MEDICAL EDUCATION AND E-LEARNING OPPORTUNITIES IN THE SOUTH PACIFIC

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Abstract

Over the past 10 years and particularly with the advent of collaborative and interactive "Web Version 2" (Web 2.0) technologies, medical educators around the world have taken advantage of opportunities available to develop and extend the use of '*e-learning*' in mainstream medical education. With a plethora of technologies now available at the fingertips of course directors and curriculum designers, the decision how to engage effectively in e-learning is not always easy. Although internet penetration is high in the larger countries of the Oceania region such as Australia or New Zealand, it is considerably lower for nations in the South Pacific, posing difficulties in the accessibility and viability of these technologies. This article reviews the current e-learning technologies being used in medical education globally and discusses the current and future opportunities and challenges relating to the introduction of e-learning to medical education in the South Pacific region.

Introduction

The term 'e-learning' refers to the use of the internet and computer based technologies to enhance knowledge and performance and, in relation to medical education, to enhance or facilitate the teaching and learning of medicine. E-learning often supplements face-to-face teaching (i.e. in a 'blended learning' curriculum) or real-time distance education, however this is not always the case and it highlights the importance of careful curriculum planning to ensure that e-learning is pedagogically appropriate. Over the years e-learning has been known as web-based learning, computer-assisted learning, on-line learning, or internet-based learning[1]. e-Learning is often central to programs that use distance education and computer-based instruction as their modes of delivery. Distance education traditionally used print based packages but as technology advanced it now utilizes a variety of technologies to deliver instruction to users via the internet who are geographically separated from the institution's central teaching location (usually a University campus). This has been enhanced by the use of institutional Learning Content Management Systems (LCMS) or Virtual Learning Environments (VLEs). Most of these use Web 2.0 tools to support learning (see Table 1 for a summary of Web 2.0 tools). Computer based instruction (also known as computer based learning or computer assisted learning) uses computers to deliver multimedia packages (e.g. on CDROM or DVD) for educational purposes.

Benefits and challenges

Ellaway and Masters[2] suggest that e-learning is not just about the content and delivery of teaching, but is a pedagogical approach that aims "*to be flexible, engaging and learner-centred: one that encourages interactions (staff:staff; staff:students; student:student) collaboration and communication*". With most educational institutions now engaging in e-learning, it is important to consider which courses can be delivered wholly on-line and which are best to adopt a hybrid (blended) model of learning. Before an effective e-learning strategy can be launched, academic and IT staff must be made aware of the technical tools available to them, how these can contribute to enhancing the learning experience and to review them thoroughly for feasibility and appropriateness.

It is vital that the availability of technology does not override the need for ensuring that it supports effective learning. e-Learning researchers Sanders and Haythornthwaite[3] support this approach and state "*the challenge for medical educators is to be aware of the new changes and to consider how the latest technology can be used to enhance learning".*

Examples of e-learning activities that are being implemented in on-line courses include:

- Synchronous teaching (real-time interactions such as instant messaging and virtual classroom software utilizing webcams)
- Asynchronous teaching (text based interactions such as discussion boards, blogs, wikis)
- On-line small group tutorials
- Problem based on-line learning sessions (e.g. case studies)
- Web 2.0 technologies such as wikis, blogs, podcasts, and the use of image libraries (i.e. Flickr™)
- Integrated Virtual Classroom software allowing highly interactive on-line teaching sessions given to geographically separated students

Table 1. e-Learning Terminology and Applications in Medicine and Medical Education

Asynchronous/synchronous: distinguishes live or real-time teaching and communication technologies (synchronous) versus others that are used out of synch (asynchronous). Synchronous examples include virtual classroom programs, instant messaging and chat rooms; Asynchronous examples include discussion boards and email.

Avatars: Found in virtual programs such as Second Life, avatars are a computer-generated representation of the user. Clinical teaching programs around the world are now utilizing Second Life teaching applications.

Blended Learning: educational approach that typically combines face-to-face teaching with computer-mediated instruction/learning.

Blogs: Shortened from Web Logs, are on-line personal text-based journals that can be commented on by others.

ICT: information and communication technologies refers to a country's ability to support the infrastructure to run the latest e-learning, Web 2.0 and telemedicine applications.

eHealth: encompasses a range of services or systems in healthcare including electronic health records, health care information systems and mobile technologies (see below).

Learning Objects: discrete self-contained units of instructional material assembled and reassembled.

LCMS: Learning Content Management Systems are software packages designed to allow educational institutions to introduce web-based courses by allowing students to access course materials, communicate, assess and administer while using both asynchronous and synchronous technologies. Examples include WebCT™, Blackboard™, Angel™ and Moodle™.

Mobile Technologies: also termed 'm-learning or mHealth' describes the use of portable technology such as laptops, palmtops, smart phones, Personal Digital Assistants (PDAs). Most US medical programs now endorse PDA use during clinical clerkships.

Multimedia Sharing: repository services that facilitate the storage and sharing of multimedia content on the web (example, Flickr™ for photo storage and You Tube™ for video).

Podcast/Vidcast: digital audio (podcast) or video recordings (vidcast) placed on the internet to be played on computers or downloaded to mobile devices such as MP3 players.

RSS (Really Simple Syndication) Feeds: users subscribe to a service that sends alerts of new information.

Second Life™: A virtual reality web-based world where residents represented by avatars communicate using chat and instant messaging technologies.

Social Networking Sites: web-based sites focused on community sharing and networking through the use of instant messaging, chat rooms and discussion boards. Examples include MySpace™, Facebook™ and Bebo™.

Web 2.0: a conceptual description of the World Wide Web to incorporate the current practice of facilitating interactive information sharing, collaboration and user-centered design. Examples include wikis, blogs, social networking sites, multimedia sharing sites and web-based communities and social networking sites.

Wiki: web pages that allow the community to develop edit and modify content. Wikipedia™ is an example.

- Integrating the use of mobile devices with learning platforms (interoperability=being able to use applications across platforms such as smart phones, PDAs, laptops, home PC)
- Web based simulations (such as Virtual Life™)
- Use of on-line repositories of information (approved by institutions)

What have been clearly documented are the benefits that e-learning can provide educational institutions and students (Adapted from Doherty and McKimm 2009[4, 3]):

- Improved performance
- Increased accessibility
- Ease of updating material as compared to hardcopy
- Convenience and flexibility to learners
- Learning of digital skills required for operating in the ever-changing digital world
- Learners and teachers can access courses from a variety of locations
- Decreased cost of travel

Notwithstanding the benefits, in developing countries, including those in the South Pacific, additional hurdles need to be overcome if e-learning is to be widely introduced. e-Learning adoption in institutions and on a national basis is partly driven by Government ICT policy and the available IT and social infrastructure. In developed countries in the Australasia Pacific region, such as Australia and New Zealand, competition in a reasonable sized market (22.5 million and 4.4 million people respectively in 2010) allows for pricing structures that are globally competitive, delivering value for money to the customer and to educational institutions (both government and private). However there remain considerable challenges for small island nations in the region, especially in the South Pacific.

Dr Robert Whelan from the Centre for Educational Development and Technology (University of South Pacific, Fiji)

(USP) delivered a ministerial briefing paper titled "e-Learning in the South Pacific: current status, challenges and trends" at a Heads of Commonwealth meeting held in Uganda in 2007[5]. USP caters for over 13,000 distance based students across the Pacific region and has established the Pacific eLearning Observatory (PELO) research project to monitor the development of ICT in secondary and tertiary education in the 12 USP member nations (Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshal Islands, Nauru, Niue, Northern Marianas, Palau, Papua New Guinea, Samoa, Tokelau, Tonga, Tuvalu, Vanuatu). From a survey undertaken in 2007, 60 ICT experts across the Pacific suggested the top 3 challenges relating to ICT adoption for educational purposes are lack of adequate finance, lack of skilled personnel and access to IT infrastructure (see Table 2 below).

Table 2. Top 10 challenges suggested from 2007 USP PELO survey (adapted from Whelan 2007)[5]

	Top Challenges for educational ICT development in the South Pacific
1.	Lack of adequate financing
2.	Lack of skilled personnel
3.	Poor access to infrastructure and ICT equipment
4.	Low awareness about the benefits of ICT
5.	Ineffective secondary infrastructures such as electricity, roads and related services
6.	Low connectivity speeds and inadequate networks
7.	Difficulties in maintaining/repairing broken equipment
8.	Lack of integration of ICT into the curriculum and outdated curricula
9.	Lack of 'ICT culture'
10.	Lack of trust and suspiciousness about ICT

The challenges for educational ICT development in the Pacific island nations are significant. A number of strategies to address these barriers were also proposed:[5]

- **Improve planning and policy**
  Development of a national, workable ICT implementation plan
- **Review and Develop Legislation**
  Especially policy hindering ICT development in education
- **Enhance training and capacity building**
  ICT training was seen as vitally important to lead to overall capacity development and improvement in distance education access
- **New curriculum development**
  ICT needs to be integrated into educational curriculum
- **Increase access to ICT**
  Expand existing internet and communication networks and public internet centers
- **Cost reduction**
  ◊High costs of hardware and internet access by local internet service providers (ISPs) are hindering ICT uptake
  ◊Free or low cost access to internet for rural areas or outer islands
- **Sustainable development of ICT**
  Sustainable and environmentally sound ICT adoption and practices

The PELO project also emphasizes the high cost of equipment and telecommunication expenses as being important barriers to adoption. For small island nations, satellite internet is currently the only means of gaining access to internet and in larger Pacific nations a mixture of satellite and undersea optic fiber access is available. An example where government policy has made a difference is Samoa where in 2009, the undersea optic fiber cable between Hawaii and Auckland was redirected to American Samoa and then to Apia, Samoa which resulted in a significant increase in available bandwidth and internet speed. The 2 competing telecom companies now offer increased broadband internet speeds however the packages are expensive as compared to more developed countries such as Australia and New Zealand (270 tala for ADSL2 for 2 Gigabytes per month as compared to ~ 120 tala for ADSL2 for 50 Gigabytes[6]) where multiple ISPs engage in price competition. OUM has utilized the increased speed into its main campus and is at the forefront of providing e-learning to both its local and internationally-based students. High telecom costs will continue to inhibit ICT uptake and e-learning opportunities for developing world Pacific island nations until governments (with the help of donors and global aid institutions) can improve the access of ICT in urban and rural areas. While ICT challenges are struggling to be overcome in the region, educational initiatives, including medical and health education, will continue to lag behind more developed nations.

e-Learning in practice: using Web 2.0 and other tools in medical education

There has been a general shift in education towards a blended learning approach utilizing e-learning, traditional face-to-face classroom teaching and self-directed learning. This enables teachers to design programs that utilize the most appropriate learning modalities and technologies to stimulate and promote effective learning and assessment. Examples might be a lecture supplemented with an online tutorial that students study in their own time, students working on a group assignment using a wiki which they then present

back in the classroom, clinical students learning about surgical procedures (e.g. laparoscopy) via video streaming or the use of virtual online patients and robot technology before they work with real patients.

We have been talking about Web 2.0 as providing some of the main tools used in e-learning today, however this is only part of a generational development that started with the early technologies (Web 1.0) found on the World Wide Web (WWW) since its inception in 1991. The Web 1.0 era delivered static web sites that focused primarily on commerce and flow of content to the user. At a landmark internet conference held in 2004[7], the term 'Web 2.0' was coined to define the current age of the internet in regards to the technologies it utilizes. After the 'dot.com' bubble burst in 2001, new web-based technologies began to emerge that shifted the emphasis on "read-only" material and the one-way flow of information on the web to a use of decentralized web content with many users being contributors and producers of information as well as the traditional consumers. Web 2.0 is commonly associated with web applications that facilitate interactive information sharing, interoperability (the ability of diverse systems to work together), user-centered design and collaboration on the World Wide Web.

Many experts suggest we are already moving into the next phase of web development, Web 3.0, with a focus on semantic web (the meaning of data), personalization (e.g. iGoogle™), intelligent and tailored searching and behavioral advertising (see Table 3 for a comparison of features). However, the term is conceptual and has a long way to being properly defined.

Critics of the Web 2.0 term consider it a buzzword and that the Web 2.0 applications are what the original web was designed to be.

Other critics[8] question the accuracy of user-generated content that creates a cult of digital narcissism and amateurism, noting for example that Wikipedia™ is full of mistakes, half-truths and misunderstandings. However, Web 2.0 applications are widely used in many industries, in health and in education, including medical education.

Table 3. Comparison of key features between Web 1.0, Web 2.0 and Web 3.0

Web 1.0 Features (1991-2003)	**Web 2.0 Features** (2003-current)	**Web 3.0 Features** (2010-future)
Read-only web	Read-write web	Portable personalized web
Focused on companies	Focused on communities	Lifestream™
Owning content	Sharing content (e.g. Facebook™, Twitter™)	The Semantic Web
Britannica Online	Wikipedia™	Widgets, Drag and Drop Mashups
Web forms	Web applications	iGoogle™, NetVibes™
Proprietary HTML	XML, RSS	User behavior
Static home pages	Blogs, Wikis	Consolidating dynamic content
Netscape™	Google™	Advertainment, iGoogle™

Virtual Learning Environments (VLEs)

Virtual Learning Environment (VLE or LCM) systems such as WebCT™ (now known as Blackboard Learning System™[9]) and Moodle™[10] (*modular object-oriented dynamic learning environment*) are continuing to increase their market share of the e-learning software market. VLEs are a multi-user environment where developers may create, store, reuse, manage and deliver digital learning content from a central object repository. VLEs such as Moodle and Blackboard are used to deliver e-learning strategies such as on-line courses to students, many geographically separated from the main campus or learning centre.

Moodle is a free, open source e-learning platform that is a cost effective way to introduce e-learning strategies into an institution, especially those that are financially limited such as those in the Pacific region. Moodle has many similar features to traditional LCMS but supports the web 2.0 approach of supporting interaction and collaborative construction of content[11].

In the South Pacific, the National University of Samoa (NUS based in Samoa), the University of the South Pacific (USP with its main campus in Fiji)[12, 13] and Oceania University of Medicine[14] (Samoa) have all launched e-learning initiatives utilizing Moodle platforms. OUM implemented Moodle™ as its prime teaching platform for its distance-based teaching in 2002, followed by USP in 2007 and NUS in 2009. At OUM, Moodle™ is used as the primary facilitator of resources in its 4 year graduate-entry medical program and 5 year undergraduate program offering enrolment into courses, access to problem-based learning case studies, notes, podcasts, recorded lectures, discussion boards, instant messaging access and the ability to store curriculum files for the students to access whenever they want (24/7 access).

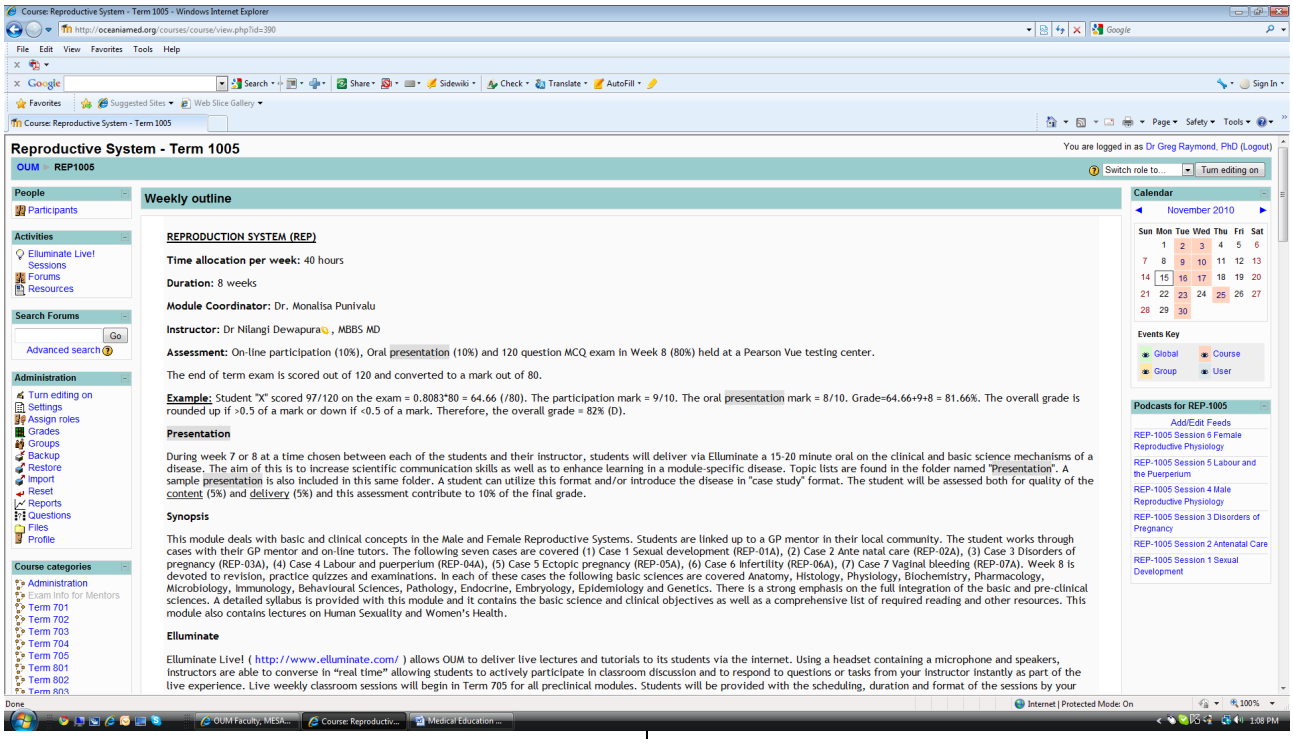


Figure 1. Screen capture from OUM's Moodle™ application

OUM utilizes Moodle™ as a file and information repository for students and staff. Students are enrolled into interactive preclinical modules (e.g. Cardiovascular System) where they can download curriculum materials, instant message instructors or other students, interact in daily discussion board sessions, and download or stream RSS podcast recordings of each lecture (middle right of Figure 1). A calendar informs students of live lecture times.

Live teaching software is integrated into the Moodle™ platform allowing a synchronous and asynchronous approach such as discussion board interaction with other students and the instructor. Universities around the globe are establishing VLE sites to support the ever-increasing variety of new online courses and programs.

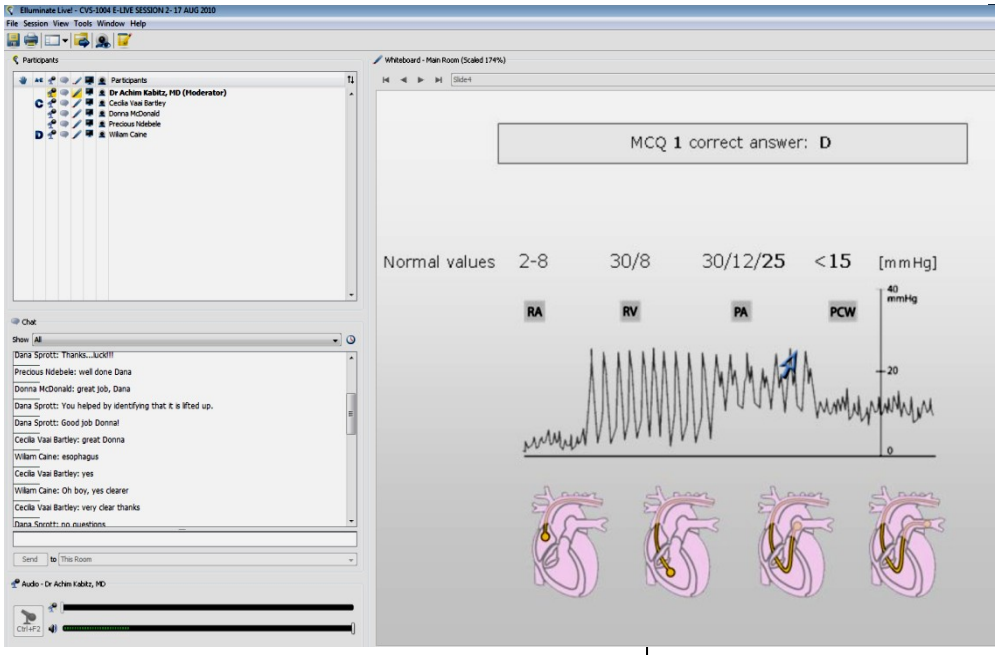
Live Teaching Technology

Traditional face-to-face didactic lectures as the mainstay of medical education are slowly becoming a thing of the past as new and effective ways of interactive teaching using e-learning are being implemented. Many Universities are now developing undergraduate and postgraduate programs (degrees - bachelor, PhD, Masters; certificates; diplomas) in blended curricula that in part can be run on-line through asynchronous teaching (using discussion boards and text based assignments) and synchronous teaching (using instant messaging, real-time audio tutorials and teleconferencing). Such programs would also involve face-to-face and practical sessions that are deemed essential for subjects like medicine that require learning complex practical clinical and communication skills underpinned by an extensive knowledge base.

Over the last five years, teaching software has been developed that allows real-time and interactive learning to take place in a virtual on-line classroom environment. Software developers and programmers work together to ensure that these types of programs can be integrated within the University-wide LCMS. Examples of virtual classroom teaching software including Elluminate Live! ™[15], Wimba™[16] and Dim Dim™[17] allow the use of video and audio and can record PowerPoint™ lecture sessions run by teachers and instructors on the internet. Students log into the live sessions and have the ability to answer and ask questions via real-time audio as well as see pointers directed at PowerPoint™ items on the screen or a whiteboard, containing text or images that can be manipulated by the instructor or students dependent on pre-set permissions.

There is a huge shortage of qualified medical educators in the South Pacific. Oceania University of Medicine[14] has used virtual classroom teaching software and Moodle to involve a network of internationally based on-line faculty in course delivery, teaching basic and clinical sciences over the internet. Using Elluminate Live!™ software, high quality on-line lectures are delivered to students located in Samoa, Australia, New Zealand and the United States (see Figure 2).

Figure 2. Example of small group on-line medical teaching using Elluminate Live!™



PowerPoint™ lectures can be run in real-time with the instructor speaking through a microphone attached to a computer. Students have the ability to answer and ask questions as well as use the instant messaging function to communicate.

Although software such as Elluminate Live!™ is designed to allow users with low bandwidth to join in, the technology works best and is maximized for users with a broadband connection. Recent technological improvements to ICT infrastructure in Samoa has enabled the OUM medical program to showcase invited guest live web lectures for Samoan physicians as part of their Continuing Medical Education (CME) program as well as to undergraduate students. The authors are not aware of other live web-based teaching software used in other South Pacific educational institutions which provides an opportunity for other Pacific Island nations to utilize this model to bring in additional teaching expertise into their countries.

Web-based Simulations and Virtual Patients

Medical students and graduates are increasingly required to attain a minimum competency prior to providing patient care, while regulatory and accreditation bodies are mandating demonstration of competence prior to licensure or board certification. Economic pressures to provide adequate patient care has increased demand on hospital physicians and often reduced the teaching time available for medical students. Mechanisms by which baseline principles of clinical skills, patient communication, interviewing and examination skills can be taught using e-learning techniques have evolved that include the use of virtual patient databases and patient simulators/ mannequins. A virtual patient review by Cook and Tiola[19] proposes that certain core teaching functions be aligned with different teaching techniques including the use of real patients and human patients such as actors (see Figure 3). They define a virtual patient as a specific type of computer program that simulates real-life clinical scenarios where learners emulate the roles of health care providers to obtain a history, conduct a physical examination and make diagnostic and therapeutic decisions.

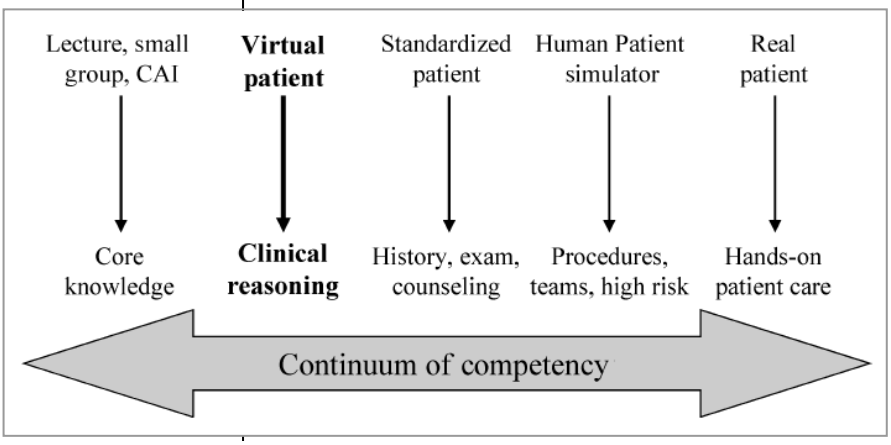


Figure 3. Aligning instructional modalities with desired outcomes (Cook & Tiola, 2009[19]). CAI = computer-assisted instruction.

Other Virtual Patient definitions include a broader range of techniques for medical educational purposes:
(1) Artificial Patients or animal models (computer simulations designed to teach biochemical or physiological principles without conducting experiments on humans or animals)
(2) Human Patient Simulators (mannequins or life-like models reflecting human appearance, pathology and physiology)
(3) Simulated Patient (patient information recreated by humans using fictional data and stored in a database for student use)
(4) e-Patients (use of real patient data with different name to maintain anonymity, e.g. electronic

health record information)
(5) Virtual World Patient (patient is a computer generated character - an avatar - living in a virtual world environment).

Artificial patient software and patient simulators are becoming increasingly commonplace in medical schools all over the world. Simulated patient databases however take considerable time, effort and resources to establish and are often created by individual medical schools or consortia. Access to a patient database by other medical schools is often under a licensing arrangement and dictated by budget issues. Recently, virtual patient databases have become available to be shared amongst member medical schools requiring registering schools to participate in the development of the database[20].

Virtual World software applications have grown rapidly over the past decade as academic institutions around the globe sign up to develop a presence in those virtual worlds. Examples of virtual world software[21] include Second Life™ (Linden Lab's), ProtoSphere™ (ProtonMedia), OLIVE™ (Forterra Systems), the Croquet Consortium™, and Open Wonderland™ (Open Wonderland Foundation). In these on-line worlds, users choose an avatar (or virtual character) and interact in a 3D environment with other on-line users controlling the character's movement, actions and voice. Educational institutions, including medical schools[22] and health organizations, are developing educational activities to be taught to students in this environment. Recently there has been growing interest in the medical and public communities in using Second Life™ for public education, outreach and training. Imperial College, London has created a game-based simulation in for undergraduate medical students where they can interact with virtual respiratory therapy patients in order to build their skills and confidence[23]. Many medical school pilot projects have been established to test the Virtual World teaching capability and quality[22]. As this technology is reliant on reliable, fast and cost-effective internet access it is prohibitive to many of the South Pacific nations. However, as internet pricing becomes more competitive and higher bandwidth becomes available within the next few years, opportunities exist for medical institutions in the Pacific region to collaborate with developers of medical education virtual sites. For example, OUM is investigating the possible use of virtual world surgery applications with Professor John Windsor of Auckland University who has developed a laparoscopic teaching environment in Second Life™.

Podcasting, Vodcasting and RSS feeds

Since the 1990's, with the advent of reliable and clear audio recording technology designed specifically for the classroom, medical school lectures around the world have been recorded directly on video cameras set up in the classroom or lecture hall or by dedicated microphones. Initially utilizing tape media, recordings were played back in video tape players or tape recorders for students who missed a lecture. Access was carefully controlled, usually by the medical librarian. Over time, digital audio recordings have replaced analog tape, with the ability for computers to play the files, allowing educational institutions to store digital audio files of lectures on their servers. This allows for efficient and flexible downloading via the internet and is securely controlled behind the University-wide LCMS with the majority of tertiary institutions offering this service.

Podcasting refers to a series of digital media files, either audio or video (sometimes called vodcasts), that are released episodically and often downloaded through web syndication. The term 'podcasting' has been around since 2004, closely linked to Apple Computer Company's™ portable media player, the "iPod"™ [24] that originated in 2001 with the capability of playing audio music files in the MP3™ format. Podcasting however refers to a number of digital audio formats (i.e. MP3, wav, midi) rather than the device to play the files and these files can be played on any portable or home audio/video device (car CD player, portable CD player, iPod™, MP3™ player, DVD player). As portable devices improved in regards to screen size and storage capacity, video files became popular.

Although most lectures are now available in both formats, students prefer video podcasts so that lecturers can be seen, whiteboards viewed and PowerPoint™ presentations watched. Files are accessed using RSS technology (Really Simple Syndication) that is a web uploading service that automatically updates a server with new files.

OUM in the South Pacific offers audio podcasts to all students within 48 hours of each lecture. Processing the files currently takes place overseas, however, with the recent improvement in ICT bandwidth, the service will be managed in Samoa over the next year along with the introduction of video podcasts. It is not known whether other universities in the South Pacific offer this service.

Continuing Medical Education and e-learning

When students graduate from medical school and take their medical oath of service to the community, there is an expectation that each doctor will be a lifelong learner and reflective practitioner who keeps abreast of the dynamic changes in medical technology and disease management. To make this a reality, governments, licensing and regulatory bodies, State Medical Boards and Medical

Associations around the world have introduced systems of professional development and revalidation that are linked to a doctor's license to practice. The schemes of professional development are typically termed Continuing Medical Education (CME) and Continuing Professional Development (CDP) which require practicing doctors to accumulate and record credit points or hours of attendance (over a varying period of time, up to five years), linked to a combination of short courses (face-to-face or online), conferences, workshops, professional meetings or written publications. Industry funded CME or CPD events run by pharmaceutical companies have sometimes been criticized as 'biased' or 'having an agenda' and now most CME programs are controlled and approved by a medical regulatory body such as the Accreditation Commission on Colleges of Medicine (ACCM) in the United States or the Medical Royal Colleges in Australia and New Zealand.

In the South Pacific, limited CME or CPD programs are available. Fiji School of Medicine (FSM) runs several courses for Fijian based physicians and Oceania University of Medicine (OUM) has started to offer CME events. Physicians from other islands are required to attend local CME lectures as the sole source of training. In Samoa, each year a medical practicing certificate is validated after attendance at CME lectures is confirmed. However, there are new opportunities to extend the scope of learning using international e-learning CME programs that have grown over the past decade[25]. New Zealand and Australia now offer e-learning based CME training in many specialty areas often linked to medical schools, Medical Associations or professional bodies. Pacific Island nations need to consolidate and build on their professional relationships with leading nations to access on-line courses that will significantly expand doctors' training options without having to engage in the expensive option of traveling to these countries.

m-Learning

As digital equipment becomes smaller and more portable there is an increasing integration between traditionally computer-based technologies and mobile communication devices. m-learning (or mobile learning) is supported by a growing trend for medical students and young doctors around the world to purchase the latest mobile smart phones (e.g. iPhones™ and Blackberry's™) or PDA's[26] for use in a hospital or clinical environment where bulky laptops are not practical and where wireless networks are available. Sales of these devices are also being driven by the availability of medical software and files for these devices such as the MSOffice™ suite, e-textbooks (digital copies of medical textbooks), clinical skills videos (stored as a library for review), drug reference guides (e.g. Epocrates™), medical calculators (e.g. for drug dosage, Arterial Blood gas calculations), medical dictionaries, medical study tools (Netter's flashcards, diagnosis guides, mnemonics guide) and patient database software (track patient information for log books).

Generation Y students are highly knowledgeable about these technologies[27] and are adopting mobile technology and new software applications that are quick, easy-to-use and medically relevant for practicing medicine in a hospital environment where students, doctors and patients are constantly on the move. Medical school IT departments often make recommendations of devices and software to standardize the range and quality across the student populations. In the Pacific, telecommunication companies have lowered prices on some smart phones but prices are still prohibitive for most students and the adoption of this technology has been slow. This situation may improve if telecom companies consider offering bulk deals with Universities, government or institutes of higher learning but it remains to be seen if this will occur.

Mobile health (mHealth[28]) Moodle™is the practice and delivery of medical and public health services by mobile technology such as mobile communication devices (mobile phones and PDAs - personal data assistants), computers, communications satellites, and patient monitors. Due to the rapid rise of mobile phone penetration in low-income nations, mHealth technology is exponentially growing in countries where physical medical access for rural populations is limited. This allows for an improved ability to diagnose and track diseases and an increased access to healthcare and health-related information in rural areas. Tomorrow's doctors will need to be aware of and familiar with using a wider range of such devices, particularly when working in rural or remote areas of the world.

Conclusions

New and advancing technologies provide huge opportunities for curriculum designers, teachers, students and patients to engage in exciting and innovative learning experiences for the benefit of all. As with any educational intervention, care must be taken to ensure that the availability of technology enhances learning and is not just 'technology for technology's sake'. More limited access to computers and communications devices, and reliability and speed of the IT infrastructure may mean that medical students in the South Pacific and other remote areas of the world may have fewer opportunities available to them than their counterparts in more developed countries. However, the selective use of e-learning as part of a blended learning curriculum enables medical

students in the Pacific to engage with high quality teachers and doctors around the world in both real time and asynchronous learning events. As electronic and mobile technologies become more widely available at reasonable cost, and as governments work collaboratively to address IT infrastructure challenges, the use of such technologies in both healthcare and education will become more widespread. This is the huge benefit of e-learning, in that tomorrow's Pacific doctors will be true 'digital natives', working to care for patients living in rural and remote areas, providing access to screening, preventive care and medical treatment delivered in new ways by doctors who are familiar and confident in using a range of technologies as part of their everyday practice.

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