AMEE Guide 32: e-Learning in medical education
Part 1: Learning, teaching and assessment

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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 concerned with 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.

'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

Practice points

- 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.

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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.'

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 covers a wide range of topics, some in broad outline, and others in more detail. Each section is concluded with a brief Important Messages section which serves as 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 (in a separate publication) deals primarily with technical issues 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.

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 to address the 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

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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 our 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 2006a, Ellaway 2006b).

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).

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: 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 later section in this guide 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 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 that 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 also many e-administrators and e-support staff. 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 & 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 program 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.'

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 (Part 2) 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 knowledgebases a major part of the e-learning landscape. While some see this as a positive development (Surowiecki 2005; Tapscott & 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 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 or video 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 programs 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 really simple syndication (RSS). 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 2002), 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.

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, Tomorrows Doctor, ACGME or CanMEDS, can be supported by cross–mapping the internal curriculum map with these third–party authority systems (Ellaway 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.

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 & 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 programs 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 organized 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.

- 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 the section in this guide on facilitating online learning for more details.

- 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 (a shortened form of 'weblogs') 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 course-work.) Note that the authors (working 10,000 km apart) prepared this entire guide using a shared wiki.

- 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 below.) 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 in this guide 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 parti-cular 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 support-ing 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.edutool-s.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).

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 below), 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 & Wilkie (2007) for a range of different approaches and perspectives on ePBL.

> *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).

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 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, Candler 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 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 'thinslicing' 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.

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.

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.

The success of group work relies on active participation by all in the group. In online learning, low levels of participation is problematic (Fisher & Baird 2005; Swan 2001; Irizarry 2002; Rovai 2002). 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; Pilkington et al. 2000; Salmon 2000; Oliver & Shaw 2003; Masters & Oberprieler 2004) 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.

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 'lighpaths') 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 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.

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 (Stacey 1999; Carr 2000; Rovai 2002; Fisher & Baird 2005). 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).

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.

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; Lundeen et al. 1994; Robishaw & Roth 1994; Burnham & Perry 1996; Shelstad & Clevenger 1996; Dorsch 2000).

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 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 & 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 are 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?
- 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.

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 QuestionMark 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

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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 formalized 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.

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).

> *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 the following.

- 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 are 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 (Stone 2004; Masters 2005; Microsoft 2006; Masters & Ng'ambi 2007). 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; Kho et al. 2006; Taylor 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 (Sharples 2003; Masters & Ng'ambi 2007). 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').

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 (Rothschild et al. 2002; Houston et al. 2003).

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.

> *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.

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

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.

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.

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, organizations and services online in the hope that your search will be more rewarding than having it done for you.

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