

**Harnessing Technology – emerging technology trends,
March 2009**
**Research to support the delivery and development of Harnessing
Technology: Next Generation Learning
2008–14**

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The trends identified – a summary

In April 2008, Becta launched a major research programme to support the delivery and further development of the Harnessing Technology strategy.¹ The research covers the education and training system as a whole: children's services; schools; further education, skills and regeneration (FESR); and higher education (HE).

In addition to the core reports of the research programme, each of the project teams produces bi-annual summaries of trends they have observed which are outside the scope of their work but which nevertheless give insight in to the changing world of educational technology. This report is the second such and reports observations made between October 2008 and February 2009. It presents an overview of the trends identified, and suggests why these trends are important and how they relate to the Harnessing Technology strategy and the ongoing research work.

The format of this report reflects the structure of the programme of research and thus presents trends in three broad areas: the learner and their context; curriculum and pedagogy; and business processes for education.

Research related to **the learner and their context** examined devices and applications in three phases of technological adoption:

New and emerging technologies:

- E-Book readers
- OpenID
- Photosynth
- Touch screens

Developing ways of using existing technologies:

- SMS Texting and Mobile Internet
- Virtual Worlds

Rapid take-up:

- Netbooks, and microblogging sites such as Twitter.

Some of these are emerging technologies which may be poised for wider adoption (the use of OpenID, for example, to help users manage the growing use of password-protected access to sites with user-generated content), or wider application of existing technology, such as touch screens. Some, like Netbooks and sites such as Twitter, are enjoying rapid take-up amongst older students, but have yet to be adopted by younger learners. The use of SMS texting is widespread amongst learners of all ages, but its potential to support learning is only beginning to be explored.

Research focused on **curriculum and pedagogy** identified six key trends:

¹ See *Harnessing Technology: Next Generation Learning 2008–14*.

- The ubiquity of mobile learning is being continually augmented by the richness of new devices, applications and services
- The growth of the personal Web
- A gathering momentum toward curriculum re-design
- The increasing dependence on Cloud computing
- Widespread use of personally owned laptops and mobile devices in formal education is moving down the sectors, from university, to FE, and starting to appear in secondary
- Support for learning design and orchestration of learning is growing in the HE, FE and Adult Learning sectors.

The first two were identified previously but have seen sustained growth. The third incorporates several trends in response to activity around supporting the skills required for the early 21st century, including the Rose Review of the primary curriculum. The growing range of mobile technologies clearly offer potential to support learning, but as this research observes, as learners move between a variety of different locations (school, home, work) ‘the challenge is to a) create micro-sites for learning, and b) enable the continuity of learning across locations and devices’.

The third area of research examines trends in **business processes** that have enabled organisations to improve their information management processes. The aim is to illustrate the main infrastructure and processes business has found essential to its advancement so that education can emulate this success.

The research identified two fundamental trends in networking:

- Network capacity and speed are increasing rapidly, while costs are falling. This is supporting a widespread shift to virtual servers and storage.
- Voice, data, and still and moving images are converging on Internet Protocol (IP). The advantages of this are lower network costs, interoperability across different types of network infrastructure, and the facilitation of integrated multimedia applications.

In the researchers’ view, advances in networking technology and storage capability will be key contributors to the five Harnessing Technology outcomes. In common with business organisations, educational institutions are also information-intensive and will need to consider electronic document and records management systems (EDRMS). ‘Schools and education authorities need to take a concerted and organised approach to electronic document and records management. Although implementing an EDRMS may be quite substantial from both a financial and resources perspective, it is becoming increasingly difficult to ignore the need to do so.’ Nor can schools ignore the need for ICT resources to support learners in the activities they wish to pursue, as the research finds that ‘A key consideration for schools will be to ensure that ICT resources can support Web 2.0 implementation from a technical infrastructure and security perspective. It is easy to underestimate

the time and effort to maintain and run something like a blog, online community or interactive capability’.

The challenges to education are many – this report looks at the tools that, in 2009, appear likely to offer support.

The Learner and their Context – trends

This area of research, conducted by the University of Oxford Department of Education, primarily raises questions about potential new trends in terms of young people's uses of technologies in the home and elsewhere, away from school or college. It focuses on innovations which the data suggests could be important and which are expected to influence how learners will use technologies in the future.

As in the previous trends analysis, the issues included in this report are potentially important because:

- the researchers encountered them elsewhere but not as yet in their own data gathering, and therefore need to be alert to what may become more significant during the course of the project, or
- the issues appear to indicate signs of a possible trend in discussions with young people, and the researchers want to check this impression against evidence from further afield.

The issues discussed in this report are as follows:

New and emerging technologies:

E-Book readers
OpenID
Photosynth
Touch screens

Developing ways of using existing technologies:

SMS Texting and Mobile Internet
Virtual Worlds

Rapid take-up:

Netbooks
Twitter

New and emerging technologies

E-book readers

Recent reports in the media suggest that e-book reader sales are increasing in the US (with a projected growth of 110 per cent expected in 2009) and this is predicted to follow a similar pattern of growth in the UK (BBC, 2009a). Whilst the research team did not encounter any learners using e-book readers in the research so far, there is every reason to suppose that some will be found during the remainder of the project. It is anticipated that e-book readers are likely to become popular amongst young people who have already spent their 'formative years' reading from screens (BBC, 2008). Moreover, whilst at present they are still viewed as quite expensive – costing around £230 – organisations such as the Consumer Electronics Association (CEA) suggest that, as they are seen as a green, more environmentally acceptable technology, this will provide a 'purchasing factor' and again could make them popular with young people. In the UK, publishers have been rather slower than their US counterparts in publishing books in electronic format. Nevertheless, they are now developing strategies for progressing with this.

The e-book reader is also seen as having potential for blind and partially sighted learners in that the print size is easy to magnify, and models such as the Kindle 2 have text-to-speech (TTS) capability. Nevertheless, the TTS applies only to the books' content so far, rather than the unit's controls, so would not provide full accessibility to a blind user.

OpenID

One trend emerging within this data is the increasing usage of websites which require users to log in in order to access the full capacity of their features. Through interaction with learners, the researchers discovered that users visit a number of different sites requiring log-in credentials, including social networking software, games and email systems, and other sites that can store personal information and where users must log in to communicate with others, including YouTube, Stardolls and online games. Learners often made comments about the difficulty of remembering a large set of passwords, and sometimes found it difficult to log in to specified sites owing to this problem.

A current technological development which aims to combat this increasing problem by providing the user with an easy method to access websites is called OpenID. An emerging free software, this allows the user to store a digital ID centrally in one place, thus enabling them to use the same log-in credentials to access a variety of log-ins on the internet. OpenID.net (2009a) describe the concept as 'simplifying your online experience'. The software works by allowing the user to choose an OpenID provider from one of a number of major brand-named log-in sites that the user might already use and to carry this ID with them as they explore the internet. This ID then enables them to access a number of different sites through the use of a single username and password, and the user is only requested to input this material once.

As noted by OpenID.net, the concept 'has arisen from the open source community to solve the problems that could not be easily solved by other existing technologies'. It is an interesting new technology owing to the potential positive impact it could have on the ways that learners interact with websites in their own time. A number of benefits have been noted for the user which might be witnessed in further conversations with learners:

- Only one username and password needs to be remembered to gain access to a number of applications
- It persuades further users to sign up who may have been deterred by the lengthy sign-up process for the website
- Letting 'experts' handle password security reduces the risk of accounts being compromised (see Weiskotten, 2008).

Whilst a number of the learners interviewed in the research did not express concern about people hacking into their private accounts, they did discuss the worry of having to remember a number of different passwords, and many deliberately choose not to have accounts on sites such as YouTube simply because it is another site for their details to be placed on. With the use of this developing software, learners will not have to worry about their security being breached when signing up to new sites.

Importantly, while this technology will prove beneficial to learners currently juggling numerous account names for different applications, Weiskotten also discusses the potential risks if, for example, the information regarding a user's OpenID is compromised, in which case their online identities for a number of sites are also at risk. Thus Weiskotten recommends that a person's OpenID provider must be chosen carefully as one trusted by the user. The user is mainly at risk through phishing websites and must be aware that their OpenID provider may also have access to information on the other websites that they visit. Despite this, OpenID.net suggest that the user base for OpenID is growing, with OpenID now being widely provided by a number of websites mentioned by learners in the project including AOL, Blogger, Flickr, LiveJournal and Yahoo (OpenID.net, 2009b) and being supported by various technological giants including Microsoft and Google. The number of users preferring OpenID to traditional methods of authentication is also said to be on the rise (Weiskotten, 2008). However, being a relatively new concept, there are as yet few signs of learners harnessing the benefits of a single sign-on application and this is something that will need to be monitored in future research.

Photosynth

Although less popular amongst younger learners, some of the older learners described and demonstrated skills in digitally editing multimedia, including video, imagery and music. It is therefore worth paying serious attention to a new piece of software entering the technology scene that promises to revolutionise the way in which young people can edit their images, and might indeed be of particular importance to a number of learners who are keen photographers. Microsoft Live Labs (2009) describe a new Web 2.0 service allowing users to experience a 'three-dimensional, 360-degree experience' where a number of successive photographs are analysed for similarity, allowing a model to be applied which 'synths' the photographs together. This feature allows the user to both become more inventive in their own photography, and to enjoy 3D synths created by other users.

Photosynth integrates Seadragon (2006) technology, which enhances clarity and smoothness of visual information on the internet, and was developed on the back of an idea called 'photo tourism' taken from the research of Noah Snavely, Steve Seitz and Richard Szeliski (2006, cited by Microsoft Live Labs, 2009). Microsoft Live Labs also discuss how the software works through the use of two unique pieces of software: a viewer enabling navigation of the imagery, and a 'synther' to create the end-products. The software has a number of benefits, which include:

- ease of ability to create a synthesis of images. By downloading a desktop application, the actual process of creating the synth is simple, only requiring the user to choose the images they wish to synth, give the collection a name and click 'synth'. The software then looks at common features of the images and places them together.
- an online viewer which allows the user to zoom in and out of an image, move around the picture and view the image in a 3D slide show. (Lardinois, Readwriteweb.com).

Photosynth.net (2009) have also recently released a portable version of the Photosynth application for the iPhone, the iSynth, thus enabling users to use the software 'on the go'. The research team predicts that those young people who are interested in creative editing will start to harness this new form of digital photo manipulation, and therefore that the use of Photosynth software will start appearing within discussions with young people. As these new sorts of technologies become more available portably they open up possibilities for those on practical FE courses who may wish to showcase their work three-dimensionally within their portfolio as well as for other learners with a keen interest in photography.

Touch screens

Influenced in part by the success of the Apple iPhone, and the upcoming arrival of Windows 7 (due for launch in early 2010), it seems likely that the researchers will be encountering learners using touch screens during the course of the project. Microsoft have announced that 'Windows Touch' will provide an alternative way of interacting with the computer alongside the mouse and keyboard: 'Gesture and touch are the two biggest changes to how we interact with our computers since the launch of the first Graphical User Interface, and the use of the keyboard and mouse' (BBC, 2009b). Furthermore, a survey of internet experts collected by the Pew Internet and American Life Project in the US, showed that touch interfaces were predicted to be prevalent and accepted by 2020 (Pew Internet, 2008).

Developing ways of using existing technologies

SMS Texting and Mobile Internet

It was notable that a large majority of learners within secondary school and above owned their own mobile phones and a trend is emerging amongst a large number of 'pay as you go' users, who show a preference for using the text messaging service instead of the lengthier and often more expensive voice calls. As learners already appear comfortable with the use of such informal communication, it seems likely that this technology might be used in some way to aid learning within more formal educational settings and help improve learners' interactions with one another regarding their formal learning.

Mobile technologies have already been shown to influence teaching in classrooms and lectures. For example, clicker technology – whereby a student is given a hand-held device from which they can vote electronically to answer questions set by the teacher and show their understanding of a lesson – have been used in Glasgow and Edinburgh universities. These devices are said to bring a number of benefits to both the student and the lecture, which would help the student to learn more efficiently:

- The student remains anonymous, and avoids embarrassment if they get a question wrong
- Students cannot be influenced by others' answers
- Teachers and lecturers can immediately summarise what the learners are thinking
- The method allows students to communicate reasons for their choices with nearby friends, and to share knowledge with others
- Lecturers can pitch their lecture to the right level of understanding (Sharman, 2008).

Thus, with the frequent availability of home-based technologies such as the mobile phone, and with increasing capacity to use mobile internet technology and SMS to contact others whilst on the move, there is reason to suggest that bringing mobile

phone technologies into the classroom will work in a similarly beneficial way to clickers, whilst eliminating the cost of ordering the hardware and training teachers in how to use it. Although the use of personal mobile phones within formal settings has been discussed as limited (with some reference to using it as a calculator or for taking photographs of pieces of work), the following research suggests evidence that mobile phone technology has already been shown to be very important in supporting learning in formal contexts and enabling interaction and learning outside of school and university:

- A technology has been developed which harnesses a user's own mobile phone as a method of electronic voting within the classroom. The authors suggest that mobile technology will become more feasible in a classroom environment, as students' phones become more user-friendly with regard to internet interfaces. This project discussed the trialling of a web-based system whereby the users connected freely to a university LAN on their mobile phones to access a URL where they could post answers to multiple-choice questions in the lecture. This URL could contain either pre-determined questionnaires (which suffer much the same problems as might clicker-based technologies in that they have to be devised before the lesson) or questionnaires which harness the authors' 'E-Chalk' system, thus allowing the lecturer to handwrite a question spontaneously on an electronic blackboard which is then copied as a questionnaire onto the URL and can be accessed by the learners via their mobile phones. The development of E-Chalk in particular is an interesting trend as the developers are currently experimenting with allowing learners to write their own annotations to lectures that may be added onto the URL and accessed at a later stage. Similarly, the authors note that by using an accessible URL, this will be useful to remote viewers who can also cast votes when not in the lecture (Esponda, 2008).
- Mobile phones are a useful personal technology to use within lessons as the learner is much more likely to have the technology with them than handheld devices such as PDAs: projects have shown that 25–35 per cent of participants forget to bring other technologies into class on a given day (Draper and Brown, 2004, cited by Markett *et al.*, 2006). Mobile phones are also low cost in comparison to other possible handheld devices as they require minimal technical and financial support, with most students already owning the necessary software and hardware (Divitini *et al.*, 2002, cited by Markett *et al.*, 2006).
- SMS in particular might be a very powerful source of communication within a school setting as studies involving student populations suggest that 80 per cent send SMS every day (Divitini *et al.*, 2002; Markett *et al.* 2004, cited by Markett *et al.*, 2006).

- During the project 'PLS TEXT UR Thoughts' in Ireland, a tool was developed to enable groups of students within a university to SMS from their own mobile phones to a centrally stored university mobile number where SMS messages could be stored on a laptop and continuously refreshed as an Excel file. This enabled the teacher to view and respond to messages as they appeared. A second tool was developed as a database-driven website, where students could access anonymous threads from the class, and ask and answer students' questions outside the classroom.

Regarding the usefulness of the SMS messaging system during the class, the project found that 76 per cent of texts received were usefully regarding the content of the lesson, and 6 per cent were administration related (some of which were described as useful such as "We can't hear u! Speak up"). The project was beneficial in that it increased interaction within the lecture, encouraging interactions that would not necessarily have happened (for example by the 38 per cent of students who noted in an after-study questionnaire that they would never, or rarely, ask a lecturer a question during class), and allowed better feedback to be given to students after their presentations. However, it also provides challenges in that the vast majority of students within the study used pre-pay mobile phones and therefore some were 'out of credit' or were tempted not to text the lecturer owing to costs of SMS messages (Markett *et al.*, 2006).

The studies above describe the usefulness of mobile phone technologies within classroom and lecture settings, and thus suggest that a future trend to be observed within the data will be more students being allowed to bring their mobile phones into the classroom for learning purposes. Whilst at present much research into the use of mobile phones inside and outside formal education settings has been with higher education learners, there may be scope for this type of technology to enter schools and provoke an intense reflective response on the lessons that happened that day, to promote higher-order learning.

Virtual Worlds

Since 2007, there has been a rapid increase in the membership of Virtual Worlds and the number of higher education institutions with a virtual presence. These institutions exist within worlds such as Second Life, which grew in general membership from eight million in June 2007 to 14 million by May 2008 (Kelton, 2008). Moreover, others such as the Active Worlds programme, Active Worlds Educational Universe, which includes over 80 educational worlds [<http://www.activeworlds.com/edu/>] are also popular.

Educators such as A. J. Kelton, Director of Emerging Instructional Technology in the College of Humanities and Social Sciences at Montclair State University, are

predicting the increased use of Virtual Worlds for educational purposes. He describes how one of the barriers to this happening so far has been that the legal age of 18 for access has prevented younger learners from participating. However, now that there is growth in virtual worlds which accommodate under-18 learners, he says that the signs are that there could be a massive shift to their uses for education. He anticipates that Linden Labs (who produce Second Life) will remain a major player given the strenuous efforts they have made to reach out to the educational community, including offering discounts to investment in 'land' to be used for educational purposes.

A recent project considered the opportunities for learning within Second Life and explored feedback interviews and student commentaries collected from postgraduate learners who engaged in four sessions taught within Second Life. Reactions were generally positive, and learners found the sessions:

- “chaotic but motivating”
- a good complement to conventional VLEs such as Blackboard, particularly for social interaction which tends to be rather ‘dry’ socially
- potentially disorientating for students
- potentially time-consuming for tutors (Carr, 2008).

Issues have been raised about the accessibility of Virtual Worlds such as Second Life for learners with disabilities and whether this may become a barrier to their appropriation by educational institutions. Nevertheless, there are positive moves there too, in particular projects such as the IBM one aimed at making Second Life accessible to blind users (Techpin, 2007). IBM is developing an ‘innovative audible system’ which can be integrated into Virtual Worlds in order to provide detailed descriptions of the surroundings whilst text-to-speech software allows blind users to access chat.

These predictions and initiatives suggest that we will be increasingly seeing Virtual Worlds used by learners of all ages and would expect to find examples of their uses within the sample during the remainder of the project.

Rapid take-up of Netbooks and Twitter

Netbooks

A number of learners spoken to over the course of the last year suggested that they would either like, or indeed already own, laptops because of their portability and the ability to take the laptop into different rooms to work. Netbooks are portable and highly efficient laptops which first came onto the technology scene in 2007, and have become extremely popular owing to their portability and low cost. The researchers believe that these may grow in popularity amongst learners within the sample, particularly those at university and in higher or further education institutions who might be required to travel frequently from home to university or college, and can therefore make use of the portability benefits these provide.

Anand Chandrasekher of Intel Ultra mobility groups noted on a BBC news report “The next generation of computer users is kids and the way they use it is totally different... If you look at what’s happening underneath we think it’s about the internet and the internet becoming pervasive...People want it wherever they are.” (BBC, 2009c). Netbooks are steadily growing in popularity and predicted to be taken up by young learners in the future:

- Intel found that 80 per cent of people with a smartphone get frustrated when accessing the internet on it as they only get to see a section of what they would normally be able to on a computer. Chandrasekher explains that this is leading to the growth of other portable technologies where users can access a fuller image of the internet, such as Netbooks.
- Sales of Netbooks jumped by 63 per cent in 2008, with sales expected to double in 2009 (Computer Electronics Association, 2008).
- Current developments in the Netbook industry are looking to improve its capacity for game playing and media handling, thus proving more attractive to younger users. Nvidia are currently developing a prototype based around the Tegra chipset to enable the Netbook to support graphics and allow videos and films to be watched. This was expected to be ready for release before June 2009 (Stuart Bonnema, technical marketing manager for Nvidia’s mobile products group) (BBC, 2009c).
- It is currently rumoured on technological blogs that another new form of Netbook technology being worked on will be a touch screen model made by Apple, similar to the iPhone (Malik, GigaOM.com, 2009).

Whilst Netbooks were not yet mentioned by any of the learners interviewed, the research team believes that they will grow in popularity as their specifications suit more of the needs of learners who prioritise graphically intensive activities such as

games and watching television on the computer. Similarly, their low cost might appeal to parents wishing to buy their children a cheap laptop for their own personal use. It is therefore likely that increasing usage of Netbooks will be witnessed in the next two years of research.

Twitter

Although the learners interviewed so far have not mentioned using Twitter, it is very likely that its use will emerge during the course of the project. From 2008 to mid-January 2009 the Twitter website went from being 2,953 on the list of most popular UK websites to 291 (BBC, 2009d). It is difficult at the moment to find statistics from reliable sources in the UK, however a Pew Internet and American life project study carried out in December 2008 found that 11 per cent of American adults said that they used a service like Twitter or similar to share updates about themselves or update themselves on others (Pew Internet, 2009). Relevant to this project is the finding that one in five (19 per cent) of adults who are online between the ages of 18 and 24 have used Twitter or its ilk. If learners in the UK follow suit, we could see similar trends, particularly amongst learners in further and higher education.

Conclusions

This brief report provides an overview of the technologies that are potentially likely to have an impact on the learners participating in the research project. In collecting the data, the research team is developing a strong sense of what learners like to do and the barriers that they encounter and therefore which hardware and software is likely to be attractive to them. Nevertheless, the team is keenly aware that it is difficult to predict which technologies will be appropriated and which will disappear without trace.

A note on the Rose Review

One influence whose scale cannot yet be estimated is the final report of the Rose Review of the primary curriculum, whose publication is imminent at the time of writing. If, as recent speculation has anticipated, children are required to be familiar with blogging, podcasts, Wikipedia and Twitter (BBC, 2009e), this is very likely to have an influence on how the children in the sample use the internet and other technologies at home.

Curriculum and pedagogy – trends

The first Curriculum and Pedagogy research report² identified 24 core trends affecting the development of learning technology relating to curriculum and pedagogy, which were extended in the first Trends Analysis³ and clustered around six cross-cutting themes (see Appendix One).

This report presents an analysis of newly emerging trends and significant developments in trends which have already been identified. A variety of approaches were used, including desk research and horizon scanning, expert witnesses, symposia and analysis of conferences and exhibitions, in recognition of the problems of keeping pace with rapidly emerging trends. It also included, for the first time, a systematic study of the 'grey literature' (more accurately termed 'community literature' – see Appendix Two for a summary of this research) to reveal trends which might otherwise have remained undisclosed at this juncture.

The six key trends identified for discussion in this report are listed below. The first two are, to some extent, continuations of trends identified in the previous reports. The third incorporates several extant trends in response to an apparent intensification of interest in, and activity around, supporting the skills required for the early 21st century. Notwithstanding this, the research team feels that these have evolved sufficiently to merit revisiting.

The key trends are:

- The ubiquity of mobile learning is being continually augmented by the richness of new devices, applications and services.
- The growth of the personal Web.
- A gathering momentum toward curriculum re-design.
- The increasing dependence on Cloud computing.
- Widespread use of personally owned laptops and mobile devices in formal education is moving down the sectors, from university, to FE, and starting to appear in secondary.
- Support for learning design and orchestration of learning is growing in the HE, FE and Adult Learning sectors.

Each of the trends is examined below.

² http://partners.becta.org.uk/index.php?section=rh&catcode=re_rp_02&rid=16049

³ <http://emergingtechnologies.becta.org.uk/index.php?section=etr&rid=14522>

The ubiquity of mobile learning is being continually augmented by the richness of devices and applications

The near ubiquity of mobile phones (Ofcom, 2008) has been well studied elsewhere. Whilst mobile phones are only one aspect of mobile learning, alongside PDAs and other handheld devices, it appears that the strength of the global mobile phone market (over 1 billion phones are manufactured every year) is driving innovation and will continue to do so in the foreseeable future (Johnson *et al.*, 2009). As such, the impact of mobile learning is being augmented by the richness of devices, applications and services.

The increased functionality and availability of inbuilt geolocation tools is resulting in them becoming a relatively common feature across all sectors of education. These tools exploit GPS technology to allow the user to denote the precise location of an object and/or to tag the location of digital photographs and videos at the point of capture.

The new generation of mobiles with their high-speed, increasingly reliable, connection to the 3G network (and 4G, which is expected to be available from 2012), touch screen functionality, good quality photo, video and audio capabilities and inbuilt GPS, have increased their potential for enhancing teaching and learning. Allied with this has been the development of low-cost third-party applications which offer 'games, reference materials, tools for measuring and calculating, checklists, reading material, productivity applications, social networking tools, and more to a single device that slips into a pocket' (Johnson *et al.*, 2009). This has been supplemented by the increasing number of applications available through Google Android and the App Store for Apple i-Phones. However, what mobile learning researchers and practitioners agree is that 'It's the learner that's mobile'. So learners move between a variety of different locations (school, home, work) and the challenge is to a) create micro-sites for learning, and b) enable the continuity of learning across locations and devices. For example, recent papers on podcasting for students have found that most students prefer to use home computers to listen to the podcasts rather than mobile devices (Clark, Westcott and Taylor, 2007). Thus, it is access to services wherever the user wants them that is important, rather than the specific device.

One trend being discussed is how different countries and cultures are adopting and interpreting mobile technology in different ways. African countries are using SMS services to support administration and co-ordination of learning. Asia and the Americas are focused on classrooms supported by 1:1 devices such as PDAs or UMPCs. Europe has a focus on connecting learning in formal and informal settings. These are now starting to merge as best practice is spreading.

A trend observed in the blogosphere is for edubloggers to seem strongly driven by the technologies that underpin their *own* communication and integration preferences and that these are the educational innovations of first choice among such practitioners.

The New Media Consortium classifies 'Mobiles' as being one year or less away from adoption (Johnson *et al.*, 2009).

The growth of the personal Web

The increased availability of free and/or inexpensive, intuitive tools is allowing learners to customise their own web-based environments. Tools such as blogs and microblogs, RSS feeds, social networking sites, sharing and collaborative software are now relatively common in the social and professional spheres. Whilst this growth has been driven by informal use, the obvious potential for teaching and learning is beginning to permeate the education landscape.

At the heart of the growth in the personal Web is the availability of easy-to-use tools:

...it is easy to create customized, personal web-based environments – a personal web – that explicitly supports one's social, professional, learning and other activities via highly personalized windows to the networked world. Online material can be saved, tagged, categorized, and repurposed without difficulty and without any special knowledge of how web pages are put together. In fact, the underlying technology that supports the web has all but vanished for most users; all that is necessary is to know which tools to use... (Johnson *et al.*, 2009)

The potential implications for education are clear. Ofsted recently concluded that 'By the time all schools have established virtual learning environments, the technology may well have moved on, making them an expensive irrelevance. Further consideration should be given to the value for money provided by this national initiative' (Ofsted 2009). In the community literature there is a recurring theme of the VLE as a walled garden. However, many Web 2.0 enthusiasts sidestep the walled garden and the security debate (rarely discussed by edubloggers). This may ultimately prevent, or at least delay, virtual learning environments from becoming irrelevant.

Indeed Ofsted's view somewhat over-simplifies the trends at ground level where three sub-trends can be identified. Firstly, the introduction of specific PLEs (personal learning environments) as replacements or supplements for VLEs (PebblePad, for example). Secondly, already apparent is the burgeoning (but still limited) integration of VLEs with Web 2.0 tools, contributing to a shift from VLEs to social PLEs. And thirdly, in formal education (starting in HE) we are beginning to see the use of tools developed for social use.

The growth of the personal web in education is also supported by the increased variety, quality and appropriateness of audiovisual technologies from multi-touch surface computing platforms to interactive and handheld projection systems. This may be viewed as a continuation of a long-term trend for education to co-opt tools initially designed for use in business.

The New Media Consortium predicts 'The Growth of the Personal Web' as being two to three years from adoption.

The increasing dependence on Cloud computing

Cloud computing potentially allows users access to relatively inexpensive, remotely provided and hosted services which '...enable thin-client, web-based applications for image editing, word processing, social networking, and media creation' (Johnson *et al.*, 2009). The capability and performance of these services, and the processing/programming power and data storage facilities may far exceed those previously available to an individual or an institution. It is the first of these – commonly known as Software as a Service (SaaS) – which is most relevant to curriculum and pedagogy.

Cloud computing means that software (and indeed files) can be accommodated within the cloud, enabling many services which are now central to education (email, collaborative and social software, spreadsheets etc.), to be carried out inside a web browser. Thus, institutions and individual learners may have access to very low cost alternatives to current proprietary tools. Furthermore, these browser-enabled applications can be accessed anywhere the internet is available via a variety of devices. For universities and colleges the cloud offers access to the processing power of a magnitude sufficient to tackle extremely complex modelling and experimentation.

The thin-client solution which *may* be facilitated by cloud computing is increasingly being considered by local authorities as an option for the Building Schools for the Future programme since it appears to offer benefits in terms of both economic and environmental sustainability. However, concerns currently remain with regard to the appropriateness of existing thin-client solutions to meet complex demands of the evolving curriculum. Some LAs have already procured cloud solutions for large numbers for schools (Sheffield now provides all primary schools with email and other applications this way) as do individual institutions such as Cottenham Village School and the University of London's School of Oriental and African Studies (SOAS).

There are several barriers to the growth of cloud computing in education. Firstly, there are perceived risks of placing all work and data in the hands of a single service provider. Secondly, cloud computing represents a recurrent, *revenue* spend as opposed to the more usual *capital* spend on technology with which schools, in particular, are familiar. Thirdly, there is a lack of clarity about how cloud computing services will be integrated with managed services for ICT (which are a growing

characteristic within BSF, for example). This last barrier has already been addressed by some industry suppliers and we can expect others to follow.

To some extent we have observed a lack of alignment between the white literature and the community literature with regard to cloud computing. Away from the specialist technical blogs and fora (that is, those by, and for, technicians) there is very little discussion. Even at the extensive BETT Show cloud computing and SaaS were little in evidence apart from a very few service providers.

The New Media Consortium sees cloud computing as less than a year from adoption (Johnson *et al.*, 2009).

A gathering momentum toward curriculum re-design

The imbalance between the current educational system and the skills, competencies and qualities desirable to prosper in the early 21st century is now gaining national and international recognition amongst governments and industry.

The disjuncture between ‘traditional education systems’ (both in terms of curriculum content and testing regimes) and the skills required for the 21st century has been questioned since before the turn of the millennium and this has been brought increasingly into focus with the emergence and pervasiveness of new technologies. In the meantime the pervasiveness and variety of technologies continues to increase at speed.

However, the cusp of 2009 appears to have marked a step-change. Two major ‘enquiries’ into the primary curriculum published interim reports, with the University of Cambridge ‘Towards a New Primary Curriculum’ (Alexander, 2009) review claiming to have stretched the scope and ambition of the official Independent Review of the Primary Curriculum (Rose, 2008).

However, possibly the most significant development was the joint ‘call to action’ by Cisco, Intel and Microsoft announced at the Learning and Technology World Forum (Cisco, Intel, Microsoft, 2009). This identified reform of assessment across the curriculum as a global necessity and acknowledged the role of technology in supporting reform. The call also declared that the three were jointly funding a three-year research programme in which the Trends in International Maths and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) will be major partners. The key questions to be addressed are:

- Which high priority 21st-century competencies should be assessed?
- What methods of assessment could be used?
- How would the classroom environment need to change to support such assessments?
- What technology infrastructure will be necessary to support such assessments?

- How can countries engage in partnership to arrive at common solutions?

It is evident that technology can support many aspects of any agreed curriculum re-design. Indeed, much of what technology can do to enhance learning – collaborative learning, autonomous learning, publishing for an audience for example – is valued by teachers and learners but not acknowledged by the current system. Furthermore, the potential for technology-mediated formative assessment or linking individual and group assessment, will remain under-exploited without a recalibration of the curriculum throughout much of the compulsory, further, adult and higher education sectors.

A recurrent theme among teachers contributing to the community literature was a reluctance to embrace new collaborative tools. This was largely because of the tension with assessment regimes because of their incompatibility with collaborative working styles.

Ownership of laptops and mobiles in formal education is moving down the sectors, from university, to FE, and starting to appear in secondary

Fears around network security continue to impede the pervasiveness of personally owned laptops and other devices in compulsory education. However, the example set by HEIs, where thousands of students now use their own devices (both mobile and fixed) and risks are successfully managed, the increasing affordability of hardware, persistent concerns around the sustainability of institutional provision, the extension of government and school backed ownership schemes^{4, 5} and students' desire to use their own laptops and devices, are set to support the trend towards the use of personally owned devices in education. The picture with regard to personal *laptop* ownership in FE is somewhat opaque and there is relatively little data on which to draw. However, there is significant and widespread interest in the use of mobile devices for learning in the FE sector and this is increasingly demanding that colleges address and resolve the attendant network security and pedagogic issues.⁶

There is as yet no consistent picture of how the implementation of managed services within the BSF programme will affect this. However, there is a persuasive lobby for students with special needs or disabilities to have unrestricted use of their own devices in BSF schools (Liddle and Waits, 2008). Where these devices are the students' primary means of communication and/or making learning accessible, it is almost unimaginable that they will be deprived the opportunity to use personal technology. This may act as an exemplar and drive through change in more reluctant schools and service providers.

⁴See for example <http://www.independent.co.uk/news/education/schools/will-a-one-pupil-one-laptop-initiative-change-classrooms-for-ever-1365969.html> and <http://innov8ed.wordpress.com/about/>

⁵ See for example <http://www.thisisderbyshire.co.uk/news/year-pupils-mini-laptops-Alfreton-Grange-Arts-Collegearticle-493569-details/article.html>

⁶ See <http://www.molenet.org.uk/>

Whilst there are appreciable pedagogic advantages to students using their own devices – as a multimedia portfolio device, offering familiarity, consistency and convenience etc. – there appears to be relatively little research into the impact of students using their *own* laptops on campus as opposed to institutionally provided devices which are repeatedly accessed by multiple users. The community literature is also sparse on this topic with most of it concerning acceptable use policies (AUP), classroom behaviour issues and security implications in the compulsory education sector. The lack of HE edublogger traffic perhaps reflects that the argument for students to use their own devices has now been largely settled in HE. As noted above, most HEIs in England now encourage, more or less overtly, students to own their own devices (which may include desktop models), and provide support to integrate these with the university network, both in halls of residence and with laptops on campus (the latter usually through wireless access). After a slow start (compared with the US) wireless access has spread widely across campuses although it is not yet ubiquitous.

Support for learning design and orchestration of learning is growing in the HE, FE and Adult Learning sectors

In England the ongoing exploration of the way that digital technologies, practices and innovations can be employed to support lecturers, tutors and teachers in designing technology-enhanced learning is currently significantly (though by no means exclusively) focused around two consortia: the Learning Design Support Environment (LDSE) Project⁷ and the Open University Learning Design Initiative (OULDI)⁸. Both of these have their roots in the much broader JISC Design for Learning Project⁹, the evaluation of which concluded:

The conceptual underpinning of the Design for Learning Programme provided a robust basis and framework for further pedagogic research, professional capacity enhancement and technical development. Future innovation programmes will find value in underpinning their intentions with a conceptual framework for the development and implementation of technologies to support learning and teaching. (JISC, 2009)

The LDSE Project, which builds on the work of the London Pedagogy Planner¹⁰ and Phoebe¹¹, is a three-year ESRC/EPSC funded partnership of six English HEIs and is based on four key assumptions:

⁷ See <https://sites.google.com/a/lkl.ac.uk/ldse/>

⁸ See <http://ouldi.open.ac.uk/>

⁹ See <http://tinyurl.com/cezfqy>

¹⁰ See <http://www.wle.org.uk/d4/> ‘...an interactive tool for designing teaching and learning at both the module and session levels’

¹¹ See <http://phoebe-project.conted.ox.ac.uk/> ‘...which supports the design of individual sessions and incorporates a community-owned resource bank of learning designs.’

1. Teachers will be required to use progressively more technology-enhanced learning (TEL)
2. The teaching community should be at the forefront of TEL innovation, and not cede responsibility to other professionals
3. The development of new knowledge, in this case about professional practice, should be carried out in the spirit of reflective collaborative design; and
4. The same technologies that are changing the way students learn can also support teachers' own learning in new ways. Computer-supported collaborative learning has long been established as an important form of TEL for students; it should be equally applicable to teachers' professional development.

The OULDI project began in September 2008 and runs through to May 2012. This OU/JISC funded project has identified six main benefits to adopting a learning design approach:

1. It acts as a means of eliciting designs from academics in a format that can be tested and reviewed by others involved in the design process, that is, a common vocabulary and understanding of learning activities.
2. It provides a method by which designs can be reused, as opposed to just sharing content.
3. It can guide individuals through the process of creating new learning activities.
4. It helps create an audit trail of academic (and production) design decisions.
5. It can highlight policy implications for staff development, resource allocation, quality, etc.
6. It has the potential to aid learners and tutors in complex activities by guiding them through the activity sequence.

As yet, there is little evidence of this being consciously extended to the primary and secondary school sectors either by government or its appointed bodies, or by individual leaders and practitioners.

Conclusions

Discussion here has focused on six of many trends identified by the research team over the past six months (and previously). There are several other trends which it is important to recognise and continue to observe and analyse. Some of these are as yet indistinct in terms of the breadth of impact, some in terms of the depth of impact and some in terms of longevity. The New Media Consortium identifies Semantic Aware Applications and Smart Objects as visible on the educational horizon with an estimated time to adoption of four to five years (Johnson *et al.*, 2009). Already apparent is the continued growth of Open Source software across the educational landscape, an area that is already well documented elsewhere.

The trends identified are obviously closely inter-related. Developments in mobile learning are somewhat contingent upon those in the Personal Web and Cloud Computing and vice versa. These trends will all continue to evolve and will be monitored and revisited. For example, the Pew Internet project¹² predicts that mobile devices ‘... will be the primary connection tool to the internet for most people in the world in 2020’ and that ‘...voice recognition and touch user interfaces with the internet will be more prevalent and accepted by 2020’ (Quitney Anderson and Rainie, 2008).

The research has concentrated on those trends believed have the potential to have the most immediate and significant impact on the domestic educational landscape. However, research suggests that, despite national and cultural characteristics in the way technologies are used, the best practice across these varied modes is shared and the practice merges to some extent. As such, the plan is to extend the scope of research over the coming year to include a more intense analysis of developments beyond the domestic landscape.

With the growing availability of tools to connect learners and scholars all over the world – online collaborative workspaces, social networking tools, mobiles, voice-over-IP, and more – teaching and scholarship are transcending traditional borders more and more all the time. (Johnson *et al.*, 2009)

¹² See <http://tinyurl.com/6m92m2> for the Pew Internet Project

APPENDIX 1

The six cross-cutting themes identified in the first Trends Analysis were:

- the wide-ranging implications for curriculum and pedagogy of Web 2.0 technologies and the behaviours of young people who are incorporating them into their lives
- the longer term impact on curriculum and pedagogy of capital build programmes
- the changing demands of workplace skills
- the extent to which economic, social and technological drivers will lead to a fundamental transformation of the character of education and how it is organised
- the implications for the pedagogical role and professional development of teachers and other enablers of learning
- the implications for education of the development of mobile, ubiquitous and contextual computing.

APPENDIX 2

A review of Community Literature

This is the first time this approach has been used in the research programme as the team feels that, new as it is, it is important to be aware of the emerging nuances in this field.

Community literature provides a rich source for detecting innovations and trends whilst also acting as a barometer with which to test the reaction to, and impact of, top-down trends and policies. However, the material generated requires sensitive handling. Among the mainstream community there is a clear enough appetite for theorising or 'big-picture' expressions – as is evidenced by traffic pertaining to 'personalisation'. However, there remains a conservative orientation to ICT innovation. While among the professional enthusiasts and trail blazers there is energy and a radical spirit it remains focused on preoccupations with various forms of social networking and the development of visual expressiveness. Finally, when invoking material from community literature it is important to recognise that little is explicitly based upon the 'white literature'; formal research evidence is rarely referenced.

Background

It is assumed that trends and innovations are seeded (and sustained) by some mixture of top-down and bottom-up influences. Much of the reporting in this research strand has been oriented towards the kind of top-down pressures that arise from shifting macro-economic conditions, changes in curriculum design, and broad educational policy initiatives. Bottom-up forces are more challenging to detect and the dynamic of their influence is less well understood. However, it is likely to operate within less formal or official channels of communication. In other domains of social practice, a 'grey literature' is often invoked as an important context of such communication. Typically, its form is very much 'literary', with the emphasis being on texts that range from government discussion documents, through professional magazines, to informal newsletters. However, the growth of internet communication has revealed an appetite for a still wider and still more informal space of 'grey' communication. Moreover, educational practitioners sympathetic to ICT are very likely to be active in this digital space.

We have therefore found it helpful to make a preliminary map of the (fast-expanding) grey territory. However, to highlight its more participatory nature, we have termed it 'community literature'. There is good *a priori* reason to suppose that it will be an important *source* of innovation and stimulus of trends. But, also, that it will offer a barometer for how top-down trends and innovations are received and responded to.

Method

Our mapping of the community literature covers a large number of arenas but the comments made here are based upon scrutiny of that part of it that is most active and most dynamic. In particular we have considered three arenas of dissemination and debate. First, discussion forums: that is, web services inviting user registration to develop threaded text exchanges. Second, personal blogs: that is, websites maintained by individual educators to support postings upon which others can comment. Third, ning sites: that is, a discussion forum somewhere in between these two – one in which a community of individuals can have equal stake in a topic-defined shared discussion and dissemination space. We have identified prominent exemplars of these three genres of informal communication and base our comments here on a sampling of their activity within the period January–February 2009 (covering times of both school vacation and term as well as being shortly after the possible stimulus of the annual BETT Show).

For discussion fora, we dwell on the TES Forums because of their breadth and depth of engagement. Over 2000 postings were made on these boards in the two-month period. Of a typical evening there are over 150 users signed on. We also consider the BETT research discussion list, because it is active and represents a more circumscribed community within which innovation is a priority concern. We considered several nings that focus on education but the extent of participatory discussion was modest and most of our attention converged on educational bloggers. From the large number of UK-based individuals we extracted a group of 24 that attracted particularly high rankings based on visits and cross referencing. For example, blogs in this group would typically attract several thousand readers a month.

Observations

The structure of the communication as outlined above allows us to comment on the larger, undifferentiated community of educational practitioners (particularly through the TES forum), the more ICT-focused (through nings and blogs) and the research-oriented community (through the Becta forum). The following points relating to trends and innovations arise from our observations so far.

- 1) These media cultivate considerable activity and statistics suggest that they have a wide reach with a large community of readers. However, they are characterised by a declarative rather than a debating style. So the median number of comments on a high-influence educational blog is just two. Similarly the threads in the TES forum were typically no more than 2 to 3 postings long.
- 2) The *authority* for views expressed or arguments developed is highly experiential. This applies even to the Becta research forum, where well-articulated points are made but it is very rare to see reference to a published piece of research. In the practitioner fora and blogs there is scarcely any mention of official documents or

organisations. Thus Becta, Futurelab and Naace together attract scarce reference on the TES board. Similarly 'harnessing technology' rarely is invoked there or on blogs. On the other hand this should not suggest that that policy-defined discourse is invisible. Thus the terms 'personalisation' has a very strong presence on the TES board and has clearly become a focal point for the expression of practice ideas. Interestingly, it is rather rarely mentioned in blogs and almost absent from the Becta research forum.

3) Fora discussion that invoked ICT is dominated by troubleshooting. Reference to particular forms of technology-enhanced learning is dominated by smartboard references and, to a lesser extent, learning platforms. Outside the ICT subject community itself, the modern language disciplines are the most actively engaged by ICT. This is reflected in the blogosphere where a significant number of influential blogs have a focus on modern languages. Innovative themes such as cloud computing, mobile learning or virtual worlds are rarely invoked on the TES board.

4) On the other hand, the influential blogs are preoccupied with disseminating new ICT opportunities. However, these are highly focused on web 2.0 applications. Keyword searches indicate that there is significant attention to microblogging, social networking, video activity and mobile technology opportunities. There is rather scarce mention of virtual worlds, learning platforms, home-school issues or the design of learning spaces.

Networking and virtualisation – trends in business processes

This research, carried out by Kable, examines some of the trends in information and communications technology (ICT) that organisations are using to improve their information management processes. Even as the rate of technological development continues to accelerate, it is remarkable that new applications and uses are being devised just as quickly.

The technological trends presented in this report were selected because of the very real impact they promise to have on business processes. Although broad in scope and addressing distinct issues individually, they also focus on a single unifying theme: the infrastructure to accommodate increasingly information-intensive activities and outputs. Ever-increasing quantities of data or digital material are being accessed and manipulated more readily, and involve greater storage requirements and computer capacity.

While many new ideas are easily integrated in an existing structure, a key consideration to be addressed from the inception of such an ambitious endeavour as the Harnessing Technology programme¹³ will be the need to ensure the quality of the infrastructure.

The aim of this technological trends analysis is not, therefore, to enumerate the staggering variety of new devices and gadgets created out of silicon and circuit boards. Instead, the focus is on how they are being used and the new ways of working they engender, and where the real creativity can be identified. It is not, after all, the duty of educators and policy-makers to devise such solutions. It is, however, their responsibility to lay claim to those that can enhance the experience of learners, and cement the professional capacity of educational institutions.

The task of 'harnessing technology' implies understanding its potential and directing it to achieve desired results. In this paper, we look at how businesses are using some of the recent innovations in ICT capability, infrastructure advances and process improvements. By analysing these trends in relation to the Harnessing Technology outcomes, and their general relevance to the education sector, we lay the groundwork for adoption and adaptation. Timely awareness of these trends will enable education professionals to assess their potential and devise a strategy for effective and worthwhile implementation.

¹³ <http://feandskills.becta.org.uk/display.cfm?resID=37346>

Background

The technology trends analysed here are those related to business processes for education, encompassing, according to our definition, as:

All 'back office' processes plus processes that enable access to resources for education.

Kable conducted a survey of education professionals in November 2008 to begin to establish which business processes are most in need of improvement. The top 10 most onerous areas cited by those questioned are shown in Table 1. Activities that rely heavily on effective and efficient information management processes to prepare outputs were consistently found to be the most difficult, namely preparation for inspections, preparing personalised learning programmes and preparing end of year reports.

Table 1 : Most time-consuming and complicated activities amongst education staff (based on a non-scientific sample of UK education professionals: 467 people surveyed online during 2 weeks in November 2008)

| Rank | Description |
|------|--|
| 1 | Preparation for institution inspection (e.g. Ofsted inspection) |
| 2 | Planning staff training |
| 3 | Reviewing and preparing special education needs code of practice |
| 4 | Scheduling examination timetable |
| 5 | Preparing personalised learning programmes |
| 6 | Preparing end of year reports |
| 7 | Accounting with respect to staff training and development |
| 8 | Constructing business models and calculating budgets |
| 9 | Managing staff performance |
| 10 | Curriculum mapping |
| 10 | Assessing examinations |

Highlighted activities rely on information management processes

Each of these activities involves the collection of information from multiple sources involving collaboration with others, identifying information pertinent to specific uses and then reforming that information so it is appropriate to each use. These are the kinds of areas where the technologies in this analysis become relevant. The world of business has attacked these information management processes head-on as a means to gain competitive advantage in the market.

This report presents the ICT trends experienced outside the education sector that have enabled organisations to improve their information management processes. The aim is to illustrate the main infrastructure and processes business has found essential to its advancement so that education can emulate this success.

Advances in networking technology and storage capability will be key contributors to the five Harnessing Technology outcomes. While the trends addressed here most explicitly support 'Enabling infrastructure and processes', the ubiquity of the development involved means that they will need to be integrated completely into the operating ethos of the educational institution. They are likely to prove a fundamental component in any future ability to deliver the other four outcomes:

- Improved personalised learning experiences
- Confident system leadership and innovation
- Technology-confident, effective providers
- Engaged and empowered learners.

The networking revolution

Computer chips are now able to store so much information on a speck of silicon, and manipulate it so quickly, that the longstanding passion for 'smaller and faster' has been more or less satisfied. Now, connectivity, networking, mobile applications and remote storage are where the attention of both developers and users is focused.

This section considers the network developments interacting with new devices to create that virtuous circle of innovation which underlies some key business process trends. Educational institutions will be confronting growing opportunities to interact with information-intensive outputs, combined with demands to access these in an increasingly 'natural' manner, as the boundaries between real life and the virtual world continue to blur. This new technological environment will be driving the direction and personality of business processes and information management.

There are scarcely any business computing devices, services or applications emerging now which are *not* designed to interact with networks. Network capabilities are a motivation for new devices, which are in turn accelerating network developments and their adoption.

There are two fundamental trends in networking:

1. Network capacity and speed are increasing rapidly, while costs are falling. This is supporting a widespread shift to virtual servers and storage.
2. Voice, data, and still and moving images are converging on Internet Protocol (IP). IP enables packets of any type of data to be routed, using a common addressing protocol, to their network destination, where they are re-assembled into a coherent whole. The advantages of this are lower network costs, interoperability across different types of network infrastructure, and the facilitation of integrated multimedia applications.

These advances enable otherwise location-dependent tasks to have data and application access virtually anywhere at any time. The following sections review five different, albeit interrelated, elements of these trends, and consider their relevance for the education sector.

Storage virtualisation and networked servers

Advances in networking, speed and capacity are being reflected in the growing importance of virtualisation in servers and storage. The advantage is lower terminal costs, and more importantly, greater simplicity in managing software updates, storage back-up and security.

Whereas until recently the strategy was to pack more power and functionality into fixed and mobile personal computers, an opposing – or rather, alternative – trend is now apparent: the move by some organisations towards offering low-cost terminal devices (thin clients), with no hard drive and limited processing power, which rely instead on networked servers for their applications and bulk data storage. Servers can be maintained in a remote, even outsourced, data centre, minimising management supervision, and space and energy requirements. This trend results in cost savings and greater securability, with automatic back-ups and failsafes, and virtually no risk of data loss due to individual equipment failure.

Every computer or mobile device such as a laptop, smartphone or notebook, can be connected to the internet to access networked servers offering full functionality. Put simply, virtualised storage removes the need for data or applications to be held on each and every device. Each unit can therefore be simpler and cheaper, and less subject to obsolescence. The technology also supports communications with digitised functions outside those usually associated with ICT, due to the elimination of processing requirements. This might allow interfacing with security and alarm systems, utility meters, and peripheral devices.

This will have a number of implications for the infrastructure and working methods of institutions, which can gain many operational advantages through storage virtualisation. The task of managing software and applications is simplified, since updates are handled automatically rather than having to be applied individually to each machine, while licences can be maintained centrally. Data and records can be both more widely accessed, but also more easily controlled.

The shift to virtual storage means that the working environment is able to shed its boundaries. Being able to access all an organisation's systems from anywhere will alter the conception of workspace. On the one hand, it is much easier to work remotely, while on the other hand, shared data and virtual meetings mean that one's colleagues and associates are also more available.

Security

The move to virtual storage has immediate implications for data security, by eliminating the need for multiple copies of databases and the consequent inherent risk of loss, misappropriation or unauthorised access. It also becomes much more viable to implement different levels of access to only those areas of a system for which a user is authorised.

The more data is shared and made available to employees, customers and citizens via intranets or the internet, the more vital it becomes to ensure that individuals can access only the data to which they are entitled.

‘Security’ is a catch-all term, and covers a growing range of issues:

- Is the user authorised to access this data or network? Is the data protected from unauthorised use or manipulation? Is data on a device secure from unauthorised users?
- Is the site the user is accessing secure and legitimate?
- Is the device seeking to access a data or network free of viruses or other possible contaminants?

Although data encryption is an established tool, many organisations still do not adequately protect themselves against loss or theft of data¹⁴ and this risk inevitably increases as more use is made of laptops and mobile devices, given their tendency to go missing.

Integrated firewalls are being augmented by ‘deep packet inspection’ (DPI) to provide greater security around and between virtual machines. This aims to reduce the risk of intrusion, infection, compliance violations or other attacks. DPI examines aspects of data as it passes an inspection point, searching for protocol non-compliance, viruses, spam, intrusions or predefined criteria. It is able to protect vulnerabilities outside the scope of a firewall, which is mainly aimed at keeping unauthorised users out and shielding legitimate users. It can also protect against introduction of threats such as viruses, worms and spyware, into the corporate network, through mobile devices accessing from insecure connections. While firewalls do not distinguish between permitted and forbidden uses of legitimately-accessed applications, DPI enables policies and protocols to be set and enforced at all layers.

EDRMS

As more and more of any organisation’s current document production is electronic, it is also becoming necessary for records systems to engage with unstructured data,

¹⁴ ‘UK organisations fail to protect data with encryption’, 18/03/2009
http://www.securitypark.co.uk/security_article262806.html

such as emails, photos, web pages, audio, videos, presentations, or scanned images. Unstructured records can be thought of as those intended primarily to be used by human users. Structured records, by contrast, are those with information already in a form appropriate for computer applications, such as databases, spreadsheets, or electronic records.

Although rather prosaic-sounding, 'electronic document and records management systems' (EDRMS) are a powerful and sophisticated tool to capture, catalogue, search/identify, reform and present information. These systems are far more than digital filing cabinets. Record-keeping becomes integrated with the full extent of an organisation's operations, automatically updating, triggering actions or feeding into knowledge systems.

EDRMS removes the need to keep physical copies of most documents and records, saving vast amounts of physical storage space. It is, of course, reliant on adequate digital storage capacity, and so becomes increasingly cost-effective through the virtualisation discussed above.

The aim is for an organisation's complete documentation and activities to be available when required, so as to improve workflow and reduce operating costs, enhance collaborative activities, reduce errors, and extend the boundaries of the workplace through better access to records and information from remote locations or mobile devices.

EDRMS may also become indispensable for public sector organisations to meet statutory and legislative requirements, and to ensure compliance with the Data Protection Act, Freedom of Information Act, Reuse of Public Sector Information Regulations, and other government policy.

One consideration in EDRMS, particularly for regulated and public sector organisations such as schools, is digital preservation: ensuring that measures are taken so that files remain readable in the future. An EDRMS records when each record was created and which application created it. If a particular file type is at risk of becoming obsolete, the EDRMS can find all the records which use that file type. It can also sort records according to retention periods, and ensure they are either kept or deleted appropriately.

Schools and education authorities need to take a concerted and organised approach to electronic document and records management. Although implementing an EDRMS may be quite substantial from both a financial and resources perspective, it is becoming increasingly difficult to ignore the need to do so.

Collaborative working

Information management requires not only that information be created and communicated, but can require multiple user involvement, often simultaneously, in different locations.

A collaborative working environment (CWE) provides the capabilities for professionals to share information, exchange views, and access material whatever the geographical location of everyone involved. A collaborative workspace can be defined as an inter-connected environment with common resources in which all the participants in dispersed locations can access and interact with each other just as inside a single building.

A CWE relies on adequate networking and document management capabilities, and communications options which might include email, instant messaging, application sharing, video conferencing, workflow, and social networking tools such as wikis, blogs, discussion lists and chat rooms. These technologies enable an 'e-professional' to work as part of a group or within knowledge networks, and to be involved in distributed cooperation processes that have not been possible before.

The emerging use of collaborative working tools encourages wider interactions to take place, and can be used to bring together and improve the effectiveness of interactions between education providers, learners and other stakeholders. Sharing of best practice, expert support, planning of joint projects, discussion of educational plans for individuals, and other forums for communication, usually involve physical meetings. Some of these could be supplemented, enhanced or replaced by virtual meetings, booked and implemented using collaborative working tools – with documents shared on-screen and stored and available for subsequent reference and update.

A further opportunity with CWE is when extending beyond a single organisation and to create collaborative relationships and partnerships with complementary providers. Business processes can be streamlined, and the co-operative nature of project implementation can generate improved results by making better use of available resources.

Mixed media data streams

Convergence on Internet Protocol (IP) for the transmission of voice, data, image and text reduces network costs and, more importantly, enables the development of integrated, multimedia applications such as unified communications (UC).

UC is a loosely defined suite of communication applications which exploit two aspects of an IP network: (1) voice, data and images can all be carried across a single IP network in a common form, and (2) these communications are addressed to the IP address of the target person or device, wherever it is attached (wired or wirelessly) to an IP network, as opposed to addressing a fixed network point, such

as a desk-phone. UC can operate within one organisation and across multiple organisations using a common virtual private network (VPN) or (with rather less sophistication) the over the public internet.

Applications usually included within UC are Voice over IP (VoIP), IP telephony, multimedia conferencing, tele-presence (high-definition video conferencing, giving the impression that remote people are just across a desk), unified messaging (all types/media of messages can be easily accessed from a single user interface regardless of location or device), instant messaging (pop-up messages between colleagues), and presence (indicating an individual's availability to receive various communication media, or not as the case may be).

UC facilitates collaboration at the human level, and complements and accelerates take-up of data sharing and distributed project management. According to one supplier¹⁵:

Used effectively, unified communications and collaboration strategies, applications and infrastructure enable organisations to add value to a range of core business processes, realise significant operational benefits, and achieve quantifiable bottom-line savings.

Technology-enabled virtualisation of tasks and teams is an essential support for specialisation and outsourcing – including international specialisation and off-shoring. As Thomas L. Friedman, author of 'The World is Flat'¹⁶ put it:

The more we connect everyone through common communication standards and then, on top of those protocols, connect more and more people through standardised business processes, the easier it is to chop up work and send pieces of it to be done anywhere in the world. This increases productivity and enables a whole digital ecosystem to collaborate better, cheaper and faster...

Web 2.0 and social networking

The term 'Web 2.0' is used to describe the proliferation of interconnectivity and interactivity of internet applications, particularly with regard to social networking, online communities and user-generated information including blogs, wikis, video-sharing, and virtual universes such as Second Life. It is not about new technical specifications or programming, but about how users actually engage with the World Wide Web, and with each other.

Businesses and other organisations are increasingly looking to exploit the possibilities offered by this trend, and the education sector is particularly well placed to gain through targeted participation. This might include setting up a wiki to which all

¹⁵ BT, 'Unified Communications and Collaboration' https://www2.bt.com/static/i/media/pdf/ucc_wp.pdf

¹⁶ <http://www.thomasfriedman.com/bookshelf/the-world-is-flat>

an institution's members can contribute, communicating with students through social networking sites such as MySpace and Facebook, or establishing a similar private network that can also be integrated with existing databases¹⁷.

A report¹⁸ published by the National School Boards Association in the USA suggested that educational bodies needed to get to grips with the social networking phenomenon. It recommended they:

- explore social networking sites
- consider social networking for staff communication and professional development
- find ways of harnessing the educational value of social networking
- ensure equitable access
- pay attention to nonconformists
- re-examine social networking policies.

A number of social networking sites have also sprung up specifically around educational issues. A dedicated wiki, Social Networks in Education¹⁹, has even been established to keep track of them.

A key consideration for schools will be to ensure that ICT resources can support Web 2.0 implementation from a technical infrastructure and security perspective. It is easy to underestimate the time and effort to maintain and run something like a blog, online community or interactive capability.

Supply networks and ecosystems

Development of online supplier networks and purchasing organisations is also reliant on secure access to appropriate shared data, over a common network, with adequate capacity and using common standards to a significant degree. Many companies are active members of interacting, inter-trading communities of complementary goods as services provided by different organisations. An electronic trading platform (known as an e-market, exchange, marketplace or e-hub), allows multiple trading partners to achieve process efficiencies, cut costs and generate sales opportunities. E-hubs are often formed around a large organisation, such as a global oil company or carmaker, or the Ministry of Defence.

A broader concept, according to Cedric Thomas, is the 'digital business ecosystem':

Although ecosystems are built on industry-wide value chains, they are more than just a mechanical sequence of supplier/buyer relationships. 'Community' is the important word in the definition of an ecosystem.²⁰

¹⁷ http://en.wikipedia.org/wiki/Web_2.0

¹⁸ <http://simply-speaking.blogspot.com/2007/08/social-networking-in-education.html>

¹⁹ <http://socialnetworksined.wikispaces.com/>

Although the concept has been around for some years, the capabilities of Web 2.0 applications now make such ecosystems more viable, with interactive communications able to build trust and relationships²¹.

A business ecosystem will comprise a range of ICT and EDRMS-based components. Related supply-chain applications fall into three broad categories²²:

- *Commerce related* – member organisations' systems are linked directly for purchasing, improving process efficiency and cutting inventory requirements.
- *Information sharing* – market forecasts, production schedules, and other operational data are co-ordinated to optimise planning of the production process.
- *Collaborative activities* – research and development, design and project management are linked to reduce time to market, improve outcomes and reduce errors.

The figure below shows how these capabilities and functions have grown as network capabilities have increased:

²⁰ Cedric Thomas, March 2008, 'Introduction to the OW2 Consortium Business Ecosystems Strategy'. Working paper.

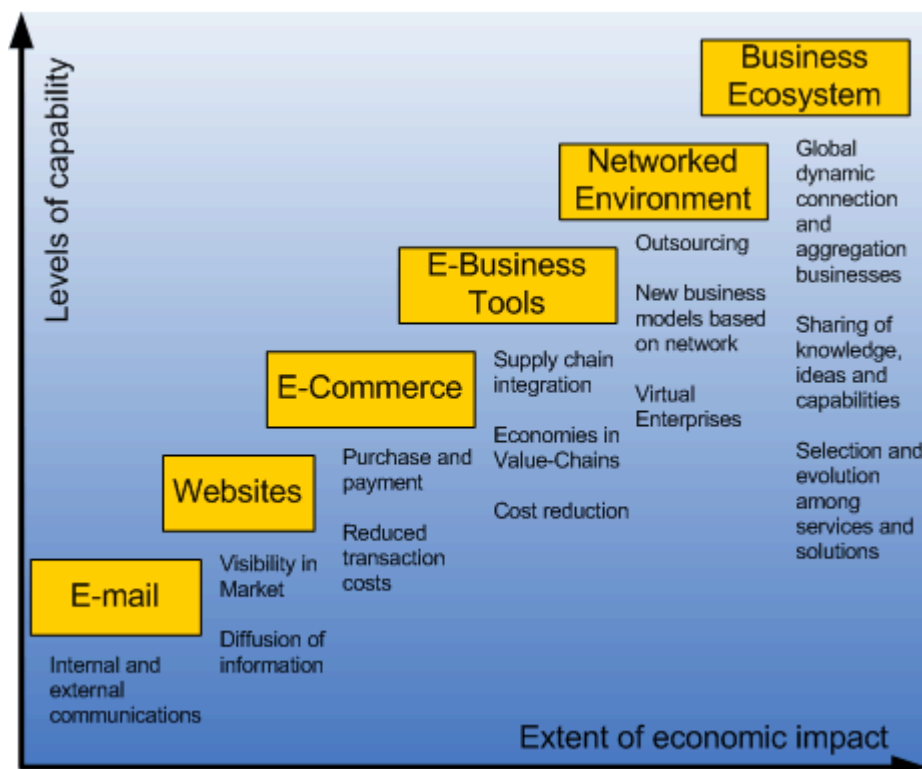
<http://www.ow2.org/xwiki/bin/download/Main/WebHome/CedricThomasBusinessEcosystems0805.pdf>

²¹ Jeff Risberg, 'Online Communities and the Business Ecosystem', November 26, 2007.

<http://serus.wordpress.com/2007/11/26/online-communities-and-the-business-ecosystem/>

²² QAD, 'The Line56 e-Business Ecosystem'.

<http://www.sie.ua.es/DocDocencia/SIE2/otros/ecosistebusiness.pdf>



Source: Risberg, 2008²³

Although e-hubs and digital ecosystems have been well established in industry for over a decade, the education sector has not yet embraced their potential. No inter-trading ecosystem has been enabled, although the size and potential combined purchasing power of the education sector should readily support a trading e-hub. The fragmentation of the industry, both in terms of buyers and of suppliers, means that any development would need to be co-ordinated by a central body. One interesting initiative is The Energy Consortium, a not-for-profit organisation to purchase energy for institutions in the higher education and further education sector²⁴, allowing them to benefit from economies of scale.

In the case of schools, it may require market-shaping action by system leaders to create closer ties to national partners and major suppliers, improve access to key resources and facilitate efficient procurement on an aggregated basis.

While in industry the ecosystem is based on purchasing relationships and supply chains, it can also be considered without the commercial aspects, as a way of exchanging and managing knowledge. In Switzerland, for example, the Swiss e-Hub has been set up to exchange e-learning products and services²⁵, and aims to form the basis of a nationwide network.

²³ <http://serus.wordpress.com/2007/11/26/online-communities-and-the-business-ecosystem/> which was itself adapted from <http://www.digital-ecosystems.org/>.

²⁴ <http://www.energyconsortium.org.uk/index.php>

²⁵ <http://www.bakom.admin.ch/themen/infosociety/01691/01745/index.html?lang=en>

The education community has created a number of portals to online educational resources such as the National Grid for Learning (NGfL). However, organisations reached via educational portals have not, in the main, connected to each other, except for ad hoc communications over the internet. Adjacent to the education sector, regional development bodies, such as Yorkshire Forward, are establishing high speed VPNs (NYnet²⁶ in the case of Yorkshire), which are likely to attract HE and FE institutions, as well as other public bodies, private companies and community groups, as connected members. This type of network could form the core of an ecosystem for HE/FE institutions.

Continuing trends analysis – further research

Business processes in education are affected from two directions – pulled along by the technological developments in the wider commercial world, and being pushed by demands arising from changing needs of learners and teachers. The trends presented here demonstrate some of the areas where these two pressures coalesce. Advances in networking technologies are driving many of the social and economic innovations that are of growing importance to the educational environment, and also bring their own challenges.

Cutting-edge industries outside the education sector might be characterised as typical ‘early adopters’, and rely on being first to exploit novel technology or develop new applications. Many of their ideas offer more generalisable value and soon become commonplace, or even essential. Others are less obviously appropriate for the education sector, although aspects can be identified and adapted to lend value.

This perspective will continue to inform future trends analyses. Concentrating on particular themes and, where appropriate, exploring specific developments in greater detail, the objective is to explore the potential for business processes in education to benefit from, or be transformed by, technological innovations.

²⁶ <https://www.nynet.co.uk/index.php>

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