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e-Learning in Medical Education

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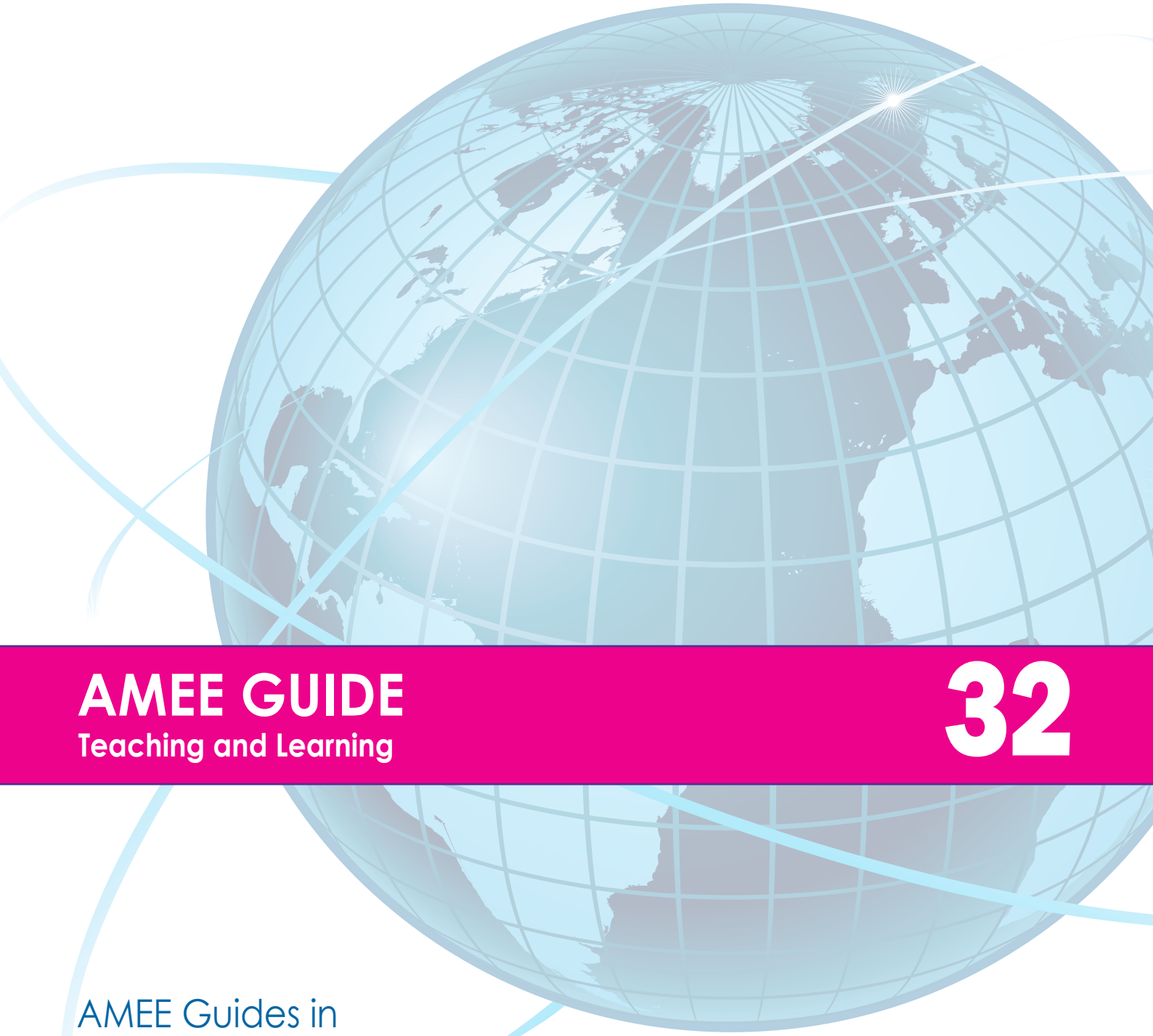

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e-Learning in Medical Education

Part 1: Learning, teaching and assessment

Rachel Ellaway & Ken Masters

Part 2: Technology, management and design

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e-Learning in Medical Education

Contents

Abstract

In just a few years e-learning has become part of the mainstream in medical education. While e-learning means many things to many people, at its heart it is about the educational uses of technology. 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.

Deploying new technologies usually introduces tensions, and e-learning is no exception. Some wish to use it merely to perform pre-existing activities more efficiently or faster. Others pursue new ways of thinking and working that the use of such technology affords them. Simultaneously, while education, not technology, is the prime goal (and for healthcare, better patient outcomes), we are also aware that we cannot always predict outcomes. Sometimes, we have to take risks, and "see what happens." Serendipity often adds to the excitement of teaching. It certainly adds to the excitement of learning. The use of technology in support of education is not, therefore, a causal or engineered set of practices; rather, it requires creativity and adaptability in response to the specific and changing contexts in which it is used. Medical Education, as with most fields, is grappling with these tensions; the AMEE Guide to e-Learning in Medical Education hopes to help the reader, whether novice or expert, navigate them.

This Guide is presented both as an introduction to the novice, and as a resource to more experienced practitioners. It covers a wide range of topics, some in broad outline, and others in more detail. Each section is concluded with a brief "Take home message" which serves as a short summary of the section. The Guide is divided into two parts. The first part introduces the basic concepts of e-learning, e-teaching, and e-assessment, and then focuses on the day-to-day issues of e-learning, looking both at theoretical concepts and practical implementation issues. The second part examines technical, management, social, design and other broader issues in e-learning, and it ends with a review of emerging forms and directions in e-learning in medical education.

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Part 1: Learning, teaching and assessment

"It is through education that the daughter of a peasant can become a doctor, that the son of a mineworker can become the head of the mine, that the child of farm workers can become the president of a great nation"

Nelson Mandela 1994

Introduction

Archimedes was using technology when he drew his theorems in the sand with a stick, but we would be unlikely to consider the use of a stick as particularly technological today; such is the fate of any technique or tool that enters the mainstream, and thereby becomes commonplace. For centuries, various technologies (books, pens, paper, over-head projectors, radios and televisions) have been used to augment and mediate teaching and learning. In most cases, these technologies were not originally conceived as educational, but were appropriated by educators, ever-watchful for methods of improving their practice. Computing and the Internet are merely the latest instances of technology use in education, and their novelty still attracts a distinct label of "electronic learning," or, more typically, "e-learning."

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This Guide covers a wide range of topics, some in broad outline, and others in more detail. Each section is concluded with a brief 'Take Home Message' section which serves as a short summary of the section. The Guide is divided into 2 parts. Part 1 introduces the basic concepts of e-learning, and then focuses on the day-to-day issues of e-learning, looking both at theoretical concepts and practical implementation issues. Part 2 deals primarily with technical and broader issues, including the planning, the social and the legal issues surrounding e-learning. The distinctions between these concepts, however, are not always clearly defined, and several issues are raised in both Part 1 and Part 2.

Box 1

Take home messages

- In just a few years e-learning has become part of the mainstream in medical education. While e-learning means many things to many people, at its heart it is about the educational uses of technology
- Educational technologies can be used in support of virtually any aspect of medical education
- E-learning, e-teaching and e-assessment are related but distinct areas of activity
- Integrated e-learning systems in the form of virtual learning environments or learning management systems are now the norm
- Working with online learners requires particular competencies and approaches of the tutor
- Mobile learning affords many new opportunities to work with learners in new contexts
- Some e-learning involves a focus on content while other forms focus on process
- E-assessment presents particular challenges to both students and tutors

e-Learning in healthcare education

In its broadest sense, e-learning is the use of the Internet for education. However, this definition falls short of describing many subtleties and important aspects of e-learning. Although the content and method of delivery is important, e-learning (often referred to as online learning) is not simply a broadcast of documents in electronic format to students via the Internet. E-learning encompasses a pedagogical approach that typically aspires to be flexible, engaging and learner-centred; one that encourages interaction (staff-staff, staff-student, student-student), and collaboration and communication, often asynchronously (though not exclusively so).

Any course that employs e-learning might be run exclusively online, or might be a mixture of online and face-to-face (f2f) activities (combining activities like this is usually referred to as "blended learning."). A purely online course might be pre-packaged (or "stand-alone"), in which there is no interaction with any person, except, possibly, an examiner. A course might also be highly personalized (or individualized), where material and methods are targeted at a learner's specific needs. Students might be at a distance, or might be at traditional campus-based universities, accessing their online learning environment from computer laboratories, lecture theatres, cafeterias, or any other site that has Internet access. The classroom, then, is the world; any location that has Internet access can become a classroom.

With these complexities, it is easy to see that the initial definition helps to set the scene, but fails to impart the breadth and depth of e-learning and the many complex ways it relates to more traditional approaches. As you move through this guide, we encourage you to reflect and to develop a more holistic view of e-learning and how it does or can relate to your own practice.

The e-learner, the e-teacher and other roles

We should perhaps begin by observing that 'e-learning' is a concept often used by those not directly involved in online-mediated teaching and learning, conflating, as it does, many differing kinds of approaches and techniques as to be of little practical use. It is helpful therefore to disambiguate the concept of e-learning and to distinguish between the many differing roles, identities and goals involved (Ellaway 2006).

Let us start with the 'e-learner', the central player implied by 'e-learning'. An e-learner is any individual that mediates some learning activities online. What is often classified as 'e-learning,' however, does not typically reflect a learner's choices, but rather is a term used to represent content and activities that have been pre-emptively selected for them by a teacher or an education institution. True e-learning is what the student actually does, and it often therefore occurs out of sight, and even out of scope, of the teacher. If we are really interested in pursuing e-learning, then we need to consider what it is the learner actually wants and does, only some of which will coincide with those activities pre-selected for them as part of their studies. It will, by necessity, include student-selected activities, such as using Google, Google Scholar, or Wikipedia for resource discovery, research or general inquiry, instant messaging or Skype for communicating with their peers, and blogs or social tools like Facebook for creating informal collections of things they have done or that interest them and their peers (rather like e-portfolios).

"If we are really interested in pursuing e-learning, then we need to consider what it is the learner actually wants and does, only some of which will coincide with those activities pre-selected for them as part of their studies."

The e-learner, although more independent that the traditional face-to-face learner, uses content and activities created and determined by teachers and independently by the learner or communities of learners. The relative proportions will, of course, differ from learner to learner, teacher to teacher, course to course and institution to institution.

The support of e-learning, however, depends on a separate, but interconnected set of activities and practices that comprise 'e-teaching'. Although it is typically benign, the construction and practice of e-teaching can significantly affect what can and cannot be done and even how teachers and learners construct what they know and how they know it (Harris 2001). To an extent, this echoes the probabilistic relationship between e-learning and e-teaching described in Snyder's concepts of the 'hidden curriculum' (Snyder 1971). By directly considering 'e-teaching,' we can more clearly see its dependence on the role of the teacher and the curriculum context as a whole: e-teaching requires competent and engaged e-teachers. This, in turn, has significant implications for profiling and developing the professional skills of teachers working through online media.

An added complication of e-teaching is that its novelty renders institutions unsure of how to afford the e-teacher the support and recognition that they give to their traditional teachers. For example, performance factors, such as contact hours, academic recognition and advancement still militate against e-teaching by valuing embodied encounters and often disregarding online activity altogether.

Not only can we separate e-learning and e-teaching as relatively distinct concepts, but we can also see the following as relatively distinct parts of the online educational matrix:

- e-Logistics and e-Administration: the greatest part of many e-learning applications actually supports the administration and logistics of the learning environment, rather than the learner's cognitive development. This is especially notable in medicine, where managing placements and rotations, timetabling, providing exam results, allocation to groups, tracking of content and participants, and other aspects of planning and non-educational communication with students outwith the campus environment are essential prerequisites of students' education. More widely, there are many instances where educational systems can, and should, connect to independent administrative systems and services such as Registry, finance, human resources and estates and buildings. One often overlooked, but essential, administrative task that increasingly depends on the online environment, is that of audit, quality assurance and compliance, involving both internal and external scrutiny. For example, in North America the AAMC's Curriculum Management & Information Tool (CurrMIT – see http://www.aamc.org/meded/curric/) is commonly used to support curriculum audit and accreditation requirements.
- e-Assessment: the use of ICT for authoring, delivery, marking, feedback and analysis of both formative and summative student assessment – see page 25 for more on this topic.
- e-Community support – tapping into the deep seated human will to collaborate, share and engage in community activities of many kinds. The so-called web 2.0 revolution has taken many by surprise as to how many individuals participate in content creation (Wikipedia, blogging), file sharing (YouTube, Flickr) and discussion (Facebook, instant messaging). Although participation in a medical community is an essential part of any student's entry into that community, it is debatable how

"One often overlooked, but essential, administrative task that increasingly depends on the online environment, is that of audit, quality assurance and compliance, involving both internal and external scrutiny."

such online participation is 'e-learning' *per se*. We would certainly like to believe, however, that what is taught to the students is not only something to be learnt for examinations, but is also internalised, and carried over to the students' role in society. This debate will continue as those concepts continue to evolve.

Not only does this new media environment involve e-learners and e-teachers, but there are just as clearly e-administrators and e-support staff in this new educational medium. Prominent among the latter are the roles of the educational technologist (or instructional designer) and the e-librarian:

- Educational technologists are specialists whose presence in medical education is a direct consequence of the move to computer-assisted teaching and learning. They typically act as mediators, facilitators, developers and enablers for all those working in an educational technological environment, and their particular responsibilities and skills fall between the purely technical (such as programming), creative (such as animation) and educational development (such as writing materials), and may cover academic, technical and administrative domains. One of the most important roles they perform is resolving tensions between what educators want and what is technically possible and desirable, including the essential option of not employing technology at all.
- The recent emergence of the role of e-librarian reflects the many changes to the roles, and even identities, of information specialists in the modern age, which have, in turn, required the rethinking of the traditional identities of the academic librarian. Typically, these e-librarians (or even 'cybrarians') extend their traditional forms of engagement to support key curriculum topics such as evidence-based practice, literature searching, information appraisal, rights issues, as well as supporting both learner and teacher access to online resources such as e-journals and databases and managing the balance between the traditional physical library and its online equivalents (Kovacs and Robinson, 2004).

Take home message: The roles of the learner, teacher and institution in the process of e-learning differ from each other and from the equivalent roles in face-to-face (f2f) learning. Understanding these roles is crucial to the successful implementation of e-learning in any institution.

e-Learning: content and process

The 'process vs. content' binary opposition assumes a particular meaning and significance in e-learning, namely whether the predominant focus should be on digital content or on the digitally mediated process. The importance of these differing perspectives is clear. If a course or programme is primarily about accessing materials (content), then designs and functions are going to reflect this intent by focusing on repositories, associating content with particular tutors and their students, and managing said content using metadata. Functions such as content upload/download and even content-creation are likely to be the dominant aspects of such a system while process management (such as discussion boards) will be a relatively minor component. On the other hand, if the course or programme is primarily about participating in activities, then the focus is more likely to be on scheduling, discussion and tracking activity, with content management a relatively small part of the overall system. Although most Virtual Learning Environment (VLE – explained in more detail below) software can be used fairly well for either kind of approach, locally-developed systems that are well aligned with their contexts of use often show more differentiation in this area, as they directly reflect the local culture and philosophy. For example the TUSK system developed at Tufts in Boston follows a strong content heuristic, while the EEMeC system developed at the University of Edinburgh is much more about supporting processes (Ellaway *et al*. 2003).

In real life, most courses will fall some way along a continuum between these two absolutes, their orientation fundamentally shaping the expectations and choice of technologies used and the kinds of activities that are supported within them. An indication of the differentiation between content and underlying process is the Open Courseware (OCW) movement (see http://www.ocwconsortium.org/), which, originating at MIT, has aimed to place large amounts of teaching content online for free use (and reuse). The underlying message of OCW is that attendance and engagement with specific institutional processes is a more critical aspect of higher education, than the content it employs. This is not to deny the need for definitive, accessible and well-designed educational content, but its relationships to the processes that employ it are perhaps more clearly observable in a technological environment.

These differences are, to a large extent, culturally defined. For instance, it is more typical for lecturers to write their own canonical course materials in the USA than in the UK, and the lecture (or any other didactic heuristic) is more dominant in knowledge-based disciplines than in performance-based ones. To employ the vernacular, some people see e-learning as being about 'accessing stuff' and some see it as about 'doing stuff.'

"Some people see e-learning as being about 'accessing stuff' and some see it as about 'doing stuff'."

e-learning content

For the sake of clarity, we will deal with content as the materials that students use (such as websites, books etc) separately from the course/programme content related to syllabi or curricula.

The role of content in an electronic learning environment can take many forms, including teaching materials, reference materials and any materials from the practice domain, such as research papers or clinical protocols and guides. Some notable examples include:

- Course materials are perhaps the most common content considered in e-learning. Typically consisting of study guides and lecture slides, these are relatively low in instructional value (viewing slides without access to the spoken dimension of a presentation often makes little sense), and serve instead to give

structure and continued access to information about, and artefacts associated with, a course or programme of study.

- Another mainstay of educational content within the institution is the library. Rapidly changing to meet the challenges of the information age, the contemporary medical e-library typically provides access to content in the form of e-books (such as reference books and textbooks), e-journals and bibliographic (e.g. PubMed) and research (e.g. Web of Science) databases. Increasingly, even paper-based published content such as textbooks now provide an 'e' component such as images, animations or other additional content.

- Although perhaps a smaller market than many initially expected, the provision of commercial e-learning content such as the A.D.A.M. series (http://www.adam.com) or pharma-CAL-ogy (http://www.pharmacalogy.com) has been a mainstay of many courses and programs for more than a decade. More recently, "plug-and-play" content modules or cartridges have been provided by publishers such as McGraw Hill for integration into commercial VLEs such as WebCT or Blackboard. The most recent round of commercial content provision has been through subscription-based online materials such as those provided by BMJ Learning (http://learning.bmj.com) or ImagesMD (http://www.images.md). With all of these kinds of resources, the exact nature of the agreement between the supplier and the user needs to be clarified. For instance, does the individual have full or partial copyright, are some rights (such as viewing) licensed, while others are not (such as the incorporation of images in other materials), and is the access open ended or time-limited? See the section on the economics of e-learning (page 53) for more on this subject.

- Finally, the Internet as a whole is a huge potential source of e-learning content. There are a great many websites that are intentionally or indirectly useful in this way, although care needs to be taken with respect to the intellectual property rights (IPR) and veracity of any third-party materials you may wish to use. The power of search engines like Google, Google Scholar or Yahoo, and the use of content aggregators such as Answers.com make finding such content relatively straightforward. It is important to remember, however, that search algorithms will typically identify the most viewed or linked-to content rather than the best quality and this can greatly impact on the sites found by students (Masters *et al*, 2003). In recent years the growth of public wikis and Wikipedia in particular, have made openly accessible collaboratively authored knowledge bases a major part of the e-learning landscape. While some see this as a positive development (Surowiecki, 2005; Tapscott and Williams, 2006), others are more critical of this phenomena (Keen, 2007).

The idea of educational content in the form of learning objects, in particular reusable learning objects (RLOs), was the subject of much development and speculation at the turn of the new century (Wiley 2000; Littlejohn 2003). The basic premise was that educational content broken into "chunks," each covering a discrete topic, could thereby become reusable in support of teaching that topic wherever and whenever it occurred, irrespective of its original context. For example, an animation explaining the transport of oxygen in the blood could be used to teach medical, nursing, pharmacology or physiology students. Essentially a reductionist and engineering-based approach, the idea of chunking and reusing content may give better return on investment. It can, however, be a complex and "lossy" process as context, culture, language and professional specificity, often critical factors in making educational content meaningful and useful (Friesen 2004; Ellaway, Dewhurst, *et al* 2005) are lost in this 'chunking' process.

Audio and video

A good way for novice e-teachers to begin using audio and video is to create sound files that can be placed on a website or VLE for download by students. These might be recordings of lectures, tutorials or clinical narratives, or they may be clinical recordings, such as heart sounds or coughs.

There are many simple recording programmes that can be used to create and edit sound files and convert them to the highly compressed MP3 format that allows these files to be both small and agile. For example, 'audacity' (http://audacity.sourceforge.net) is a very powerful, multi-platform, and free sound-editing tool that will meet most needs.

Once edited and ready for release, these files can be linked to web pages or uploaded to a VLE in much the same way that any other files (documents, presentations) are made available online. These files can then be accessed and played on a myriad of devices, including music players such as iPods, many mobile phones, PDAs, and desktop and laptop computers.

Syndicated content and casting

For the more adventurous, the next step is to move into true podcasting, in which audio and video files (often referred to as 'vodcasting') are 'streamed' directly into the student's device, using a format known as RSS (Really Simple Syndication). The use of RSS also allows text 'news feeds' that link to specific sites in much the same way. Because of the direct connection, they appear to be part of the VLE, and not something external to the learning environment. The popularity of these approaches in education is reflected by the creation of 'iTunesU', an offshoot of the massively popular desktop music tool.

For more information on podcasting, see http://en.wikipedia.org/wiki/Podcasting. For a list of useful references on the use of podcasts in medicine, also see the list by Jeremiah Saunders and Dean Giustini at http://weblogs.elearning.ubc.ca/googlescholar/podcasting_resources_May8.doc

e-Learning processes

In comparison with e-learning content, e-learning processes evolve over time, and are essentially performed in such as way that they structure human activity using designs such as schedules, rules and protocols. Common e-learning activities include participating in online discussion, chat and other forms of conferencing (Salmon 2000), accessing specific e-learning content, taking tests and assessments, working through short exercises to stimulate thinking (Salmon 2002), or completing web forms such as those used in e-portfolios or course evaluation. While some e-learning activities are direct analogues of offline activities, the majority (such as asynchronous communication) are significantly transformed by being in the online domain, and others, (such as interactive simulations and animation) are difficult to provide in any context other than an online environment.

Following reusable learning objects (see previous section), reusable e-learning processes (either in the form of descriptive and formative designs for learning or formal technically-based Learning Designs) are a growing area of research and development (Ellaway, 2007), and new and innovative tools based on encoding educational flow and choreography such as the LAMS system (see http://www.lamsfoundation.org) are now changing the way that e-learning can be planned and conducted.

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Curricula as content – curriculum mapping

An often overlooked dimension of e-learning is that of the course or programme syllabus (indicating which topics are taught and to what level of detail) and curriculum (the sequencing and relative weighting of how the syllabus is delivered). Because these are, by definition, databases and systems for expressing what the students must do, they can be relatively easily transferred to an electronic environment. Not all environments are suited to the dynamics of healthcare education curricula, however, as most e-learning systems are modelled around discrete courses, and may not support the representation and tracking of curricula integration, sequencing patterns such as attachments and rotations or mapping to external audit criteria such as professional competencies or learning outcomes.

The idea of 'curriculum mapping' has been well articulated (English, 1980; Harden, 2001), but in an online environment, the use of relational databases to map out the relationships between the various elements in a curriculum unlocks their potential for coordinating and modelling an educational enterprise. For example, the curriculum map can be dynamically linked with educational content, student and staff profiles, assessments and other elements as well as representing the many and subtle interrelationships within the map itself. Once established, this kind of integrated map can better support tracking of individual students and whole cohorts as well as review processes such as quality assurance. Furthermore, the increasing use of common outcomes or competency frameworks, such as The Scottish Doctor, Tomorrow's Doctor, ACGME or CanMEDS, can be supported by cross-mapping the internal curriculum map with these third-party authority systems (Ellaway, Evans *et al*. 2007).

Take home message: there are both content and process dimensions to working with educational technologies, and different institutions or even cultures may tend to emphasise one aspect or the other. New media and technologies are affording new forms of content in the form of syndicated media and curriculum mapping.

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Systems: LMS, VLE and MLE

Although there are a great many tools used in the delivery of e-learning, the most common approach is to use an integrated suite of tools and services, typically called a Learning Management System (LMS), Course Management System (CMS) or a Virtual Learning Environment (VLE) (Dewhurst and Ellaway 2005; Weller 2007). The individual differences between these concepts are far less than the somewhat arbitrary differences between the systems identified as one or the other type. Typically the acronym LMS is used in North America and VLE in Europe. For simplicity's sake this guide will use the term VLE.

Although, at first, these systems required students to use dedicated 'thick' client programmes to access them, the vast majority are now accessed online using standard web browsers. Despite sharing a common theme of providing integrated e-learning platforms, there are many variations. Some (such as Blackboard or WebCT), are provided on a commercial basis, some (such as Moodle or Sakai) are open-source and/or free, and many others are developed specifically to meet local needs and conditions.

Most provide a separate instance of the system for each course or module, and require teachers and students to be registered for the module in order to access it. Assigned different roles (such as tutor or student), participants are presented with different tools, content and services as befits their roles, and that follows the designs set up by the tutor and/or learning technologists running the system or the module. Typically, the system can control the material's availability based on various criteria, such as date and time, group membership, role, completion of tasks, scores for tasks, and so on.

Typical VLE functions and services

The following are some of the more common functions, tools and services typically found in VLEs. Note however that these will not necessarily be found in all such systems, capabilities will vary from system to system, and some of these functions might go by other names or be combined with each other:

- Supporting resources such as the Syllabus or Course Outline hold general information, such as staff contact details, course details, description, prerequisites, learning objectives, timetables, and reading lists and information about online polices. Typically, this will be an abbreviated or full version of the course book or study guide. There may also be an area where staff can post short messages on subjects of urgent importance. In some systems these announcements or alerts can be forwarded to students' email or mobile phones for immediate consumption.
- Areas for learning content hold links to course notes and presentations, links to other resources, case studies, videos, etc. In a traditional course, this may be where the bulk of the content is situated. Allowing tutors to upload content and manage its viewing, the content area can typically be organised into sub-sections and folders, each for different parts or aspects of the course, for different tutors or for some other subdivision. Variations on content functions include areas in which students can upload files for access by the class, and also electronic versions of their assignments for grading by staff, with options such as tracking late submissions. Other common functions include the ability for students to add comments or notes to content pages supplied by staff.

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- Most systems allow users to search for materials, based on keywords, and some systems allow a student to return to the place in the course that was last visited. Some systems provide a glossary function, effectively an online word-list with explanations. This can be particularly useful for first year classes where textbook definitions might be bewildering to novice learners.

- Discussion Boards (also called Bulletin Boards or Forums) are a means for participants to communicate asynchronously. This means that someone posts a message and others read and post replies at some later date or time; threads of discussion thereby build up over time. Typically, the threads are trackable over time, allowing users to follow many separate conversations. Discussion boards can be private (open only to a group of students), or public (open to everyone on the course). It is also often useful to include a discussion board for non-academic discussions so that students do not clutter other discussion boards with social or trivial postings. Many students prefer discussion boards that can automatically forward mail to their personal email address so they do not have to log in to check for new messages, although the curiosity of discussion is a good 'carrot' to keep students engaged with a course's online presence. In addition, some systems provide an internal email system that limits the viewing of messages to those explicitly targeted. See page 21 on facilitating online learning for more details.

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- Chat Rooms are used for synchronous communication when students are dispersed but wish to "attend" a discussion simultaneously. Chat rooms can be difficult to manage, but, if used well and properly integrated, can be very effective (Kirkpatrick 2005). Often, the typed "conversations" are logged (recorded) as a text file. Where this occurs, students should be advised of this, so that they know that the conversations will not be lost at the end of a session. Some chat rooms allow for "private" conversations between specific individuals. Because the participants are all working at the same time, education in chat rooms can often become confused and noisy; for some tips on effective use, see Masters (2004). Some chat systems also provide whiteboards where users can "draw" on a shared screen. This is rather like a "paint" tool, but one in which all participants can contribute.

- Blogs typically take the form of a personal online journal, usually written by one individual, but open to be read by all. Each new post is added on top of previous posts. Some blogs allow readers to add their comments to an entry in someone else's blog.

- Wikis consist of one or more web pages that can be created and edited through the web browser itself, typically as a collaborative effort. Formatting is quick and easy (the word wiki is a shortened form of "wikiwiki", the Hawaiian word for fast) and participants require no HTML coding knowledge (although some wiki coding is often required). Participants may correct and overwrite others' work, although a history of every change is kept, allowing changes to be rolled back. Educationally, wikis are typically used for supporting collaborative writing such as student coursework, knowledge bases or project documentation. As such, while some wikis (such as Wikipedia) are open to anyone to edit, educational wikis usually have limited authoring access, which may be turned on and off again as desired (for instance, when supporting assessed coursework.) Note that the authors (working 10,000km apart) prepared this entire guide using a shared wiki.

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- Some systems provide online examination and testing (or "quiz") tools, which usually allow for a range of question types such as MCQs, matching and ranking, single word or sentence inputs. These can be set so they can be taken only once or many times and the students' performance can be analysed using a range of statistical tools. Most question types (except free text) can be automatically graded online. (See more on assessment on page 25.) The quiz tool can often also be used for surveys and polls. Once assessments are complete, many systems have a results section or grade book, which allows staff to place marks (including uploading from spreadsheets for non-VLE results) into the VLE, and release them to students. Typically, students will see only their own marks and general statistics for the class.
- Some systems may provide portfolio tools that allow students to build online repositories of their work, experiences and reflections over time as well as links to external images, documents, and media such as podcasts. See the Portfolio section on page 29 for more details.
- In addition, there is a plethora of other tools such as podcasting, external news feeds (through RSS links), personal student working spaces, tools to take into account the student's regional and cultural preferences, tutorial (and other face to face) self-registration, image data bases, and links into institutional library services.
- Lastly, and for some, most importantly, these systems provide a range of logistical tools such as scheduling (also called calendaring or timetabling), class and group allocation, and user management. In addition, many have 'themes' which allow different sets of icons to be used. Usually only staff have access to these functions, and different staff may have access to different sections, depending on their roles.

The Nature of VLE Systems

A major concern for many institutions is whether they should purchase a VLE (as proprietary software), or adapt someone else's freely-available system (open-source software), or develop their own (home-grown software).

Proprietary VLEs are perhaps the widest used and best known, in particular, WebCT and Blackboard. The advantages of this approach include ease of installation, known budget requirements, and support structures from known companies. Disadvantages include less flexibility (than the two categories listed below), little user-control over versioning schedules, and up-front costs.

Open-source systems provide access to their underlying code, allowing their users to adapt them as they wish. Usually, licence conditions require that any such enhancements should also be made available as open-source. Examples of open-source VLEs are Sakai and Moodle. Advantages include no cost for code, greater flexibility in applying non-standard adaptations, and greater user-control of the versioning process. Disadvantages include no formal support or warranty, a dependence on programmers to change the system, and the volatility of non-standard code adaptations in new versions. There is also some concern about the security of having the program's source code available to all.

Home-grown systems are usually created within a particular institution, with perhaps some open-source code included. Advantages and disadvantages can be summed up as the same as open-source, but greatly amplified, in particular the need to retain programmers to develop and support it. There is obviously no external support to one's own programming code. Of particular concern in open-source and

home-grown systems is the amount of institutional knowledge that is taken when programmers leave. Aside from general security concerns, programmers' natural dislike of documenting their code poses problems for replacement staff. It is therefore necessary to have close management, accurate documentation, and programmers working in teams to share their knowledge and expertise.

Managed Learning Environments (MLEs) provide a wider enterprise view of the electronic systems involved in supporting teaching and learning. An MLE may, therefore, contain several VLEs along with library, finance, assessment, student records and other system components. The extent to which this is of importance to the medical teacher depends on how dependent they are on these systems' integration and operation. Many VLEs have grown to provide full MLE functionality. See the EduTools site at http://www.edutools.info for reviews of the main proprietary and open-source systems. The e-learning Guild produces free electronic books on selecting and using these systems at http://www.elearningguild.com

Take home message: VLEs supply a single unified environment for e-learning, and generally include a wide range of integrated tools for content delivery, interaction, and administration. Although some may find VLEs confining, they meet most teachers' and learners' needs. In areas where VLEs fail to meet specific needs, these can be met by implementing supplemental programs and services.

Problem-Based e-Learning

E-learning is now widely used in various forms of case-based or problem-based learning (PBL). Because PBL is now so prevalent in medical education, this section will focus on PBL, in both the blended and entirely online scenarios. Even if you do not use PBL, this section should provide ideas that are applicable to your own work.

For the purposes of this guide, it is enough to note that PBL is learner-centred and constructivist, and involves students' working in groups, being presented with a real-world problem or case (usually paper-based), extracting key issues and questions, investigating them and then reporting back to the group.

Face-to-face PBL

The online environment can be used to make face-to-face cases more realistic at the time they are presented to the students. Although paper-based cases serve a valuable purpose, they do have limitations – in an effort to not trick students, they are often very "typical," and tend to use textbook-style language. In these instances, however, key words merely serve as clues to the solution. A variation is to have a video of a patient (real or simulated), with history taking, interview and examination forming an integral part of the case. The students then have to sift through the information, as they would have to do in a real situation.

Even if the case is primarily paper-based, the online environment can be used as an extension of the face-to-face PBL process. The online environment can contain a copy of the case and any supporting materials such as documents, articles, lecture notes, and PowerPoint presentations. The content can be selectively released to the students as the case proceeds. Note that there can be problems with adding material to a case area *after* the students have started to access the case. One solution is to actively indicate new materials as they are released (Masters 2007).

Coordinating the online environment to support PBL also raises a number of challenges. For instance, multiple-authorship might mean that authors might easily overwrite each others' materials. One solution is to create a central service area to receive all the material from teaching staff. The other is to assign a teacher or facilitator to each case, and make that person responsible for maintaining the materials. Maintaining a central area has several advantages, such as consistency, transferring lessons learnt from one section to others, and the absence of support staff does not disrupt the flow of information as other staff can step in. There are, however, disadvantages, such as teaching staff not learning these skills, and the overall cost of creating and maintaining the central service. The alternative approach of assigning a staff member (or facilitator) to coordinate the resources has the advantage of not needing a central unit; on the other hand, it can mean a significant additional workload, can result in inconsistency of presentation of material across cases, and unexpected absenteeism may result in delays of materials' posting.

In addition to public discussion boards, it is important that each PBL group has its own private bulletin board. This board should be restricted to the students and the facilitator for each group. Even course-convenors and support staff should not access this board unless they have permission from the group. Given the constructivist approach of PBL, it is likely that students may also need private study groups or areas.

ePBL

ePBL involves running PBL in a totally online environment with minimal or no face-to-face contact between students and staff, either as distance or distributed PBL (dPBL) (Wheeler, 2006), or because traditional PBL can require unsustainable contact time for students and staff (Rhodes, 1999).

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In one approach, ePBL can be similar to standard PBL: the case is created, and then distributed through email, or by posting into the VLE, or in a system specifically designed for ePBL (Wheeler *et al*., 2005; Wheeler, 2006). Students interact with each other via chat rooms, bulletin boards, email, or whiteboards. Questions to the facilitator might be a combination of set chat sessions, or in the bulletin boards also. The facilitator may take the role of the traditional facilitator (see online facilitation on page 21), or role-play the characters in the case.

In another format, the students work individually, receiving a case and interacting with the computer only, answering questions, and being given more information in stages as progress is made through the case. Given the value of interaction with peers and the facilitator, this scenario might be better used as a supplemental activity.

Irrespective of the method adopted, e-PBL requires the facilitator to be highly skilled and practiced in the use of chat rooms, and also to allow for the fact that bulletin boards, while easier to manage, introduce the complexity of synchronicity in the interaction (Orrill 2002). Although cases of success have been reported (McConnell 2002; Ronteltap & Eurelings 2002), the concept in still new, and not for the newcomer or faint at heart. See Savin-Baden and Wilkie (2007) for a range of different approaches and perspectives on ePBL.

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Take home message: Given the constructivist basis of PBL, e-learning can be used to guide the learner's discovery as well as the unfolding of the case. The teachers and facilitators need to carefully consider the degree of integration, and the variation between blended approaches or entirely online approaches.

Practica, simulations, virtual patients and simulators

Although contemporary medical education retains a major component of knowledge acquisition, it is increasingly focused on the application of higher cognitive skills and knowledge in practice. Designs for effective medical e-learning, therefore, need to mirror the dynamics and details of real-world practice as well as affording effective learning opportunities. These principles are reflected in Schön's conception of a practicum, "a setting designed for the task of learning a practice. In a context that approximates a practice world, students learn ... by undertaking projects that simulate and simplify practice" (Schön 1987). In terms of e-learning, these practica are reified in the form of simulators and game- or virtual-worlds (Aldrich 2005, Quinn 2005). Indeed, there is a growing belief that "the success of complex video games demonstrates games can teach higher-order thinking skills such as strategic thinking, interpretative analysis, problem solving, plan formulation and execution, and adaptation to rapid change" (Federation of American Scientists 2005).

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However, there is an important difference to be made between using video games per se and employing the principles of 'game informed learning' (Begg *et al.*, 2005). The key lesson here is that effective educational activities do not have to employ the expensive and potentially distracting presentational aspects of video games to benefit from their educational value. Instead, judicious use of gaming factors, such as narrative backstory and feedback, user identity and agency, consequences of action, and the opportunity to explore and rehearse different tactics and strategies within a situation, can be employed to create highly immersive, engaging and valid learning environments.

Virtual patients are a key exemplar of game-informed learning in medical education (Ellaway, 2007), taking a number of different forms, such as artificial patients (typically computer simulations of human physiology - see http://en.wikipedia.org/wiki/Virtual_Physiological_Human), real patients reflected in their data (electronic health records or EHRs), physical simulators (models and mannequins), simulated patients (actors and role-play), and electronic case-studies and scenarios. It is the latter form that has most relevance to e-learning in medicine as "an interactive computer simulation of real-life clinical scenarios for the purpose of medical training, education, or assessment" (Ellaway *et al.*, 2006) (see also section above on ePBL).

Typically, virtual patients take the form of an open-ended clinical narrative or a structured patient encounter, the latter being the more common. In either scenario, students may have to search for and/or interpret data, make appropriate clinical decisions or solve particular problems such as making a diagnosis or formulating a treatment regime. Furthermore, the role of the learner may take many forms: the physician or other member of the care team, the patient, or an observer. In addition, they may create a virtual patient themselves, or work through a pre-existing one, they may work alone or collaboratively, they may work through an exemplar case or have to critique a flawed one, and the outcomes may vary between decision-making, knowledge acquisition or assessment. Some virtual patients will employ a case as a framework into which didactic activities are connected while others will encourage open exploration and discovery.

Although not intended to be particularly educational, the allure of virtual worlds such as Second Life or 'The Sims' still attracts much attention, and development work in this area continues, although with relatively limited success and application. As well as the issues of cost and validity, such open environments are hard to link to

specific learning outcomes with exception of simulations that allow users to practice skills of manipulation and dexterity. Examples include laboratory simulations that allow users to try a range of techniques without the cost of the physical environment (or the need for animals on which to experiment), virtual microscopes and/or histology, and a number of surgical simulators (Rosser, Lynch *et al* 2007).

Practica, such as simulators and virtual patients, can offer highly valid and authentic learning environments, they can be scalable and replayable, they can be made available on demand, and they can be highly immersive for the learner. Furthermore, by taking a 'thin slicing' approach to learning medical practice, they are particularly useful for managing cognitive load and helping the learners to pace themselves. As such, it is likely that these educational techniques are going to be used as part of patient education as well as for health professionals in the years to come.

Rather than perceiving games solely as a platform in which learning content can be delivered, greater emphasis on student context and exposure to consequential activity within subject areas—principles intrinsic not only to successful gaming but also to established constructivist learning models—can provide especially effective, immersive learning experiences at all levels and in all areas.

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Take home message: Online simulations and virtual patients afford powerful and engaging ways to expand the scope and impact of traditional face-to-face teaching and learning. This area is fast-growing and there is still much to explore.

Facilitating online learning

This section assumes that the reader is familiar with face-to-face small-group facilitation in medical education (see http://www.keele.ac.uk/depts/aa/landt/docs/small-gr.html for a primer).

Synchronous and asynchronous text interaction

Online facilitation typically uses bulletin boards or chat rooms as the point of contact between students and facilitators. Many of the principles of face-to-face teaching and learning also apply to online facilitation. For example, the principle of the facilitator's being the 'guide on the side' rather than the 'sage on the stage' still stands; instead of supplying information, the facilitator should allow students to work through issues themselves as much as possible. In addition, familiar issues of competition, conflict and responsibility also need to be addressed. Online environments also allow students to take turns as a moderator or facilitator and learn much from the process.

All forms of group work require rules of participation, and in an online environment, these form part of the required 'netiquette.' If the course is a blend of online and face-to-face learning, then one should emphasise that the online environment is merely an extension of the face-to-face environment. This means that rules of group participation, such as confidentiality and respect for others, also apply online. If the course is wholly online, then it is imperative that the rules are established and agreed to before starting. Occasionally, students will post messages inappropriately, either into the incorrect board or by making an ill-judged remark. Such messages should be moved to a more appropriate board or a holding area rather than simply deleting them.

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The success of group work relies on active participation by all in the group. In online learning, low levels of participation is problematic (Irizarry 2002, Fisher and Baird 2000, Rovai 2002, Swan 2001). All the factors that reduce participation in f2f groups also apply to online groups, with the added complication of technical expertise and accessibility.

Various strategies to increase participation have been considered (Burgstahler, 1997; Klemm, 1998; Masters & Oberprieler, 2004; Pilkington *et al*., 2000; Oliver & Shaw, 2003; Salmon, 2000) including minimum numbers of postings, awarding marks for particular postings, or by carefully constructing questions that are engaging for the students. Although awarding marks is likely to increase postings, they can become mini-assignments rather than spontaneous thoughts. Awarding marks might also conflict with the pedagogical approaches in other parts of the course. Careful preparation and the posing of probing and interesting questions is therefore of particular importance. As a last resort, a facilitator might also contact students privately, asking them about their participation, just as one might call on a student in a face-to-face group to offer a contribution. Because the facilitator will usually be unaware of private circumstances, these discussions must be handled delicately.

Some synchronous activity designs include:

- Synchronous formal question and answer sessions in a chat room: this is a meeting of staff and students online in much the same way that they would meet in a lecture theatre. After allowing the class to settle down, the facilitator asks for the first question, which becomes the current topic. If any other student poses a question, it is ignored until the current topic has been completed. The discussion follows a pattern similar to a classroom discussion, with the facilitator moving the discussion with probing questions and comments, but the students are responsible for the content creation. (In this type of scenario, it is recommended to have small groups (10-20) students, but it is possible to break this rule if the students are disciplined.) Students don't take notes, because the activities are logged. After the session, the log file can be cleaned up, and circulated amongst other staff members who may wish to add information, references, clear up issues, etc. This file is then made available as a resource to the students.

- Formal classes in bulletin boards: the teacher poses questions at regular intervals (e.g. every 20 minutes), and the students debate the issues. Questions should be thought-provoking, open ended, and related to the course. Students can return to the discussions at any stage and continue them (Masters & Oberprieler 2004).

Informal asynchronous activities (for instance, queries around specific course content) are also an important component of bulletin boards. In many courses, the informal (course-related) discussions amongst students will make up the bulk of the messages posted into the VLE.

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Audio conferencing

Although the majority of communication is conducted using text, other multimedia alternatives are growing in popularity and utility. Some systems and tools allow their students to access tutors online using audio conferencing, while the rise of free voice over the Internet (Voice over IP, or VOIP) services such as Skype, has made this a lot easier. Teleconferencing, whether by VOIP or analogue means, is still the most common application of audio conferencing, although its educational use is limited unless combined with other media such as web conferencing.

Video conferencing

Video conferencing is typically employed where remote groups of people, such as classes (rather than individuals), need to work with each other. Video conferencing, however, consumes significant network bandwidth, and usually requires dedicated (and often expensive) hardware and space for all connecting locations, all of which limits its applicability and viability. Educational use of video conferencing needs careful planning and execution, as the absence of visual cues and the small delays in coding and decoding signals (called latency) can have adverse effects on the group dynamics. Sometimes, teleconferencing for audio (that typically has near zero latency) is combined with video for a more direct experience for all concerned. The growth of fibre-optic networks (so called 'lightpaths') is improving the connectivity for many, and is helping to improve picture quality and reduce latency for videoconferencing.

Web conferencing

Desktop videoconferencing, more usually just called 'web conferencing', involves the connection of standard PCs or laptops with webcams, microphones etc. This format aims at bringing two or more individual users together, working through their own computers, rather than the videoconferencing model of a group meeting using dedicated room-based fixed equipment.

As a result, web conferencing is typically cheaper, simpler, and uses less bandwidth, but usually with lower screen resolution. Although web conferencing is now supported in many text or audio conferencing tools (such as Skype, MSN Messenger and iChat), there is usually greater educational utility in multiple channel collaborative media tools (such as Adobe Connect, Wimba or Illuminate), which allow video, audio, chat and white boards to be used as part of a single integrated system.

Take home message: Online facilitation draws on many of the principles of its face-to-face counterpart. There are, however, new problems to be solved, and new possibilities to be explored. While issues of location and time dispersion might be problematic at first, they offer far greater flexibility in the overall discussion process.

e-Learning and distance learning

There is an adage that distance learning begins in the 20th row of the lecture theatre. Distance education, however, has been practised for decades. The development of effective communication networks made correspondence courses possible in the nineteenth century, and, subsequently, new media, such as radio and television extended its reach. More recently, the Internet has extended its scope and the opportunity for learning at a distance yet again.

From one perspective, all medical students are distance students, in that they study at home or while travelling, and they are usually required to attend rotations or attachments away from the main campus. Furthermore, many students in postgraduate and CME programs also need to study at a distance due to work or family considerations. There are many issues to overcome, including isolation, home distractions, time of study (often not 9-5), lack of shared knowledge and practice (no access to tacit clues and frameworks in the f2f environment), technical support, firewalls (for instance, from hospital networks), available bandwidth, time zones, the match between expectations and reality, and encouraging peer support.

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Until recently, distance learning meant little more than the ability to broadcast pre-packaged or "canned" information to a larger audience. Whether there were 20, 200 or 2000 students on the course made little difference, except to the financial bottom line. The power of online learning, however, stems from its ability to foster interaction, and, while the teachers are increasingly 'guides on the side', they should not become absentee landlords. Isolation of learners is a common reason for the high drop-out rate from online courses (Carr 2000, Stacey 1999, Fisher and Baird, Rovai 2002). That is not to say that pre-packaged materials are worthless; indeed, they are extremely useful if used appropriately. They might be in the form of multimedia programs like Anatomedia or the more sophisticated materials such as those from the World Virtual University (http://www.websurg.com) which includes detailed peer-reviewed video of surgical procedures (Maisonneuve *et al*. 2002) or IVIMEDS (http://www.ivimeds.org) (Harden & Hart, 2002; Harden, 2005).

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Distributed Medical Education (DME) and e-learning

Although medical education has traditionally been based around the teaching hospital or academic health sciences centre, some students will also attend rural and remote practices and teaching sites. In recent decades, a number of programs that are mostly carried out in this distributed model have been developed, and e-Learning is an essential component as a means to unite and coordinate this distributed approach.

Large medical centres, however, are typically located in urban areas, which have relatively good levels of available bandwidth and network connectivity. In rural and remote areas, these are far less common, and, as a result, e-learning designs need to accommodate these limitations. For instance, high bandwidth-dependent techniques such as video should be used sparingly while low-bandwidth options such as instant messaging and text-based PBL and virtual patients may be more appropriate. These are the same kinds of issues as those faced by medical education programs in developing countries that also struggle with bandwidth and connectivity. In some countries, such as many of those in sub-Saharan Africa, mobile telephone networks provide a viable alternative to networked computing – for more, see the section on mobile learning on page 30.

Continuing Medical Education and Continuing Professional Development (CME/CPD) and e-learning

Continuing Medical Education (CME) or Continuing Professional Development (CPD) is a response to the need to maintain expertise post-qualification, particularly in an environment with rapid changes and advances in techniques and therapies. CME is "any and all the ways by which doctors learn after formal completion of their training" (Goudar & Kotur 2003), and is effective in the teaching of knowledge, attitudes, skills, practices, and clinical practice outcomes (Marinopoulos *et al*., 2007).

Traditional CME might take the form of face-to-face courses, seminars, grand rounds, or it may be informal, such as the reading of journals and texts. Such approaches, however, are not always possible or even desirable. Barriers to formal traditional CME include family commitments, inability to get locum coverage, distances to travel, costs of attending courses, and increased workload (Shelstad & Clevenger 1996, Martin 1999, White & Sheedy 2002). Barriers to informal traditional CME are similar but wider, and also include lack of time, isolation (and lack of access to professional colleagues), lack of libraries and library services, slow delivery of documents, technology problems, lack of equipment, and cost (Bowden *et al*., 1994, Dorsch 2000, Lundeen *et al*., 1994, Shelstad & Clevenger 1996, Robishaw & Roth 1994, Burnham & Perry 1996).

It is in this environment that online CME is offering the ease of access so crucial to doctors (Sargeant *et al*., 2004). Online CME is ideally suited to meet the CRISIS criteria (Harden & Laidlaw 1992, Harden 2005) of Convenience, Relevance, Individualization, Self-assessment, Independent learning, and Systematic approach to learning. Many of these, however, are affected by a range of technical and design issues (discussed in more detail in part 2 of this guide), and merely duplicating traditional efforts will serve little purpose; part of the aim of online CME is, after all, to reduce the impact of the barriers. There are still some challenges to be overcome in this area.

Take home message: The temptation for distance learning to merely broadcast material to large numbers of learners should be resisted. Once the nature of online distance learning and the needs of the distance learners are understood, distance learning allows for a learning experience as rich as any campus-based experience, particularly for CME and CPD.

e-Assessment

In addition to supporting teaching and learning, educational technologies are playing an increasingly important role in the support of both formative and summative assessment. e-Assessment (also known as computer aided assessment (CAA) or computer-based testing (CBT)) can support knowledge-based assessment (e.g. using multiple choice or extended matching items), performance-based assessment (e.g. using OSCE stations or virtual patient cases), practice-based assessment (e.g. using portfolios or logbooks) or behaviour/attitude-based assessment (based on contributions to discussion boards or peer-assessment of project work using tools such as wikis) (Crisp, 2007).

Planning for e-assessment, as with any assessment process, needs to include careful consideration of the forms of assessment required, how they relate to the immediate learning objectives/outcomes and the rest of the curriculum, and how (and indeed whether) they are to be completed electronically at all. A review of assessment regulations is also advised, as these are typically written with more traditional approaches to assessment in mind. Other strategic issues include whether all candidates are assessed in a single event, following the form of a traditional exam, or whether more asynchronous approaches, such as continuous assessment and progress testing, can be employed.

Once the required form of e-assessment has been agreed, the next step is to select the e-assessment tools and systems to use. One might use a dedicated e-assessment tool or system. Alternatively many VLEs will also have their own built-in assessment tools (although typically, lacking the range of functionality provided by a dedicated system). Choice of tools, as for any other application of educational technology, will depend on availability, cost (for acquisition/set-up and for subsequent use), ease of use, interoperability with other tools and systems already in use, and whether the tool or system supports the required kind(s) of assessment and the means of delivery required. Because data created for and by assessment is of critical importance to student progress, extra care should be taken regarding security, confidentiality and system resilience.

Advantages of e-assessment include the ability to provide instant marking and feedback, to support greater tracking and transparency and greater reuse and analytics across many assessments. Furthermore, e-assessment typically supports greater collaborative test and exam creation, increased support for audit and

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quality assurance and a more fluid and efficient set of processes. From a cognitive point of view, e-assessment can support a wider range of questions and interactions than paper-based assessment, and it can be used in a blended way to integrate and support more traditional methods (for instance, by underpinning or providing stations within an OSCE). There is also the benefit that students should be able to access their individual scores and marks more rapidly and confidentially, and see their aggregated assessment performance over time to help them manage their own study and performance. Other advantages include the requirement for normalised and structured approaches to assessment, and the ability to support different kinds of sequencing, presentation and interdependence. The latter, for instance, can allow for adaptive selection of questions based on their prior behaviour or performance.

Disadvantages of e-assessment include needing to support and resource the practical complexities of carrying out any kind of high-stakes e-assessment, formatting limitations within available question types and formats, risks of technical failure (and the need for backup methods in case of any such failure), the need to provide equipment, invigilation and assurance of candidate identity and security.

Formative e-assessment

Formative self-assessment is often popular with students, as it can help them to assess their current knowledge and competence and identify areas of weakness. Although this typically equates to knowledge-based tests using multiple choice questions (MCQs – such as best of five or true/false), more advanced forms of formative e-assessment may involve self-directed virtual patient exercises, skills simulations or the use of video to record and review performance. Feedback is key in any kind of formative assessment, and e-assessment can be designed to provide feedback instantly to the learner both during a question (suggestions, supporting materials) as well as after (learner performance, explanation of answer, suggested follow-up). Furthermore, online formative assessment can be taken time and again allowing for practice and experiment. It is also scalable from a few to a great many learners with little impact on the services providing the assessment.

Another key advantage is that simple item analysis (looking at the classes' overall selections and scores for each question) can be used to feed information back into the teaching, so that misconceptions can be cleared long before the students arrive at their final examinations.

Summative e-assessment

Summative assessment presents its own challenges and opportunities.

- The logistics of e-assessment can also present a number of new challenges. For instance, will the institution provide computers or will the students use their own? If so how can they be secured against cheating and how is equality of opportunity maintained? Is there a physical space available to take the numbers of students involved, along with sufficient computers, power, network and so on? Although regular student computing labs can be used for e-assessment, issues such as sight screening, spacing between students, problems associated with taking a lab out of service just as students are revising and the number of students that can be accommodated in one sitting all need careful consideration.
- As with all exams, assuring security and identity is vital. In assessments run in-class, standard procedures such as requiring student ID to be visible and turning off cell-phones, will apply. In addition, the use of strong personal passwords and IP

restrictions help to increase security. The invigilator has the added advantage that it is easy to scan a large class of screens to see if any screen does not match the expected display, and most e-assessment packages can lock down the computer while an exam is in progress so that students cannot access any other tools or information. If students are taking the exam from a distance, then an open-book exam might be considered - this is especially valuable for CME courses. While one should be mindful of bandwidth issues when using images and video, taking a little care can allow one to use images very effectively (see section on technical issues in Part 2). Simply having colour images in an assessment is already an advantage over much paper-based assessment. In addition, if you are concerned that the reduction of the image to fit the screen hides some detail, then having a separate link to show the full image in a separate window is extremely useful and easy to implement (Masters and Duffield 2004).

- One must also consider the way that the students will sit the test. For instance, will they be working online or offline with a subsequent synchronisation step where the data is sent back to the organization; will the e-assessment be purely 'e' or will it be combined with face-to-face methods (such as an 'e' station in an OSCE); is it based on just one sitting or will it be more open allowing a number of attempts or sessions?

Once planned and designed, actually running an e-assessment can present further challenges including:

- Ensuring that there are sufficient invigilators to oversee the students and they are adequately briefed as to what kinds of behaviours and misdemeanours they need to be looking out for.
- Having technical support on hand to respond quickly if the system does not function perfectly. Furthermore, given the high stakes of the event, resilience and disaster recovery is an essential step. For instance, backups must be conducted (although these are usually part of the standard backup policies), and, in the event of significant technical failure, alternatives such as rerunning or conducting a paper-based exercise need to have been set in place. It is also useful to alert your institution's system support staff, so that they do not perform maintenance or other procedures while examinations are in progress. (The time of year during which examinations are written is often also often considered to be a quiet period during which disruptive systems work can be performed.)

Once the e-assessment has been completed, there are a number of follow-up steps that need careful attention:

- Marking e-assessments can be a lot faster for questions where answers are absolute and predetermined (such as best of five MCQs or EMQs), but others may need as much human scrutiny as their paper counterparts (such as essay questions). Thus, while it may be possible to give students their results as they leave the exam hall in some cases, in others, the marking process may still take some time. Although intelligent parsing of free text is gradually improving, it is still a long way from matching human scrutiny and interpretation.
- Providing results and feedback to students is an essential part of any assessment process, and you have several options at your disposal, and choices that you may make. For instance, will this information be provided online, if so, then, at what stage and in what level of detail, will it remain visible to the student indefinitely and what happens when the data or feedback changes for whatever reason?

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- Long term strategic issues will also need to be considered, such as how the results data are aggregated and processed to form course, year and even final assessment information. Although this may currently be done using individual spreadsheets, this is typically an error-prone and risky way to proceed. A better solution is to have a central database system to do this, although there are many procedural issues associated with such an undertaking, including consistency between assessment processes, dealing with missing or inaccurate data and ensuring resilience and stability of such a system. Getting this process right is also essential to ensuring quality assurance and audit requirements are met.

Assessment interoperability and question banks

Above and beyond the reasons for local adoption of e-assessment methods, the medium offers a number of advantages over paper-based assessment in its ability to support the reuse and exchange of assessment items and the ability to perform and track a wide range of assessment analytics.

Question Banks are specialist kinds of repositories that allow question items to be stored along with appropriate metadata such as performance metrics and subject headings. This allows the repository to be searched for any item that meets the required criteria (such as subject, education level, discrimination index, or provenance) and that item to be reused or adapted and data on this reuse to be subsequently entered into the repository to enhance it further. To actually exchange an e-assessment test item between systems, it needs to be expressed in a format compatible with these different systems. The most commonly used assessment interoperability specification is IMS Question and Test Interoperability (QTI) (see http://www.imsglobal.org/question/), which sets out a common XML-based format for encoding and sharing a number of question formats between QTI-enabled systems.

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e-Assessment resources

Many VLEs support e-assessment, usually in the form of quizzes, while a number of multimedia tools allow you to create questions and tests, including Adobe's Flash, Authorware and Director. Dedicated tools such as Question Mark Perception (http://www.questionmark.com), Respondus (http://www.respondus.com) and Triads, (http://www2.derby.ac.uk/CIAD) allow for more involved development of e-assessment materials and activities, and there are a number of large scale e-assessment membership-based collaborations including UMAP (http://www.umap.org.uk), the NBME (http://www.nbme.org) and the IDEAL Consortium (http://www.hkwebmed.org/idealweb). See Crisp (2007) for more examples.

Expanding e-assessment models

New media afford new ways of conceptualising and developing assessment for medical education. For instance, learners' collaborative behaviour can be assessed by analysing their contributions to discussion boards or to live chat sessions. Simulations and models can be used to assess skills, for instance, as task trainers or OSCE stations and game worlds such as SecondLife, or virtual patients can provide many different ways to assess student performance.

Take home message: Care should be taken to select the appropriate tools and methods for e-assessment. If these are properly understood, then e-assessment (whether formative or summative), can greatly enhance the capabilities of traditional assessment methods.

e-Portfolios

The move to include portfolios in higher education reflects the growth in personalised and holistic approaches to education, with the portfolio acting as a collection of information, resources or other evidence of an individual student's performance and reflection over time. The personal development profile (PDP) is a more formalised form of portfolio, typically based around a framework of professional competencies.

Many portfolios are now run online as a way of providing easy access to their content and services for both students and staff, and to integrate them with the rest of the online learning environment. E-portfolios may include tools such as logbooks and critical event analyses, written case reports, progress tests, professional curriculum vitae, individual objective tracking as well as more personal and formative entries. Overall, e-portfolios either concentrate on the storage and representation of content (as evidence or record keeping) or they track individual negotiation of portfolio processes and workflows.

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e-Portfolios in medical education

Portfolios and e-portfolios for healthcare education tend to be quite institutionally-focused (rather than student-focused), particularly where they are used to support the assessment of key outcomes such as fitness to practice. This usually entails a greater staff role and level of access, higher levels of institutional ownership (as opposed to student ownership), greater formality, and a greater level of associated tracking and accountability than in other disciplines. The affordances of the portfolio approach have been taken up in CPD and CME to track and thereby ensure that practitioners are keeping up to date wherever they are. This postgraduate focus tends to influence earlier stages in healthcare education, introducing pressures to integrate student and practitioner portfolios and their associated activities – a notable example is that of the move to create better links between UK doctors' undergraduate and foundation portfolios.

Despite healthcare portfolios' requiring relatively high levels of tracking and accountability compared with more traditionally academic domains, the information contained remains personal, and, in some cases, particularly sensitive. Security and controlled access is important, and, as such, careful attention should be paid to access rights, and to ensuring that all parties, particularly the students, understand them.

Getting started with e-portfolios

Since the concept of e-portfolios can cover many different practices and systems, there can be problems around equivalence and interoperability between different e-portfolio systems. Although there are emerging interoperability specifications for portfolio systems, they are as yet relatively underdeveloped and limited. It is worth noting that blogs are increasingly being used as a way of supporting e-portfolio activities, as they support regular diary-like reflections with appended files and other evidence, including comments from other individuals (such as tutors or peers).

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Take home message: E-portfolios combine the aggregating power of the portfolio with the flexibility and connectivity of the online environment, making them powerful tools for evaluation, assessment, and personal reflection.

Mobile Learning (m-Learning)

Simply put, m-Learning is the use of mobile, hand-held electronic devices in education, and, as such, it constitutes far more than providing another way of accessing online content through a VLE. Effective use of m-learning can promote many new kinds of approaches to learning. These devices include Personal Digital Assistants (PDAs), and cellular (or mobile) phones.

m-Learning in medical education

The advantages of m-learning in medical education include:

- Mobility, portability and small size: doctors or students can enter patient data, transfer information and access their online material, without being tied to a specific location and the device can easily be dropped into a pocket to free both hands.
- Price: mobile devices are typically much cheaper than desktop or laptop computers. As with all technology, however, they become outdated relatively quickly, and one would probably need a new PDA every three to four years.
- Coordination: Medical students are highly mobile, performing much of their work off-campus, balancing self-directed and scheduled activities such as lectures, grand rounds, and tutorials. Getting messages to students about changes in their schedules or alerting them to new information can be problematic. An m-learning solution is to use web-based Short Message System (SMS) or "text" messaging. This involves selecting which students are to be contacted, typing the SMS message, and sending it, after which the message is delivered to the students' mobile phones within seconds. These systems are widely and highly successfully used in medical and non-medical training, in both the developing and developed world (Masters 2005, Masters & Ng'ambi 2007, Microsoft 2006, Stone 2004). A variation is one in which students can SMS queries (such as requests for marks) and questions into the VLE directly. An example of this is Dynamically Frequently Asked Questions (DFAQ) at http://data.meg.uct.ac.za/faq/EDN/
- While almost all mobile phones can accept text messages, the next step in class management is the use of handheld computers such as PDAs and SmartPhones. Much more computer-like than mobile phones, these devices include productivity tools such as calendar, memos and address lists, allowing much greater support for the student and teacher alike (Criswell & Parchman 2002, De Groot & Doranski 2004, Torre & Sebastian 2005, Walton *et al.*, 2005).
- Multimedia: PDAs (and other hand-held devices) can usually also play sound files and many can also play video files, which makes them ideal for playing podcasts or vodcasts, or even recording audio such as in lectures or tutorials. Other examples include PBL videos which can also be converted to cell-phone format so that students can copy the case to their cell phones, and revise the case at any time they desire. (In the case of simulated patients, this will be far less controversial than using real patients). There are a number of freely-available mobile video resources such as those at http://www.pocketsnips.org.

- Knowledgebases: a PDA is essentially a hand-held mini-computer, and can accomplish many tasks that are normally associated with a computer. In both medical practice and education, PDAs are used for a variety of activities such as accessing electronic texts, obtaining drug dosage information, patient care and patient tracking, student-tracking of cases (Criswell & Parchman 2002, De Groot & Doranski 2004, Torre & Sebastian 2005, Walton *et al*., 2005, Taylor *et al*., 2006, Kho *et al*., 2006).

On the other hand, some of the disadvantages of PDAs include:

- Small devices have small screens - this is especially limiting when using graphical applications, viewing large amounts of data, or when a devices is being viewed by more than one person. These devices also have limited versatility compared to desktop or laptop computers.
- Although reasonably robust, mobile device portability exposes them to greater risks of damage, loss or theft. Security and confidentiality is also a greater risk. Because of this, password protection and file encryption is vital.
- Wifi, mobile phone and other forms of connectivity make it easier for students to exchange files and data; while this can be helpful, it is also an essential learning point that they maintain confidentiality and other aspects of professional practice and responsibility. For instance images of patients (or even cadavers) should not be acquired or shared except in highly controlled contexts.
- Although there are many application packages for practicing physicians, there are relatively few for students per se, and, as such, mobile devices may be of less use for specialised applications until a student achieves a certain level of clinical proficiency.
- The use of mobile devices is the disruption of other activities (Masters & Ng'ambi 2007, Sharples 2003). Although this disruption is a natural part of education, when working in their professional arenas, students should conform to the basic etiquette of mobile and cellular devices ('mobiquette' or 'celliquette').

"Although reasonably robust, mobile device portability exposes them to greater risks of damage, loss or theft. Security and confidentiality is also a greater risk."

m-Learning – medium and message

Mobile devices can blur the lines between medical education and medical practice, as they are used for both formal and informal education (Topps *et al*., 2003). There is the possibility in clinical practice that the mobile device might be just "another medical gadget in the doctor–patient dialogue" (Turner *et al*., 2005), and could act as a barrier between the student/doctor and the patient (Torre and Wright 2003). This is similar to earlier concerns about the PC on the doctor's desktop, but which actually increased rather than decreased patient satisfaction (Mitchell & Sullivan 2001, Hsu *et al*., 2005). Handheld case-logging systems have increased patient encounters (Baumgart 2005), and can reduce errors and time taken in storing and retrieving information (Criswell & Parchman 2002; Fischer *et al*., 2003). Although there are still reservations by doctors, the patients themselves are positive about the use of mobile devices and other hand-held computers during the consultation (Houston *et al*., 2003, Rothschild *et al*., 2002).

Although there are many brands of PDA-like devices, there are four main operating systems; Palm Operating System (OS), Windows, Symbian OS and Blackberry OS. Application data are not easily compatible across the two systems, so the choice of which system to use must be considered carefully. Although the Palm OS has a greater number of medical applications, Windows is currently overtaking Palm, while Blackberry devices concentrate on email handling. At the time of writing, dedicated PDAs are being phased out in favour of devices that combine cell phone and PDA functionality as well as other functions such as a music player and/or a still or video camera. As such, successive generations of devices combine greater ranges of functions as well as fidelity and usability, so that m-learning is likely to become far more a normal part of practice in the years to come.

"Successive generations of devices combine greater ranges of functions as well as fidelity and usability, so that m-learning is likely to become far more a normal part of practice in the years to come."

Take home message: Mobile learning is still a developing area, but it already offers many advantages over more fixed forms of computing. Although there are ongoing issues of compatibility and ease of use the educational use of mobile devices can greatly benefit both teachers and students.

Conclusions

This first part of the AMEE Guide to e-Learning in Medical Education has covered the basics of e-learning, e-teaching and e-assessment. Clearly, there are many complex functions, roles, technology and pedagogical approaches involved, as well as a variety of different ways in which they can be used, both independently and blended with face-to-face teaching and learning. Not least among the various opportunities and benefits is the ability for these new approaches to cast light on the underlying philosophies and practices in all forms of contemporary medical education. It is also important to reiterate the key point made at the start of this guide that the field is rapidly developing and therefore the only guaranteed prediction is that things will continue to change. The second part of this Guide will consider technological, management and design issues for e-learning in medical education.

"Among the various opportunities and benefits of e learning is the ability for these new approaches to cast light on the underlying philosophies and practices in all forms of contemporary medical education. It is also important to reiterate the key point made at the start of this guide that the field is rapidly developing and therefore the only guaranteed prediction is that things will continue to change."

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Part 2: Technology, management and design

"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 the more experienced practitioner.

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

Box 2

Take home messages

- In just a few years e-learning has become part of the mainstream in medical education. While e-learning means many things to many people, at its heart it is about the educational uses of technology
- Practitioners 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

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 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).

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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 keyboard, 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.

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- 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.

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- 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 laboratories 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.

"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."

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, though, 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 file 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.

"The particular choice of media 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 is typically low."

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.

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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 (Oberprieler et al 2005, Ush Kiran 2004). 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 organising 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 it 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 made 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 made 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 on page 53.

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

"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."

"There is no doubt that the technical problems have to be carefully considered in e-learning, but almost all of them can be overcome with a little thought."

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, and 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 organise and become more active in the organisation 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).

"E-learning tends to change the political climate of education by 'flattening' the previously hierarchical relationships between students and tutors."

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 (Barrett & Lally 1999, Collis and Moonen 2001, Herring 2000, Masters and Oberprieler 2004, Savicki et al, 1996).

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 and 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 learners 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 ePBL (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, Salmon 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 socialising) 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 mean 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.

"The broad effects of e-learning also mean that a much wider range of political, sociological and psychological factors are likely to impact on your course."

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

"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."

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.

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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).

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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 and 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.

"The validity and applicability of educational design and process is an often overlooked, but essential, ethical issue."

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.

"The legal and ethical aspects of e-learning can be a minefield of trouble if not taken into account properly."

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.

"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."

Economic costs

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

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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.

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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 organisation) or out-sourced (passed to a contractor outside the organisation). 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 or 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 out-sourcing 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 organisations that use them, or as part of a joint activity or project between a number of user organisations. 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, Dewhurst and Cumming 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.

"The economic impact and viability of e-learning must be considered in terms of its costs and effectiveness."

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 (Carroll, 1991; Norman, 1988). 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 and 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).

"Educational technologies provide opportunities to expand the accessibility of learning materials in ways that are not easily done with traditional approaches."

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 (page 41) 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.

"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."

- 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 beforehand 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 beforehand 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.

"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."

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 in 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 organised, 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 how 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 and 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).

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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 and 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 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 and 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 and 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, Roberts, et al. 2007).

"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"

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 globalised 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.

"The range of specifications and standards in e-learning can be bewildering. Most practitioners should be aware that they exist."

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 legal and regulatory support, such as consent, professionalism, accreditation, authorisation, 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 and 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 the 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.

"people seem to distance themselves from a critical evaluation of the technologies in their lives as if [they] were inevitable forces of nature"

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 in 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 reconceptualise, unify and advance the science and practice of information in support of better healthcare, 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 of 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.

"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."

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 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 ubiquitous 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.

"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."

- 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.

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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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Resources

The following resources should prove useful in developing your understanding and practice both as an e-learner and as an e-teacher:

Further reading

OnlineFacilitation.com at: http://www.onlinefacilitation.com/. A useful starting point of resources and links dealing with online facilitation.

Pallof, RM and Pratt, K. 1999. Building Learning Communities in Cyberspace. San Francisco, Jossey-Bass. A solid starting text, covering a broad spectrum of issues for the beginner and intermediate user. Also useful for those who have been using e-learning for some time, but need a little theoretical underpinning.

Shank, Patti (Ed.) 2007. The online learning idea book. San Francisco. Pfeiffer (John Wiley). This is a really useful book, for both beginner and expert, filled with ideas and tips for using online learning tools. It assumes knowledge of the theory, and concentrates on practicalities. Tips range from very simple to advanced. It is ideal for casual browsing to look for things to make your online course more effective.

Caban-Martinez, Alberto J; Caban-Alemañy, Alberto J. 2004. A Pediatrician's Personal Digital Assistant: Ubiquitous Computing. International Pediatrics, 19(4): 198-207. Although this is aimed at pediatricians, it gives a useful guide to some of the technicalities of PDAs.

Distance Educator.Com: http://distance-educator.com. A really useful site for those involved in distance education.

Torrone, Phillip. 2006. What Is Podcasting. O'Reilly Digital Medica. http://digitalmedia.oreilly.com/2005/07/20/WhatIsPodcasting.html.This is a really useful introduction to the concept of podcasting.

Language and links

Rather than provide a list of the great (and ever-growing) number of terms, acronyms and concepts in e-learning we recommend that you look them up online using tools like Answers.com or Wikipedia to ensure a more comprehensive and up-to-date reference that we can provide in this guide. To track the latest neologisms and concepts follow Wired magazine (www.wired.com) or Digg (http://digg.com). We have also refrained from providing a long list of web links for the same reasons of parsimony – you are recommended to look up tools, companies, organisations and services online in the hope that your search will be more rewarding than having it done for you.

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