and for consultations or surgery carried out remotely.

For education the potential of these technologies is huge. They can allow learners to experience, explore and interact with remote locations, foreign countries and inhospitable/inaccessible or environmentally sensitive places. Some simple, educational projects already exist. For example, the MIT iLab[14] allows students to conduct experiments remotely over the internet. The Bradford robotic telescope allows learners to request images from a professional space telescope located in Tenerife **[http://www.telescope.org/]**. An evaluation of the project found that it was:

> *…a new type of learning website supported by a real world facility which provides real time access to operational data to support learning programmes. The learner has a degree of freedom to define which data they wish to obtain from the facility and to generate information in support of their learning programme. This could be extended to many other areas of the curriculum, by looking at the real world science used across a range of industries.*

An evaluation of the Bradford Robotic Telescope, Smith, P., Hoshin, 2006 **[http://www.telescope.org/articles/YFRobotics.pdf]**.

Information/data handling

The power of the network increases exponentially by the number of computers connected to it. Therefore, every computer added to the network both uses it as a resource while adding resources in a spiral of increasing value and choice.

Bob Metcalfe[15]

The real world network of data will allow humans to be better informed and make better decisions, but it will also mean that machines can make better decisions too. However, the vast amounts of data about people, things and the environment that a ubiquitous computing world would generate will require new ways of handling, searching and presenting information.

Firstly, we will need new applications to take advantage of the range of real-time data being collected. Something similar to this can be seen in business intelligence applications that provide constantly updated sales figures, trends and performance measurements to managers' desktops. In education learners will be able

14 MIT/Microsoft iLabs **http://icampus.mit.edu/ilabs/**

15 Metcalfe's law. Attributed to Robert Metcalfe

to receive and manipulate real-time data from sensor networks and other distributed devices around the world.

Systems will increasingly be able to respond to data coming from the real world and take appropriate action without human intervention. Increasingly computers will be making decisions on our behalf, only presenting data and information once it has been analysed and filtered to be appropriate to our needs. This is part of a shift towards using computer intelligence 'on demand' and being presented with useful information rather than just data.

Secondly, we would need new architectures and data structures (scaleable and adaptable) to cope with the enormous processing and storage requirements of the ubiquitous world. This is likely to involve large scale networks using commodity technology to create massive, resilient information networks with in built redundancy. Currently, the closest example of this is the server farms employed by search companies such as Google. Here commodity servers are used to carry out massive parallel processing of data. However, this is a highly centralised model; increasingly with ubiquitous computing the intelligence is more distributed and moves to the edge of the network. Conceivably, connected devices and objects with embedded processors could become part of a massive distributed computer.

More intelligent ways of managing (data warehousing), searching (data mining), retrieving (knowledge discovery) and presenting data are developing to cope with the vast quantities of digital information stored and available in real time. Displaying information so that it can be interpreted intuitively will be important to making use of the data. New knowledge presentation techniques such as visual representations (and 3D) rather than text and figures are likely to be increasingly important. There is already a shift towards larger and multiple displays to improve productivity.

Machine to machine communication

The ability for machines and systems to interrogate other machines and systems and share information will be key to enabling the ubiquitous computing vision. The development of a semantic web is one suggested solution. The semantic web uses ontologies and schemas to separate data from how it is presented (unlike HTML) and give it a structure that enables information on the web to be retrieved, interpreted and shared by machines/ intelligent agents rather than just humans. **[http://www.w3.org/2001/sw/]**

For an exploration of potential uses of the semantic web in education see **http://www-jime.open.ac.uk/2004/1/**.

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Issues

Some commentators believe that ubiquitous computing is too complex to be achievable and that even if the technology worked, we would not be able to cope with the amount of data produced. There are also many technical issues to overcome such as the reliability and dependability of systems. Other areas needing development include hardware, interfaces, system architectures, standards for interoperability and battery life.

There are also genuine concerns about invasion of privacy, trust and the security of systems. Already, some RFID schemes have been halted in schools **[http://networks.silicon.com/lans/0,39024663,39127946,00.htm]** and the commercial sector because of public concerns **[http://www.theregister.co.uk/2004/03/01/german_revolt_against_rfid/]**. RFID enabled passports have been shown to be insecure **[http://www.fidis.net/press-events/press-releases/budapest-declaration/]**.

Ubiquitous computing is more invasive and persistent than for example, the internet. It would often work without any explicit user action and generate a great deal of information about a user's location and actions. It has been suggested that we may need to move to a new idea of 'privacy'. This would involve acceptance that a great deal of information is collected about us, but concentrate on maintaining control of who has access to that information and for what purposes it can be used.

Even now, people can be tracked through their mobile phones, credit/loyalty cards, and CCTV, but the convenience and benefits of these technologies are often seen as outweighing the concerns. This may not always be the case and policies and protections need to be put in place, especially when dealing with information about learners.

The problem, while often couched in terms of privacy, is really one of control. If the computational system is invisible as well as extensive, it becomes hard to know what is controlling what, what is connected to what, where information is flowing, how it is being used, what is broken (vs what is working correctly, but not helpfully), and what are the consequences of any given action (including simply walking into a room).

> Weiser, M., Gold, R., Brown, J.S., *The origins of ubiquitous computing research at PARC in the late 1980s* **[http://www.research.ibm.com/journal/sj/384/weiser.html]**.

Finally, there are questions over the social impact and desirability of such pervasive technologies. Potentially ubiquitous computing technologies could, among other benefits, help tackle the digital divide, address issues of an ageing population and encourage life-long learning. However, many benefits may be more trivial or marginal and need to be set against the financial and privacy costs of developing such an infrastructure. We need to separate the desirable from the possible.

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Conclusion

The original vision of ubiquitous computing, with an extensive real world web of networked objects and devices may take at least 10-15 years to come close to being realised. Indeed, it is unclear whether we will ever reach a situation where widespread intelligent, embedded technologies operate seamlessly in the environment around us. However, even if this vision is never achieved, processing, identity, connectivity and sensing are already being added to an increasing number of objects, locations and devices. These are beginning to allow new interactions and ways of interfacing with computer systems, as well as adding new intelligence to systems. These technologies are likely to develop rapidly over the next five years and will see a number of elements of ubiquitous computing being actively and usefully adopted. Moreover, many of the possible uses of these technologies cannot be imagined today. Over time these developments will increasingly enable more immediate, personalised, experiential and context-based learning where natural interactions take place between people, systems, places and objects.

Mobile learning[16] takes computers out of the classroom into the world; with ubiquitous computing the world becomes the classroom and the computer.

Mobile phone as interface to the world

Connected mobile devices could provide a gateway between us and the virtual and physical worlds.

Today, handheld devices (and in particular the increasingly smart mobile phone) offer us a pervasive, trusted and reliable interface that is always with us. A recent report from the ITU [ITU Internet report 2006:Digital Life, **http://www.itu.int/osg/spu/publications/digitalife/**] found that one in three of the world's population (much more in developed countries) now have mobile phones and within two years that is expected to increase to over 50 per cent. Mobile phones are adding more powerful processors and applications, content creation tools, a range of wireless technologies, GPS, cameras, sensors and RFID chips and readers that enable always-on connectivity, internet access, social networking and the possibility of interacting with objects and devices in the real world. The social aspects of the mobile phone already make it a natural and personal part of our lives, arguably unlike the PC. This is especially true for students. The permanent 'info-cloud' formed by wireless, mobile devices and the internet and the fact that these technologies are unobtrusively becoming part of our lives, helps create what Wade Roush calls 'continuous computing' [**http://www.continuousblog.net/2005/05/what_is_continu.html**]. This can only be achieved with always-on connections and unlimited data tariffs to encourage widespread use.

16 for an exploration of the benefits of mobile learning see Geoff Stead's article in *Emerging technologies for learning* (Becta, 2006)

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References and further reading

2006 Horizon Report The New Media Consortium and the EDUCAUSE Learning Initiative, The New Media Consortium 2006

Ambient intelligence.org, site developed by Giuseppe Riva, Ph.D. within the work of the VEPSY research project (IST-2000-25323) funded by the European Union **http://www.ambientintelligence.org/**

Anderson ,P., *Will we be able to cope with the invisible computer?*

ISC Technology and Standards Watch report on The Computer Journal Lecture for the British Computer Society: *Ubiquitous computing: shall we understand it?* Presented by Professor Robin Milner, University of Cambridge, 23 February 2006.

Cooperstock, Jeremy R., *Intelligent Classrooms need Intelligent Interfaces: How to build a high-tech teaching environment that teachers can use*, Centre for Intelligent Machines, McGill University

Denziger, J., *Some Thoughts on Future IST from a Designer's Perspective* Designing Ubiquitous Computing, Frankfurt/Main, Germany

Friedewald, M., (Fraunhofer Institute Systems and Innovation Research ISI)

Da Costa, O., (Institute for Prospective Technology Studies IPTS), Final report of the JRC-IPTS/ESTO project *Ambient Intelligence in Everyday Life Roadmap*, submitted for approval to the Executive Committee of the European Science and Technology Observatory (ESTO) in August 2003.

Goerlich, J. Wolfgang, InTouch RP-6 Medical Telepresence Robot, Go Robotics, February 2006 **http://www.gorobotics.net/The-News/Latest-News/InTouch-RP%116-Medical-Telepresence-Robot/**

IEEE Computer Society: **www.computer.org/portal/site/pervasive**

ISTAG, Information Society Technologies Advisory Group, Advisory Group to the European Community's Information Society Technology Program **http://www.cordis.lu/ist/istag.htm**

Lawlor, M., *Collaborative Technologies Demand Deep Change*, Signal Magazine AFCEA's international Journal, May 2006

Massachusetts Institute of Technology: Project oxygen **http://www.oxygen.lcs.mit.edu/Overview.html**

Ogata, H., Yano, Y., *Context-Aware Support for Computer-Supported Ubiquitous Learning* Dept. of Information Science and Intelligent Systems, Tokushima University Paper at 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04)

Raisinghani, M., Benoit, A., Ding, J., Gomez, M., Gupta, K., Gusila, V., Power, D., Schmedding, O., *Ambient Intelligence: Changing Forms of Human-Computer Interaction and their Social Implications*, Journal of Digital Information, Volume 5 Issue 4 Article No. 271,2004

Pervasive Computing Net: **www.pervasivecomputing.net**

RFID Journal **http://www.rfidjournal.com/**

Rogers, Yvonne and Sara Price. *Extending and Augmenting Scientific Enquiry through Pervasive Learning Environments. Children, Youth and Environments* 14(2): 67-83 2004 from **http://www.colorado.edu/journals/cye/**

Sakamura, K. Koshizuka, N., *Ubiquitous Computing Technologies for Ubiquitous Learning*, YRP Ubiquitous Networking Lab., Tokyo Univ., Japan, Appeared in Wireless and Mobile Technologies in Education, 2005. WMTE 2005. IEEE International Workshop on 28-30 Nov. 2005

SHAPE Situating Hybrid Assemblies in Public Environments, IST-2000-26069 **http://www.shape-dc.org**

Stankovic, John A. Lee, Insup, Mok, Aloysius,Opportunities and Obligations for Physical Computing Systems, IEEE 2005

Tinker,R., Banasch, S., Draft: *SmartProbes Concept Paper,* The Concord Consortium

Ward, M., Van Kranenburg, R., Backhouse, G., RFID: Frequency, standards, adoption and innovation JISC TechWatch, 2006

Weiser, M., Brown, J. Seely, *The coming of age of calm technology*, Xerox PARC October 5, 1996

UbiComp 2006: International Conference on Ubiquitous Computing: **ubicomp.org/ubicomp 2006**

www.becta.org.uk/research

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03/DD06-07/178/PDF