AMEE GUIDE

e-Learning in medical education Guide 32 Part 2: Technology, management and design

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Abstract

With e-learning now part of the medical education mainstream, both educational and practical technical and informatics skills have become an essential part of the medical teacher's portfolio. The Guide is intended to help teachers develop their skills in working in the new online educational environments, and to ensure that they appreciate the wider changes and developments that accompany this 'information revolution'.

The Guide is divided into two parts, of which this is the second. The first part introduced the basic concepts of e-learning, e-teaching, and e-assessment, the day-to-day issues of e-learning, looking both at theoretical concepts and practical implementation issues. This second part covers topics such as practical knowledge of the forms of technology used in e-learning, the behaviours of teachers and learners in online environments and the design of e-learning content and activities. It also deals with broader concepts of the politics and psychology of e-learning, as well as many of its ethical, legal and economical dimensions, and it ends with a review of emerging forms and directions in e-learning in medical education.

DON'T PANIC (Adams 1979)

Introduction

E-learning means many things to many people, but, in its broadest sense, it is concerned with the use of networked information technologies in education, and, in that respect, it can include administration, logistics, assessment and communication, as well as teaching and learning. More specifically, it can be seen as covering the instructional uses of technology, although that description also benefits from more careful scrutiny. For the purposes of this guide, we consider the many ways that the information revolution has affected and remediated the practice of healthcare teaching and learning. This Guide is presented both as an introduction to the novice, and as a resource and even a challenge to more experienced practitioner.

It is important to note that, while many of the principles presented in this Guide are relatively persistent, specific examples will date quickly. It is to be expected that new information technology affordances will lead to new tools and approaches entering the educational domain, while others fall out of favour. We anticipate that this Guide will be revised and supplemented on a regular basis to keep pace with these changes.

The AMEE Guide to e-learning is being published in two parts; this is the second part, and it focuses on technical, management, social, design and other broader issues in e-learning. It ends with a review of emerging forms and directions in e-learning in medical education. In several

Practice points

- In just a few years, e-learning has become part of the mainstream in medical education. Practitioners therefore need to know about the basics of the e-learning environment and what help and support their students require.
- E-learning involves many dimensions in addition to its educational impact. Political, psychological, legal and ethical issues all need to be considered.
- Assessing the value of e-learning requires a range of different economic analyses.
- The design of e-learning is a fundamental determinant on its success. This includes user interface design, accessibility and domain alignment.
- Research and development is an essential and ongoing aspect of e-learning practice.
- Healthcare education informatics affords better use and understanding of the many issues and themes around information systems in healthcare education.

instances, issues raised in part 1 are re-visited and viewed from different perspectives in order to provide a more complete picture.

Technology

Although there are many dimensions to e-learning, technology is the medium of action and, as such, the e-learning practitioner must be able to deal with many technical issues and concerns that arise from e-learning. This section gives

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a background to the technology in use in e-learning. (Much of this section is aimed at the novice computer user, so experienced users might wish to gloss over this section, and move to the next.)

Hardware

Hardware is the term used to describe the physical components of the computer. Generally, hardware is classified into 3 types:

- Input devices: these are devices that are used to input data or instructions, and include keyboards, mice, joysticks, scanners, still and video cameras, and microphones.
- Output devices: these are devices that are used to display the data, and include monitors (or screens) and printers, data projectors, and interactive whiteboards (although interactive whiteboards are also input devices.)
- Storage Devices: these are devices that store the data for later retrieval, and include hard drives (internal and external), floppy disks, CDs, DVDs, flash disks, and magnetic tape.

In addition to these devices are the processing components of the computer – the main processor of a computer is referred to as the Central Processing Unit (CPU).

E-learning inevitably means using computers and their peripheral devices of many different kinds:

- Desktop computers have been the mainstay of the computing world for more than two decades, and typically require a keyboard, mouse and monitor to be attached. Laptop (or notebook) computers, on the other hand, are lighter and a lot more portable, and include the computer, monitor, mouse and keyboard in the same unit. The provision of rooms full of desktop computers for students is already changing in favour of students using their own laptops, and students using laptops in lectures is increasingly familiar. This, however, does raise concerns of students using their laptops to communicate with each other or outsiders, and not attending to the lecture. In addition, students may use their laptop to instantly reference an item raised in the lecture, and use it to challenge the lecturer – see Mike Wesch's YouTube videos (http://www.youtube.com/watch?v = dGCJ46vyR9o) for fascinating perspectives on issues such as these.
- Handheld devices include mobile phones and PDAs as well as music players and GPS devices. The use of some of these devices for mobile learning (m-learning) is more fully explored in part 1 of this guide.
- The use of data projectors and interactive whiteboards in educational activities has already changed the teaching environment in many schools worldwide.
- Computers can be linked to each other, forming networks of computers. These networks allow for the sharing of devices (such as printers), and also allow for communication amongst computer users.
- The Internet is essentially the inter-connection of networks, allowing users on one network to communicate with users on another. (Although it is possible to connect directly to the Internet, without going through a small network.)

The Internet, then, is the physical architecture of the computers and the links among them.

- File Servers (or, simply 'Servers') are the computers that run the networks, serve web pages, store large quantities of content, run databases and underpin the Internet. Although learners and teachers don't use servers directly, almost all of their work in the e-learning environment is mediated or afforded by servers in some way or other.

Software

Software covers all the programs and tools that run on computers. There are many kinds of software including:

- Operating systems – these are the underlying programmes that interact directly with the hardware. There are three main operating systems: Windows, Mac OS and various flavours of UNIX (Linux, BSD, RedHat etc). Mobile devices also have operating systems (Palm, Windows Mobile and Symbian). Typically, software developed for one operating system won't run on another, although these differences are decreasing over time as standards in physical compatibility using common connectors, such as USB, FireWire, Bluetooth, Wifi, and RGB, and common file formats such as .rtf, .pdf, .jpg, .mp3, allow much greater compatibility between systems.
- Productivity tools include word processing, spreadsheet, database and presentation tools, the most common of which is Microsoft's Office suite, although there are a number of alternatives, including Open Office (http://www.openoffice.org). Using open formats such as rich text format (.rtf) rather than Word's .doc or .docx formats does not limit the end user to the one proprietary application.
- Organiser tools include calendaring, address books and note-taking. Applications such as Microsoft's OneNote are excellent tools for recording, taking notes and integrating the two during lessons or tutorials (http://office.microsoft.com/onenote).
- Multimedia – these are the tools that play music and podcasts, such as Apple's iTunes, movies, DVD-ROMs and other audiovisual applications. iTunes is increasingly being used for educational purposes as well as entertainment through activities such as iTunesU and managing pod- and vodcast catalogues and subscriptions.
- Games are a huge part of the software market, both for dedicated consoles like the Wii, Xbox or Playstation and for regular PCs and Macs. Educational games for medicine are somewhat limited although some important work has been done (see http://summit.stanford.edu/pdfs/virtual_worlds_ts.pdf).
- The World Wide Web (or Web) is not a piece of software as such, but is rather a set of protocols or technical descriptions of communication. The Web is usually accessed through software called a web browser, such as Microsoft Internet Explorer, Firefox Safari, Opera and AOL. Increasingly, services such as VLEs are run through web browsers which make them system-independent. From an educational perspective, unless you provide a standard

machine to your students, you should expect them to be using different operating systems and you should ensure that your materials and tools run well on all the main platforms. In this light, courses and their associated materials should always be tested on different browsers, especially if making use of any special features, such as JavaScript, Java or multimedia. Today, at the very least, your course should be able to run in both (Windows-only) Internet Explorer and (multiplatform) Firefox.

- Plugins or enabler programs are small pieces of software that allow your web browser to run more esoteric kinds of content, such as specialised video and sound clips. Care, however, should be taken when using any of these 'third-party' tools, as they may produce unexpected results on different computers. While many media players, such as Flash and Acrobat (for PDFs), are now common, be wary of using more specific tools that need to be downloaded and pre-installed, or uncommon third-party tools.

- In addition to the web browser, there is a plethora of software that allow users to access various Internet services – these include email, Internet telephony (IP Telephony or VoIP), instant messaging, webcams and news readers. Each function has a number of associated tools such as Microsoft Outlook for email, and Microsoft Messenger or AIM for instant messaging.

Space

Although e-learning is, in many ways, about defying situated activity, there are always people at the end of the wire, and they need the right kinds of space, whether they are individual remote learners or on-campus students. Several issues need to be considered:

- Networking connectivity and electric power are essential to e-learning, as computers cannot function online without them. In an environment that expects students to use their laptops, power outlets to allow these laptops to stay charged are essential, as is some sort of access to a network.

- Storage and security is important where laptops and other devices are to be left or used around other people. Computers, monitors and keyboards in student computer laboraties or computing clusters, are typically tethered to prevent theft, while laptop users should be given secure locker space that is large enough to hold a laptop. Storage lockers with their own power outlets are particularly useful, as the laptop can be charged while in storage.

- Health and safety is a key concern for any kind of device being used by one or more individuals. Health and safety includes ergonomic issues such as appropriate seating, posture and lighting, and avoiding common injuries such as carpal-tunnel syndrome or repetitive-strain injury. Health and safety should be a priority at every stage along the e-learning journey, and students should be provided with facilities or training and orientation in support of their e-learning activities. See http://www.safecomputingtips.com for more details, advice and guides on health and safety issues associated with computing.

Access speeds and bandwidth

For e-learning to be effective, students need to be able to access material quickly. The speed at which material is accessed (or 'downloaded') is determined mostly by the type of connection from the student's computer to the network, and, ultimately, to the server from which the material is being downloaded. There are two types of connections:

- Cable -,the device is connected via a cable to the network. This includes the typical institutional 'ethernet' networks and the home modem, which uses wired telephone lines to connect. Increasingly fibre optic cables are providing ultra high speed network access.

- Wireless – the device is connected to the network without cables. Connection types include Wifi, Infrared, Bluetooth and radio-frequency identification (RFID) - used to protect store goods or tag patients or drugs in hospitals). The mobility of wireless provides a distinct advantage over cable connection, although speeds of connectivity are generally lower than cable connections. Wireless is typically just one step between the user's device and a network hub, with the data being moved by cable networks thereafter.

An associated issue is bandwidth. Bandwidth is essentially the amount of data that a given medium, such as a cable, can transfer in a given time. It is usually measured in bits or bytes per second. A rule of thumb is that more is faster is better. Because e-learning requires connection between students and staff, it is important to note that, simply because the teacher may have fast access at the university, this does not mean that students will have the same speed or breadth of connectivity at their place of study – the slowest connection may determine the quality of experience or efficacy for everyone

In addition to the impact of the actual connection, there is the impact of different types of materials or files that you require your students to access for their e-learning. Different activities will require greater or lesser bandwidth, typically related to the kind of media or files that are being exchanged. Although file sizes can vary tremendously, the smallest files are usually text-based materials, including standard web pages (html), text files (.txt, .csv, .xml, etc.). Binary materials, (such as word processing documents, spreadsheets, small data bases, pdf files (without images), and PowerPoint presentations with no images), tend to be larger. Larger still, are images, small sound files (.mp3), small videos (.mpg; mp4), and PowerPoint presentations with images. The largest files tend to be large sound files and large video clips.

There are many exceptions to this description, including massive databases or very small images and videos, but, as a rule of thumb, the larger the content to be transmitted the slower the activity will be. The particular choice of media (and, as a result, the bandwidth that the tutors and their students require) will be dictated primarily by the educational goals, but the required bandwidth should always be considered. This is especially important for distance education, or if your course is to be available to students in developing countries whose bandwidth (when they can connect at all) is typically low.

One solution to the bandwidth problem is to provide learners with a CD or DVD of the large files so that they can be loaded locally, rather than transmitting them online when the

students need them. Another option is to make sure everything is as small as it can be. There are various programmes that can reduce the size of files, without compromising much on quality. Images can be shrunk significantly by using the JPEG format, although you should be aware that more data is lost the higher the compression, although for the most part, this is imperceptible above 60%. Some examples are:

- Audio files can be saved in MP3 or AAC format to reduce their size – see Part 1 of this guide on podcasting.
- PowerPoint files can quickly bloat with embedded images and other media. Tools such as PPTMinimizer and Impatica can be used to reduce the size of such files.
- Videos may be the biggest files of all. Tools such as ImToo 3GP Video Converter (http://www.imtoo.com/3gp-video-converter.html) and Acala 3GP Movies Free (http://www.cutedvd.com/html/3gp_movies.html) will convert most video files types into much smaller file sizes, and the free iPod Video converter (http://www.ipod-video converter.org) for Windows or Handbrake for Mac (http://handbrake.m0k.org) will convert most video types to iPod format.

As an alternative to sending whole files, both audio and video can be 'streamed,' providing enough data to start playing, while the rest is sent only as the file plays. There are a number of streaming technologies including Real, QuickTime and Flash.

Barriers

There are many intentional barriers, typically relating to security and resilience of technical systems, including firewalls, passwords, encryption and restrictions on specific computers ('IP specificity').

Firewalls are applications designed to limit the kinds of traffic between a local network and the outside world, and can restrict users' access. Most systems have some kind of password access, and single-sign-on approaches (through which users authenticate once to multiple systems) are becoming increasingly common. In many cases, this is extended to devolved authentication, where consortia allow access to subscribing systems using technologies such as Shibboleth. A second function of firewalls is the blocking of specific file types (e.g. .zip, .mp3, .mp4) – either because they are deemed a security risk, or deemed 'non-educational.' In much the same way, access to many sites (such as Facebook or YouTube), may be blocked or restricted, because they are deemed 'non-educational,' even though they may be used for educational purposes.

In some circumstances, these may become unintentional barriers, for instance, students' being prevented from accessing university learning materials from a hospital network. Working with the network administrators in advance can ensure the Firewall settings are such that the students can access what they need while not weakening the over-all security of the hospital network.

E-teachers and e-learners need some technical knowledge to be functional in an e-learning environment, although this doesn't need to be particularly in-depth. It is somewhat equivalent to the amount of mechanical knowledge drivers need to keep their cars running – basic literacy, with experts filling in the rest. It will therefore be to your advantage to have a good working relationship with your local educational technologists, and for your general IT support staff to have a keen understanding of your needs and aims.

Users

As discussed in Part 1 of this guide, e-learning implies at least two kinds of users: e-teachers and e-learners. Apart from the technical issues discussed above, there are other issues more directly related to the users that need to be addressed for a smooth-functioning e-learning environment.

Accessibility and usability

Before technology can be used, it needs to be accessible to its potential users. This is not merely a matter of access to sufficient quantity and quality of computers or the necessary environment. It is also about accommodating the many different abilities and disabilities that learners may have.

There are many technical issues to be considered when ensuring that course materials are accessible to a wide range of students. These issues, however, all have viable solutions. A good starting point to check the accessibility and usability of your course is '50 Online Accessibility and Usability Tools' at http://www.avangate.com/articles/usability-tools_83.htm which looks at colour, content, browser and other tools allowing you to effectively assess accessibility; see also http://www.techdis.ac.uk for more information.

In many instances, e-learning students see the course, but not the tutor. The overall layout and design of the online learning environment must, therefore, be as intuitive and simple to understand and use as possible. Students do not wish to spend time trying decipher what you meant, or where things are; they want to get on and learn. Stick to basic conventions, don't concentrate on being fancy and 'different,' as it can cause problems. See the section on design considerations below for more on ensuring your educational materials are more effective.

User skills and literacy

Assuming that the e-learning environment is both accessible and usable, the next technical consideration is whether the specific users in mind have the requisite skills to use it. There is an often-made assumption that all current undergraduates have the required ICT skills to harness the material in an online course, and that many teachers do not (Prensky 2001), but this can be an inappropriate position to take; not all youngsters like computers (just as they don't all like music or football), and many of those that do, may have honed their skills in limited areas such as game-playing and little else. In reality, you cannot assume expertise or even ability (Ush Kiran et al. 2004; Oberprieler et al. 2005). Often, students themselves over- or underestimate their own abilities, typically following social stereotypes; males and younger people tend to overestimate while females and older people underestimate their abilities.

In order to assist your students, it is useful to run a self-assessment exercise based on the skills required for that course so that students' true abilities may be known both by the student and the teacher. After that, based on the identified abilities of the assessments, the teacher can derive different interventions, such as explanatory notes, references to other sites, or a more detailed computer-literacy course.

Even though some of e-learning's most fervent supporters are teachers, the average teacher might still be relatively inexperienced. This is due both to their responsibilities in organizing the learning environment on behalf of their students, and because many may not have been e-learners themselves. The key here is developing teachers' confidence and literacy as to how e-learning can be best employed in their own practice. One of the best approaches is to allow them to experience what is like to be an e-learner firsthand.

Technical support

Technical support is an essential part of any e-learning environment; things need maintaining and, as with any technology, problems occur and need solving. Individual course convenors are not usually required to perform this, as it should form part of the institution's overall IT support structure. Supporting your users, both students and teachers, can involve:

- Orientation support – providing your users with the tools to get started in the e-learning environment. This may involve user guides, training sessions or a test or 'sandbox' version of the tools to let them get used to the environment before using it in anger.
- Documentation and frequently asked questions (FAQs) should be available to help users as they work through the e-learning environment. Preparing such materials can be onerous, so one way to make the process easier is to get the learners to create their own guides as they work online.
- At some point, problems or queries need to be dealt with by a human being. In these circumstances, a helpdesk function should be available. This is typically via email or a web page form, or telephone (especially when the problems prevent the user from access the Internet).
- An important consideration for the institution is the availability of support 'after hours,' especially given the fact the online learning promotes 'anywhere, anytime' access. This, however, does have cost implications.
- The extent of user responsibility is also important, as handholding users can be a bottomless pit and may be educationally counterproductive. Ideally, support should enable users to increasingly support their own needs, but it is important to not push users beyond their limits, or the difficulty of implementing e-learning may appear to be an insurmountable barrier.
- Resilience and backup support is also a critical factor. Most courses that are housed on a file server will be backed up with the institution's backup procedures. You should confirm with your IT support that this is occurring, and that files can be recovered if needed. It is also a good idea to keep your own data backups.

- While most servers will be secured through the institution's security policies, your own computer may also have copies of examinations, tests, marks and so forth. It is also possible that you are carrying this information on your laptop, on CD/DVD or memory stick. You are strongly recommended to make use of encryption software for the storage of such data (at the very least, make use of passwords that are standard with many packages). Appropriate working practices, such as only holding copies of such data on need, and carefully limiting access are also important steps to take (see http://www.isfsecuritystandard.com).

There are cost implications for support, and these are looked at in a little more detail in the later section of economics of e-learning.

There is no doubt that the technical problems have to be carefully considered in e-learning, but almost all of them can be over-come with a little thought. Neglecting the human dimensions of technology use in e-learning is a sure recipe for disaster.

Politics and psychology of e-learning

The defining presence of technology in e-learning can tend to blind users to its political, social and psychological dimensions (Nardi, & O'Day 1999). Despite this, these dimensions are significant indicators for successful implementation of e-learning, and, as such, they need careful attention to ensure they assist rather than retard its progress.

E-learning tends to change the political climate of education by 'flattening' the previously hierarchical relationships between students and tutors (in an online discussion, all contributors 'look' the same). E-learning also allows students to more directly organize and become more active in the organization of their education by providing shared communication tools, or it may change the power distribution to new media models based on information literacy and facility. As an example, consider the situation where students have more fluency or confidence within the online environment than the teacher does. In this kind of situation, the teachers' authority can be seriously compromised by their perceived lack of ability or control within the environment. Interestingly, there is some evidence to suggest that many students value online activity less than face-to-face methods (Joint Information Systems Committee 2007) a theme more widely identified as 'economies of presence' (Davies 2006).

The plurality and closely interlinked professional roles associated with e-learning also changes the political dynamics of the learning environment. The use of educational technology has increased the importance of the educational technologist. It has been shown that these professionals need to be well aligned in both action and attitude to the contexts in which they work to be truly effective (Ellaway et al. 2006). The impact of other factors such as gender, culture and language on e-learning has also been considered (Savicki et al. 1996; Barrett & Lally 1999; Herring 2000; Collis & Moonen 2001; Masters & Oberprieler 2004).

An even bigger, though often overlooked, component, is the degree of autonomy and control afforded the learner, teacher or institution in the setup and function of the environment. Although any given technology may be used in different ways (a pen doesn't determine what it writes), technologies are essentially designed, and, as such, the designers pre-emptively control every aspect of what the technology can and cannot do (Scarborough & Corbett 1992).

From a psychological point of view, there are clearly many different theories and models of learning, and just as many ways that e-learning is based on them (Crook 1994). A review of educational theory could fill a whole guide in its own right, so the following review is intended to serve as a springboard for further consideration:

- Behaviourist approaches focus on instruction and transfer of knowledge – in an e-learning environment this is reflected in a focus on e-learning content, reference materials and didactic approaches to learning that typically involve the learner in relatively passive modes of action.
- Constructivist approaches focus on internalised processes of building new learning on top of existing learning, which, in turn, require exploratory approaches with the learner afforded significant autonomy to find their own understanding. From an e-learning perspective, constructivist approaches focus on interactive materials such as virtual patients, reflective activities such as those associated with portfolio building, and inquiry-based learning such as e PBL (Savin-Baden and Wilkie, 2007). Social approaches consider learning to be socially mediated and constructed and based around active participation and discourse. From an e-learning perspective, this implies activities built around discussion, chat or conferencing tools (Salmon 2000, 2002).
- The social dimensions of e-learning arise from the ability of users to interact in many different and parallel ways. While the social (and socializing) dimensions of education are tacit (and typically unnoticed even by those involved), they are more apparent in the online educational environment, particularly by their absence. Even though students are in physical contact with one another, they will still tend to spread their social engagement into all available media (de la Varre et al. 2005). Increasingly, many effective aspects of e-learning are being modelled as essentially collaborative and social (Laurillard 2002).

The broad effects of e-learning also means that a much wider range of political, sociological and psychological factors are likely to impact on your course. Rather than creating conflict, however, these should be understood and utilised to add richness to your teaching approaches. Teaching and learning does not exist in a vacuum.

Legal and ethical issues in e-learning

E-learning can involve personal issues (such as the 'netiquette' of online discussion), systematic issues (such as professional responsibilities within an online educational environment for students, teachers and all associated support staff), and legal issues (such as respecting intellectual property rights (IPR) and patient consent for use of educational materials).

The move to online working reifies much that was previously ephemeral; interactions are recorded and replayable, and, as a result, distance and time present significantly lower barriers to access and participation in educational processes. At the same time, much that was intrinsically physical has become much less so; print, images and recordings are now typically electronic files rather than physical artefacts. The ability to track and record students' and staff activities also means that many more individuals can view what students and teachers do online, far more than they can in a face-to-face environment. This heightened visibility and the resulting increase in scrutiny and accountability marks a major change in the freedom and responsibility of action of all concerned.

Identity

If users are not physically collocated, then how can their real identities be assured? Not only is this an issue in formative environments such as discussion boards, but it also presents a major problem in e-assessment where impersonation and unseen help need to be rendered impossible or irrelevant. Given these concerns, online educational environments are typically more constrained as regards digital identities than in other situations. Interestingly, the use of virtual worlds such as SecondLife, and in particular, their use of avatars, presents quite new challenges to personal and professional self-representation and the perception of others.

Plagiarism

The Internet has made sharing and copying of electronic content (particularly text) incredibly easy and fluid; with the result that e-assessment is significantly threatened by plagiarism. This problem is exacerbated by online businesses that are willing to sell pre-written coursework to students. Plagiarism and cheating, of course, have been with us for a long time, and the online environment somewhat inevitably now includes plagiarism detection services such as Turnitin (http://www.turnitin.com) or EVE2 (http://www.canexus.com) that can rapidly compare sections and patterns of text to those in its database of other students' work and the text on the Internet as a whole. Some VLEs (such as Blackboard) include their own rudimentary anti-plagiarism services. For a longer-term solution, changes in academic assessment should be considered, so that the production of text is replaced with something more personal and performed, such as vivas or OSCEs.

Access

There are clearly major issues regarding access at all to the e-learning environment (authentication) and access to different services and resources within the environment (authorisation). Although these are, in many ways, technical issues, this does raise the question of roles within the environment, as well as issues regarding personal access and privacy. While there are technical fixes, such as directory services, security 'hardening' and automatic timeouts and logouts, the weakest

link is still human. For instance, many students lose or give their passwords to colleagues or use 'weak' passwords (real and short words) as opposed to 'strong' passwords (made up of a non-word combination of letters and numbers). This is also a key professional issue, as security-awareness is an increasingly essential competency for any healthcare professional. Good security practices should be a part of any contemporary curriculum.

Copyright

Students and staff often recklessly use material without the copyright holders' consent. Common examples are PowerPoint presentations with images from films or TV programs, or scans of material from books or journals. In some cases, this is permitted for the purposes of the presentation (under fair use in the US, for instance), but in most cases it is not. More serious is the practice of supplying slides or printouts to the audience either as printouts or as the originals files, or webcasting or recording presentations for later transmission. This practice almost certainly contravenes copyright, as it is, in essence, republishing copyrighted material. Obtaining copyright clearance can be very time-consuming, but is essential if the presenter wishes to remain both legal and ethical in their work.

An often-overlooked consequence of copyright abuse is the message it sends to students. Abiding by legal structures, including copyright, is a fundamental student competence and attitude, and, if teachers and tutors are seen or perceived to breach it at will, this sends the wrong message that respecting copyright is unimportant. The legal situation regarding this kind of use varies significantly between legal jurisdictions. For instance, 'fair use' in the US gives much more leeway than in the UK or Canada. Nevertheless, the awareness of and ability to work within copyright and IPR regulations is an essential professional competency for any contemporary professional.

The principles of openness and collaboration that underpin the Internet have led to the resurrection of ideas of the commons, an open resource or set of resources held in common by a community. Perhaps best known is the Creative Commons licensing model that defines a continuum between full copyright where all rights are reserved by the originator/holder, and the public domain, where no rights are reserved, and the artefact is freely available. The success of Creative Commons depends on its few simple licensing parameters, which allow it to have different underlying licences cast in differing national jurisdictions, while retaining the original intent intact. Increasingly, materials are being licensed for free use and reuse under Creative Commons licences (http://www.cc.org). Examples include much of the extensive HeAL repository (http://www.healcentral.org), the PocketSnips videos (www.pocketsnips.org) and ReHASH (http://www.elu.sgul.ac.uk/rehash).

Confidentiality

Data protection and confidentiality are essential aspects of any information environment or enterprise. As a rule, personal and

sensitive information should be held only where really necessary and it should be accessible only to those with a direct need to see or use it. For instance, teachers typically need to be able to see student names and email addresses, but not their home addresses, birthdays or financial status. Related to confidentiality, is the issue of consent: a particular concern associated with using clinical materials for teaching and learning while ensuring the original terms of consent continue to be met (Ellaway et al. 2006). This affords a perfect training opportunity for the aspiring health professional who will, no doubt, end up working with confidential medical information at home or on the road. Many remote connections to secure and confidential systems such as hospital information systems for learners are now being managed using a secure web browser connection using technologies such as Cirtrix (http://www.citrix.com).

Tracking

As mentioned above, tracking, monitoring and observation are significantly easier online and are normative to this medium, as every click and gesture is recorded somewhere. This has raised a number of concerns regarding the extent and use of such scrutiny (Land & Bayne 2004). Interestingly, the high stakes associated with healthcare education means that this factor is of particular importance in ensuring the quality and safety of students and, while tracking may be seen as invasive in other subject areas, because health professionals typically work in a climate of scrutiny and accountability, tracking is often accepted more readily than in other subjects.

Validity

The validity and applicability of educational design and process is an often overlooked, but essential, ethical issue; are our requirements from students appropriate for the domain, the required outcomes and the level at which they are working? In e-learning, we need to consider whether the quality or quantity of online discussion is an appropriate assessment metric, whether providing PowerPoint slides is really educationally valuable, or whether we should allow for differing levels of technical facility.

In this information age we all have 'data shadows'; records about us in various databases (doctor, banking, social security etc), and, as systems become more automated, the data shadow increasingly becomes a proxy for the individual. In terms of e-learning, we should be critically aware of whether we consider what a student does online represents the whole of their abilities. Medicine is still a physical, performed and embodied set of practices, and, as such, the online part of healthcare education needs to be carefully linked to a holistic view of both the student and their developing practice.

Equity

One last issue is that associated with cost, equity and value in an e-learning environment. We consider the economics of e-learning more fully below, but from an ethical and legal perspective, issues such as shifting costs from the institution to

the student (for instance, through having to buy computing equipment or pay for printing), the balance between investment in the online and face-to-face learning environments, and the real added value in any e-learning intervention should be considered carefully. The interrelationships between the physical and the online is increasingly blurred, with physical learning environments changing to accommodate e-learning, by, for example, providing wireless enabled social spaces in place of the serried ranks of student computers of just a few years ago.

The legal and ethical aspects of e-learning can be a minefield of trouble if not taken into account properly. There are, however, tools and services to assist you, and institutional policies and guidelines should apply to both traditional and e-learning. Finally, the teaching of these issues will be fundamental to your students when they are practising health professionals, so most of these present ideal learning opportunities for them.

Economics of e-learning

Healthcare education in the early twenty-first century faces many economic challenges: ongoing social and political pressure to provide greater numbers of high quality health professionals, which also involves broadening the applicant demographic to include under-represented social groups, ever-increasing financial pressures on medical schools (particularly relating to salaries and estate), and the ever-present pressures of supporting and responding to quality assurance and audit. E-learning has the potential to help address these and many other economic challenges, but at a cost. The economic realities of computer-mediated healthcare education should, therefore, be carefully considered alongside their educational and other merits and shortcomings. For some, this means asking whether they can afford to implement or sustain an e-learning intervention or indeed whether e-learning is viable at all. For others, given the pressures faced and the available alternatives, it is more a question of whether they can afford not to adopt e-learning methods and tools.

Economic models

There are many different approaches to economic analysis, including:

- Purely fiscal approaches, which include employing balance sheets to evaluate foreground budgeted costs, such as salaries and equipment, stakeholder models that look at the spread of costs among different stakeholders (students, teachers and organizations), and total cost of ownership (TCO) models where background costs, such as infrastructure and utilities, are also included. Savings or income resulting from the intervention should also be included.
- Comparative metrics, such as unitary costs of student activity or achievement, can be used to compare one intervention to its alternatives in order to find a more optimal solution to a given problem. For example, a face-to-face intervention may cost X per student while e-learning alternative may cost Y, the comparison thereby supporting-

decision making and planning in advance of use, or evaluation and audit following an intervention.
- Impact analyses, such as environmental scans or return on investment (ROI) studies, take a wider, more holistic view of an educational environment and the effect that an intervention will have or has had within it. For instance, the move to placing course materials online has often had a negative financial impact on students, as they pick up the costs of printing, previously covered by the institution. The return on investment for a particular application would need to consider both the quantity and quality of the educational impact.

Economic advantages

E-learning has many economic advantages over face-to-face learning:

- Scalability: an online educational activity will usually scale much more easily than a face-to-face one, particularly if the educational design requires little or no interaction with tutors. On the other hand, if a tutor is needed for every 'n' students, then scaling economies may be significantly reduced. One should also remember the underlying principles of medical education, and e-learning, and guard against simply broadcasting information at learners without any attention to individual problems or needs.
- Diversity and retention: electronic media can track and even adapt to different student cognitive styles and approaches to learning, thereby better accommodating variations in modes of delivery and instruction. This is typically seen as a way of supporting the recruitment and retention of diverse student backgrounds. Meeting student expectations of online support is an increasingly important factor.
- Business integration: systems integration with the other information systems in an organisation can allow for single master copies of student data to be used across the enterprise, and fast and global updates to be made from a single entry, thereby ensuring that students are allocated to the right courses and receive the right information, materials and instruction.
- Reification and tracking: whereas many traditional teaching and teaching resources are only locally held and accessible, online systems afford much greater access and scrutiny, as well as being able to record and archive events and resources. As a result, institutions can more directly ensure and retain the materials and activities that their teachers use.
- Access to remote learners is also a major factor for those institutions wishing to expand or tap into more sources of income. This might mean true distance learning with students rarely, if ever, physically attending the home campus, as they conduct their entire studies at a distance, online. Alternately, it might be a more distributed model, setting up satellite bases or sites that may mirror the centre or pursue various levels of devolved programmes from the core.

Economic costs

There are many sources and forms of cost in e-learning. Many of these, however, already exist in modern education

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institution, even those not directly involved in e-learning. Cost items include

- Hardware: including servers and terminals (computers, laptops, PDAs etc) as well as peripheral input and output devices such as, printers, scanners, cameras, and data projectors. Many students and staff now also use storage devices in the form of memory sticks or similar portable compact drives.
- Software: including both e-learning-specific software, such as educational content and instructional systems, more generic business systems such as administration, finance and personnel, and generic tools such as productivity (word processing, database, spreadsheet) and communications (email, web, messaging) tools. Other software costs can include licensing e-journals or online copies of books and upgrades to existing software.
- Personnel: e-learning requires both specialists (programmers, technicians) and generalists (subject specialists, educationalists). Roles may interweave, but will include developing, implementing, supporting, and evaluating e-learning as well as background tasks such as user technical support and network and server administration.
- Infrastructure: including physical space (for computer laboratories, server rooms, staff accommodation), networking (both cable and wireless) to the local area network and/or to the Internet, storage, backup and archiving, authentication and identity management, and training and staff development.
- Consumables, such as paper, toner, ink, storage media (CDs or DVDs), and the often overlooked consumable cost of the electricity required to make all computing equipment work.
- Less tangible costs associated with e-learning include dealing with risk (such as legal costs associated with legal action resulting from breaking copyright), contingency (for instance against critical system failure), change management (dissemination of new techniques and working practices), productivity and morale.

As with any enterprise, the cost profile of e-learning can vary over time. Start-up costs may be particularly high if content and/or tools need to be developed or purchased, or lower if the new course or programme reuses existing materials. Operational costs will vary depending on the amount of support students and staff actually need; some e-learning courses can run with no human support at all, and can, therefore, be very economical (although often less enjoyable). Sustainability costs may also vary depending on what needs replacing or updating. For instance, content may need to be more regularly updated in genetics than anatomy, a course that becomes very popular may need extra server capacity, and all technologies need to be replaced or upgraded at some point or other.

Human costs

The more social and cognitive economics of e-learning include:

- Impact of face to face contact: as more and more of the student's experiences are mediated online, the

opportunities for face-to-face interaction with peers, tutors and (specifically for healthcare education) patients become more important and valued. These 'economies of presence' (Davies 2006) are part of negotiating the 'blended learning environment,' a holistic model of the new and old media by which education is conducted. Negotiating this blend of on- and offline contact, and finding the appropriate economies of presence is a growing challenge for all concerned in contemporary education (Clark 2003).
- Materials' development: an often neglected cost is that associated with a dependence on the essential activities involved in clinical staff creating e-learning materials. Institutional reward and advancement models are typically built on face-to-face teaching, whereas e-learning, which is typically temporally and spatially disconnected from learners, is often not recognised or counted towards contact time, and receives relatively little institutional support. Faculty/staff development in keeping clinical staff informed of developments in the online educational environment also has ongoing cost implications.

Information technologies are particularly volatile and subject to frequent change and resulting incompatibilities. Although the effect of this change is gradually stabilising, it has left many with a sense of unease and risk associated with e-learning. While some investments in physical facilities (such as tutorial rooms) may last, say, 10 years before refurbishment, their digital equivalents may last half or even a third as long, and then need to be completely replaced. This reinforces the importance of sustainability, archiving, interoperability and appraising return on investment, as a part of any plan for implementation or evaluation of e-learning use.

Commercial, open-source and DIY solutions

In part 1 of this guide, we dealt briefly with the classifications of VLEs as propriety, open-source, or home-grown. We return to this issue, but examine it in the context of the overall technology system employed at the institution.

There are several alternative models for acquiring learning technology systems, each of which has an associated economic model:

- Technologies or services may be bought in. For some kinds of product (particularly software – because copies can so easily be made and distributed), the transaction will involve the purchase of a licence that sets out the terms and conditions under which it can be used. This is typically in the form of an end user licence agreement (or EULA): if you have ever clicked 'agree' when installing software, then you have acceded to a EULA. An alternative to an outright purchase is a leasing model where a lower, but ongoing, payment is made. Many large e-learning companies have a mandatory ongoing support charge, which, in effect, amounts to a leasing arrangement.
- Technologies or services may be in-sourced (passed to a separate contractor within the organization) or out-sourced (passed to a contractor outside the organization). For example a software company may develop a tool, provide paid support for an open-source product (such as

Moodle) or provide application hosting such as Google Mail. Care should be taken to ensure that the contractual arrangements, liabilities, support arrangements and other structures are well thought out and in place before taking on such a commitment.

- Although the in-sourcing model is attractive, care should be taken to ensure that the service provider does not become a monopolistic 'company' within the university infrastructure, having the power to dictate equipment, procedures and processes to teaching staff. That situation allows it to charge near-market-related prices, while having many of its costs (human resources, buildings, electricity, etc) covered by the university. The aim of in-sourcing is not to earn a profit from other sectors of the university; the aim is to reduce the overall cost of the business of the university – teaching and research. In-sourcing agreements should be reviewed as carefully as out-sourcing agreements. If the in-sourcing charges are to be market-related, then the outsourcing model should be fully explored.
- Some technologies or services may be free or open-source in origin. The difference between these two concepts is subtle, but the general principle behind open-source is that the code base is available for further development, while free software is just that, free at source. Although some open-source software is free, it may also be commercial (such as Blackboard's Building Blocks), and much free software (such as Skype) is not open-source at all. While the benefits of most open-source software include a zero purchase cost and the ability to adapt the software, the downsides include a lack of warranty or liability and a need for skilled staff to setup and adapt the tools.
- Technologies or services may be built by their users, the organizations that use them, or as part of a joint activity or project between a number of user organizations. While these home-grown or 'DIY' efforts were the normal (and often the only) way forward for many years, the development of a substantial e-learning systems industry has turned this route into the exception rather than the rule. Nevertheless DIY systems are still commonly used in healthcare settings, particularly where the needs of the curriculum or program do not align well with what is available off the shelf (Ellaway et al. 2003; Cook 2005).

Typically, most environments combine a mixture of these approaches – for instance an institution might use a commercial VLE, an open-source portal and a locally built assessment system. The viability of these hybrid environments has been afforded by the development and widespread adoption of learning technology standards and specifications.

The economic impact and viability of e-learning must be considered in terms of its costs and effectiveness. There are many ways to evaluate the economic impact and the choice of method must reflect the question posed.

Design considerations for e-learning

All e-learning is in some way designed. In other words, all educational technologies have affordances and usage constraints that arise directly from their designs.

At one level, e-learning design needs to accommodate the principles and practice of human computer interface (HCI) design (Preece et al. 1994; Friedman 1997), including usability (Nielsen 1999; Krug 2000) and psychology (Norman 1988; Carroll 1991). A key dimension of usability is accessibility, especially for learners with reduced sensory or cognitive function. Materials should (and increasingly are required by law to) be accessible and usable to the widest range of users. This may involve providing plain text equivalents to graphics, using high-contrast screen designs and carefully choosing colours and font sizes/faces (see more on this in the section dealing with students with disabilities).

Educational technologies, however, provide opportunities to expand the accessibility of learning materials in ways that are not easily done with traditional approaches. For instance, a teacher can reinforce a message by employing multimedia (such as text and graphics) in support of a key message. For an even more powerful effect, the text should be spoken as well as being available for the learner to read. At the same time, designs should ensure that what is presented to the learner is essential to the learning process, and not just decoration or filler, and, wherever possible, first- or second person narratives should be used to directly engage the learner in the activity (Clark & Mayer 2003). Such is the fine balance between under- and over-provision of learning affordances that quite subtle variations in what the learner can do within the e-learning environment can have quite significant impact (Garg et al. 2002). This may be the most important intervention you can make in the design of e-learning to improve its effectiveness (Norman 2007).

A useful way to negotiate this balance is by considering the cognitive load of e-learning activities or materials. The cognitive load of any artefact has been defined as having three dimensions (Clark et al. 2006): intrinsic – the cognitive load associated with the subject and level of study; germane – the load associated with improving educational outcomes; and extraneous – all that is not intrinsic or germane. Good e-learning designs should accommodate the intrinsic, boost the germane and minimise the extraneous cognitive loads.

Design guidelines

If you are designing and presenting any course, whether online or not, whether for undergraduate, postgraduate or CME purposes, there are a number of questions to be considered. Being able to answer these and take them into account during the planning stages of the course will ultimately result in more robust and sustainable courses. They include:

- Are the course objectives, schedules, and the required online time stated clearly, and is there an online learning guide, so that newcomers to e-learning will know what to expect?
- Does the design allow for the range of participant ages, genders, ethnicity and experience involved? If the course is run internationally, there will be even greater variability, particularly in the times of day that learners will be able to engage online, and the bandwidth available to do so.

- Are learners' learning styles and needs accommodated? For many, the idea of self-paced and self-directed learning is still new, and they may need a great deal of handholding. Others want the course to be highly personalized, targeting only their own needs. See http://www.learning-styles-online.com or http://www.personal.psu.edu/faculty/r/b/rbc4/dlp_aect.htm for more resources to help your planning.

- Is the course to be instructor-led, facilitated, or entirely self-directed and self-paced? Will there be formal meetings using chat rooms or video conferencing? Are they to be compulsory?

- Is there appropriate interaction? Do not make your course merely a set of lecture notes or journal articles. Interaction, in the form of quizzes, self-assessments, and interaction with other participants on the course is crucial. Simultaneously, however, many people prefer to receive their material in non-interactive pdf files, so these should not be ignored as a source of information.

- Will users need to use multimedia? Although the objective of education is not entertainment, an appropriate use of multimedia, including animations and video clips, can significantly increase the effectiveness of education (Marinopoulos et al. 2007). Technical issues, however, must still be taken into consideration (see section on technical issues for more on this).

- How modular is the course? Modular courses can sometimes be difficult to design, but are useful if you have several designers. Your students, who can complete sections as they have available time, also appreciate the modular design.

- May participants skip sections? If you trust your assessments enough, you may have a pre-assessment for each module, where a passing grade entitles the participant to skip that module. This is a useful tool for all participants, as it warns them about the level of the module. Sometimes, even those who pass will prefer to complete the module anyway.

- May participants temporarily exit, to return later? One of the advantages of online courses is their flexibility – this includes accounting for interruptions requiring the participant to leave the course temporarily. Returning to their exit point should be smooth and seamless.

- Will students be using some sort of logbook or portfolio? This is extremely useful, even if not for assessment, as it serves to remind your participants of their progress, and serves as an early warning to the tutor of learner problems.

- How will participants be assessed? Will you use MCQs, written assignments, portfolios, or other instruments and techniques? Will there be formative MCQ self-assessments that 'don't count' but which students may take repeatedly? If the course has modules, will participants be required to pass one module before progressing on to the next? If so, what becomes of those who do not pass a module?

- How will the course be evaluated? An anonymous, online questionnaire at the end of the course is the most straightforward. This should encompass the course and the participants' experience of the course, and should be a requisite of the course. The tutor should also follow up on those who fail to complete the course, because they might identify unforeseen stumbling blocks. If bulletin boards allow anonymous postings, then these can also be very useful for formative course evaluations.

- Once participants have completed the course, there might be other courses that they would like to take, especially if you see your course as part of a broader program of professional development. At the very least, there should a take-away resource pack that successful participants may use for their own studies and future reference.

Finally, if you are developing your course in conjunction with an instructional technologist or instructional designer (ID), you need to establish before-hand the respective roles, authority, and responsibilities. For example, is the ID in charge of the educational model, and you merely the deliverer, or are you in charge, with the ID in a supporting role, or are you equal partners? Not establishing this before-hand can lead to conflicts as the course evolves.

Students with disabilities

For teachers who have been struggling to make their teaching more easily accessible to students with disabilities, e-learning has opened a range of new possibilities. Although the physical requirements of healthcare practice limit the profundity of disability healthcare educators need to accommodate (Roberts 2002), making materials and services broadly accessible helps all users and concentrates the mind on how all learners experience their environment, rather than how the teacher intended things to be.

Some jurisdictions have specific legislation regarding access. If your country does not have such legislation, then some useful guides are:

- The US Americans with Disabilities Act (http://www.ada.gov/pubs/ada.htm)
- Section 508 of the US Rehabilitation Act (http://www.access-board.gov/508.htm)
- The UK Special Needs and Disability Act of 2001 (SENDA) (http://www.opsi.gov.uk/acts/acts2001/20010010.htm).

There are many assistive technologies that can support students with various disabilities including:

- Simple text-to-speech packages (such as ReadPlease at http://www.readplease.com) can be used to assist students who struggle to learn by only reading text – either because of learning disabilities or sight-impairments.
- Screen readers (such as JAWS (http://www.nanopac.com/JAWS.htm), Window-Eyes (http://www.gwmicro.com)), are more sophisticated tools aimed specifically at blind people who need to use computers. They have the ability to provide almost full functionality of the computer.
- Voice-to-text tools, such as Dragon Naturally Speaking (http://www.nuance.com/naturallyspeaking/) allow the user to type via voice dictation. These are especially useful for people who have physical disabilities or ailments such as carpal-tunnel syndrome.

To increase accessibility by students with disabilities, there are many simple things that one can do when creating e-learning

systems. These include:

- Ensure that all images, especially navigation buttons, have descriptive text in the 'ALT' (alternative text label) field. These descriptions are read by screen readers like JAWS and Window-Eyes.
- Be aware that the font size, colour and relative contrast of your materials or interface will determine its accessibility. For instance, be wary of using a range of colours, especially when coloured text is placed over different backgrounds. Ideally, text should be clear, high contrast and uninterrupted by other elements.
- If you are using multimedia such as voice-overs, ensure that the audio or video does not contain crucial information not easily accessible elsewhere.
- If you have colleagues or students with disabilities, ask them to beta test your course - you should, however, be willing to pay for this.

An excellent starting point for finding out more is the website of Equal Access to Software and Information (EASI – http://www.rit.edu/~easi). This site offer courses for instructors and hosts a range of valuable information.

Validity, domain specificity and alignment

The general issues of design and accessibility presented so far apply to a wide range of domains. There are additional design considerations for the specifics of healthcare education. The domain validity of the design should be taken into consideration, particularly its alignment with the intended learning outcomes. For instance, when teaching clinical skills such as inserting an IV line or a catheter, these skills can be greatly enhanced by the use of well-constructed videos. Students can access these videos in their own time, and watch them repeatedly as part of their revision and preparation for performing these skills in real life. In fact, there is a whole domain of medical informatics that maps directly onto using e-learning media and methods, often a missed opportunity for educators.

Domain specificity is also important as the language and terminology, the nature of discourse and other normative aspects of different professions need to be imparted along with the more explicit elements. This can be as basic as whether your VLE has a calendar, timetable or schedule function, through to more specific issues such as the way that attachments/rotations/carousels are organized, and the ways that relationships between teachers and learners are supported and/or encouraged.

Other design perspectives

In addition to themes already set out in this section e-learning design may also include issues around (Horton 2006):

- Modularity and reusability: the use of computers and the Internet makes sharing and reusing materials and tools easy and as such they afford unprecedented opportunities to make efficient use of educational resources of any kind. This can include creating or using reusable learning objects (RLOs) (Wiley 2000) and using repositories of reusable materials (Littlejohn 2003).
- Sequencing: the sequencing of concepts and materials has been shown to be critical in creating effective educational activities (Ritter et al. 2007). Sequencing includes issues such as cognitive load and constructivist theory but extends to include schema representation, task analysis and timing in activities and designs.
- Multimodal interaction: online environments are increasingly providing a range of tools that can be used simultaneously. Web conferencing systems such as Adobe's Connect (http://www.adobe.com/products/connect), Elluminate (http://www.elluminate.com) or Wimba (http://www.wimba.com) allow for educational designs that combine conferencing, chat, shared desktops, dynamic and annotatable content and the recording of whole sessions of learner interactions. The use of such environments presents new challenges around designing for learner autonomy and teacher authority, interdependencies between different modes of interaction and ho all of these relate to none-online activities.

Careful course design is not new to teaching. In e-learning, particularly because it is still new to many teachers, careful planning is crucial. Planning will allow the teacher to best make use of the functionality of your systems, so that they provide the best possible learning experience for your students.

E-learning research and evaluation

Despite several decades of research and development in and around the use of computers in education, its practices and techniques are fluid and subject to change far more than other aspects of healthcare education, and there is a strong dependency on ongoing research and development. The role of formal enquiry is not merely to create new ways of using technology in education settings, but also to evaluate its use and to understand the way we think about technology and education as a result. This work falls into either macro views of the context for e-learning such as systems, organisations and cultures, and micro perspectives that are concerned with individual learners, interventions and technologies (Conole & Oliver 2007). Enquiry may take the form of research (determining the nature of a phenomenon) or evaluation (determining the value or importance of a phenomenon) and may use quantitative techniques (controls, statistics and objective measurements), qualitative techniques (narrative, interpretation and experience) or increasingly a combination of the two (Oliver 2000).

Not only does research and evaluation help to develop and validate the use of technology in education, it also provides insights as to what technologies cannot do (Postman, 1992) and the nature of the technologically-mediated environment as a whole (Scarborough & Corbett 1992). After all, 'technological innovation is . . . at least in part a process of experiment and discovery; second . . . it both enlarges existing ends and alters our conception of them; third . . . this makes it a process of

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development which can throw up wholly new aims and purposes' (Graham 1999).

E-learning research in general covers a wide range of issues and perspectives including the context for e-learning, theoretical perspectives (both educational and cultural), policy and politics and technical and implementation design (Andrews & Haythornthwaite 2007). E-learning in healthcare education introduces a number of additional research opportunities, such as validity and representativeness of online mediated educational activities with respect to professional practice, and their alignment with their social, ethical and moral dimensions. There is also the peculiar balance in medicine between the medical professions' two foundations of technology (drugs, instruments, imaging, records) on the one hand, and care on the other. The relationship between e-learning and medical informatics is another area ripe for exploration and development. There is also much research conducted into the information revolution as a whole that is of great use to understanding e-learning, including consideration of political and economic factors (Castells 2000), organizational factors (Brown & Duguid 2000), and legal and ethical factors (Lessig 2001).

Despite the ongoing quantity and quality of e-learning research, we are still far from having all the answers; indeed, we often struggle to do more than refine and improve the questions we ask. A particular challenge for medical educational research is the domain's deep commitment to the positivist tradition that still tends to employ and value quantitative over qualitative methods. In these situations e-learning research has an essential role to play in the development of critical approaches to the ways education can be advanced or held back by technology adoption or rejection (Oliver et al. 2007).

Much of the literature, however, continues to be concerned with establishing essential differences between different approaches, particularly between online and offline analogues. Several decades of such research has consistently found little or no significant difference between media, so much so that a whole phenomenon of 'no significant difference' has been identified (Russell 2001), and is now being actively challenged (Twigg 2001). It is hoped that readers take this into consideration and widen their research questions to more fruitful, creative and productive areas of enquiry.

Although the relative lack of empirical evidence in e-learning can be disconcerting to the newcomer, it is also an ideal opportunity for those who wish to explore learning in a wider context.

E-learning standards and specifications

There are many kinds of standards that can be applied to e-learning. These include technical, legal, quality assurance, professional, ethical, construction and interoperability. Many of these have been addressed elsewhere in this guide, but, in educational technology circles, interoperability and the development of common standards and specifications has attracted the most effort and attention in recent years.

In the past, the focus of using computers in education was on developing novel and individual techniques, and understanding as to what e-learning meant and what it could (and could not) do. As e-learning has moved to become part of the medical education mainstream, issues of sustainability, economy and disposability have grown to dominate much of the debate and development in this area. To enable different systems to exchange resources (such as educational content, learner information or metadata), education technology standards and specifications have been developed by a number of international organizations like IEEE, ADL/SCORM, IMS Global, and MedBiquitous. Their impact on e-learning is not simply to create economies in which e-learning resources can be exchanged, but 'the development of standards and specifications for healthcare education can be both philosophically and practically challenging, requiring skills in abstraction, pattern-identification and codification of domains of knowledge and practice as well as the more technical skills of implementing the resulting models' (Ellaway 2006a).

Other kinds of standards and specifications that apply to e-learning include:

- technical standards as they pertain to the quality and structure of the technology. This can include coding standards, adherence to standards for a particular computer platform (such as Windows or Macintosh), documentation, and application modularity (allowing changes to some modules without affecting others). Increasingly, different systems are able to interact using XML-based web services such as news feeds and messaging.
- legal standards are encapsulated in the laws of any given jurisdiction regarding issues such as copyright, licensing, privacy and confidentiality. Trans-jurisdictional models such as Creative Commons are increasingly being used in support of more globalized digital economies, including e-learning.
- quality assurance of e-learning is of particular interest to managers, auditors and funding bodies looking to assure the efficacy of their investment in e-learning. The development of e-learning benchmarking is relatively new, but is becoming an increasingly common part of the e-learning mainstream – see http://en.wikipedia.org/wiki/Benchmarking_e-learning

The range of specifications and standards in e-learning can be bewildering. Most practitioners should be aware that they exist. There are also strong moves in the industry for a higher degree of co-ordination, interaction and inter-operability amongst the various specifications, so that movement between them can be as seamless as possible.

Healthcare education informatics

The case for the importance of alignment (Biggs 1999) and integration (Jochems et al. 2004) of educational enterprises is well established. For contemporary healthcare education, this should include informatics alignment and integration. Healthcare education informatics is a way of uniting the coincident domains, activities and services that can comprise

healthcare education and that need to be brought into better alignment, including:

- Learning and instructional design, such as online lectures and tutorials, problem-based learning, virtual patients, manikin simulators, electronic reference materials and discussion boards.
- Course administration and logistics, such as record keeping, scheduling, tracking, audit, quality assurance, transcripts, finance, health and safety, and human resources.
- Assessment practices (both formative and summative), including authoring and delivery, question banks, assessment metadata, item analysis, and data aggregation.
- Information, knowledge and resource management, including medical libraries, repositories of digital media (such as reusable learning objects), controlled vocabularies, metadata and cataloguing systems.
- Developing and working with interoperable standards, specification and systems including common data standards and specifications, web services, common architectures and modularity.
- Managing relationships between medical informatics and healthcare education informatics at a disciplinary level, as well as interrelationships between clinical information systems and education systems.
- Providing regal and regulatory support, such as consent, professionalism, accreditation, authorization, CPE/CME/CPD, revalidation, accountability, monitoring and credentialing.
- Conducting curriculum and educational development, including curriculum mapping, managing learning objectives and learning outcomes, and the representation of the ontologies and epistemologies they are based upon.
- Supporting learner-profile management, including portfolios, personal development profiles, lifelong learning support, logbooks, transferable skills profiles, reflective practitioner support and mentoring.
- Designing and managing educational enterprise systems (linking and integrating all of the above aspects into single or federated system architectures), such as VLEs.

A common phenomenon associated with the use of information technologies is that 'people seem to distance themselves from a critical evaluation of the technologies in their lives as if [they] were inevitable forces of nature' (Nardi & O'Day 1999). This is reflected in the way that research and development of educational technology applications has tended to focus solely on improved outcomes in comparison with other media. A significant omission has been the tendency to disregard many of the benefits (and problems) that technology use affords educational practice (Clark 1983; Ellaway 2006b), such as way technologies change over time, their effect on the environment's politics and cultures, their alignment with local resources and strategies, and the extent to which they are controlled or are controlling their users.

Increasingly, developments in general systems design are moving us towards more deeply interconnected and interdependent information architectures. The result is that they can no longer be meaningfully considered in isolation from each other. The synthesis and coupled development of

common healthcare education services is therefore another key consideration.

All information systems combine human and technical elements. Healthcare education informatics is also concerned with the work of all those involved acquiring, developing, deploying, using or evaluating informatics systems in healthcare education. This includes faculty, educators, students, technologists, administrators, managers, librarians, researchers, and auditors. Each brings differing perspectives, hence the requirement for a common ground, one that healthcare education informatics affords them.

In the same way that medical informatics has enabled professionals from different clinical and technical domains to reconceptualize, unify and advance the science and practice of information in support of better health care, healthcare education informatics seeks to have a similar unifying and coordinating effect in support of learning, teaching and associated practices. Healthcare education informatics is a developing domain and, as such, there are still many issues to be resolved. High amongst these is the extent of this domain's specificity and generalizability relative to general healthcare and general education informatics. Medical education is typically considered to be 'different'; one of the questions healthcare education informatics can more fully answer is in what way and to what extent.

Healthcare education informatics affords shared techniques and solutions and a better understanding of the many issues and themes regarding information use in support of healthcare education. It also offers the opportunity to improve return on investment on informational systems and processes, to achieve better articulation of the informational needs of the healthcare education sector, to obtain better fit of systems to their contexts of use, and to support better informed discourses about healthcare education informatics issues as a whole.

The future

> 'I think there is a world market for maybe five computers' Thomas Watson, chairman of IBM, 1943.

Before we draw this guide to a close, and with full acknowledgement of the perils of prediction, the authors would like to present some of their own perspectives on where e-learning in medical education is going next:

- e-learning will be an increasingly global undertaking, with opportunities to take your courses to the rest of the world and bring the rest of the world to your courses. As a result anywhere can become a classroom. This will extend to defeating limitations of time as well as space, which in turn will raise all sorts of challenges around concepts of 'working hours' and 'non-working hours'.
- All technologies are transitional. Although VLEs are the current focus of institutional e-learning provision, they are already being superseded; the use of social learning networks like Facebook and SecondLife, indicate the plurality and breadth of online working. The VLE, if it survives, may well be a common point of integration (such as a portal), but will include a more plural and learner

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defined set of interactions and supporting tools, mixing the web with other forms of interaction such as audio, video and other forms of telepresence.

- Mobile learning, and associated activities such as podcasting will become the mainstream, the remaining issues being in respect of applicability and efficacy. The opportunities will continue to grow, and institutions that are not already investigating or using mobile learning will face increasing problems and challenges from their learners. Even for non-mobile computing, cables will be relevant only for large-scale connections: connectivity at institutional and even regional level will be pervasive and ubiquitously wireless.

- Bandwidth will probably always be a challenge – online activities will always expand to fill the bandwidth available. As bandwidth increases, however, so too will the teaching and learning opportunities afforded by high speed and high capacity networks. Ideas around user-controlled lightpaths (UCLPs) where complex services are controlled and interlinked remotely over fibre-optic connections are already starting to enter the classroom.

- On the immediate horizon is the promise of 'Web 3.0' based on an increasingly semantically rich and accessible web. Search engines and other tools that can access and parse semantic data and metadata (using language more closely aligned to human speech), will afford many new challenges and opportunities to learners and teachers alike.

- Aspects of artificial intelligence (AI) will gradually become more practical although it is unclear whether machines will truly be able to think in the biological sense. Examples will include high fidelity 'Turing-test' virtual patients, decision support systems, adaptive assessment and testing and interactive physiognomic and population models.

- Related to AI will be the educational implication of the greater degree of physical integration between computer technology and humans. Innovations such as the current 'wearable' computers and chip implants, will have a profound effect on the nature of education and the sense of identity. The post-human perspective associated with such augmentation will become an increasingly contentious issue in society, both from an educational and a medical perspective.

- The term 'e-learning' as distinct from any other aspect of learning will fade from use, and will be used only to describe a short period in history. Rather than focusing on tools and machines, the issues are around fluidity and authority such as collaborative curriculum design, in which learners participate directly in the design of their learning. Those of us who will remember 'e-learning' as a concept, will be similar to those who, referring back to Archimedes' drawings in the sand, still remember slide projectors, tape-slide or the laser disk: everything changes, everything remains the same.

Conclusion

In just a few years, e-learning has moved to become part of the mainstream in most medical schools (Ward et al. 2001). However, there are many issues regarding the value of the

face-to-face experience that are still contested, and there are still many barriers, such as cost (in particular, the shift of costs/equity from the institution to the student), infrastructure (such as lack of networks in developing and remote regions), security and reliability (with an Internet seemingly brimming with viruses and hackers), and the constant change disrupting any kind of stability in the e-learning environment. Despite these challenges, e-learning affords a multitude of valuable and innovative methods and approaches for healthcare education. Where it goes next is up to you.

The authors hope that this guide and its subsequent supplements and editions will help both novices and experts negotiate this area more reflectively and critically, allowing them to better ensure good teaching and good learning for all concerned.

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