E-learning in Medical Education and Blended Learning Approach

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Introduction

Education has evolved from a material based process, where the instructor (teacher) focused on presenting information to students, to a student (learner) centered process where students are able to learn at their own pace. Furthermore, the student’s role has changed from being a receiver to a being a learner and the instructor’s role has changed to being a mentor, guiding students to acquire knowledge and improve their learning skills [1]. The focus has shifted from a teacher-centered model to a learner-centered one, offering stronger learning motivation and interactivity. Interactivity maintains learner interest and provides a means for personalized learning and reinforcement. Evidence suggests that e-learning is more efficient in most cases because learners gain knowledge, skills, and attitudes faster than through traditional instructor-based methods. This efficiency translates into improved motivation and performance. In addition, the use of e-learning is associated with improved retention rates and efficient use of content [2].

The main goals of medical education are to equip students and graduate clinicians with the necessary medical knowledge and skills and to provide them with the strategies for their application in practice. The integration of e-learning into undergraduate, graduate and continuing medical education has a significant impact on the delivery and performance of medical education [3].

The rapid evolution and growth of information and communications technologies (ICT), and the rapidly changing health care environment with advances in the biomedical sciences and in the diagnoses and management of diseases, and the delivery of health care services, have led to the development of new services and applications. Furthermore, the shift towards competency-based medical education and problem based learning, together with the increasing complexity and volume of medical content, have increased the demand for continuing education and knowledge updates. These have, in turn, created demands for new methods and approaches to medical education e.g. online continuing medical education (CME) and e-learning [3-5].

E-learning can be defined as the use of ICT or the Internet in educational activities. E-learning is also defined as learning mediated by technology, such as the Intranet, and multi-media based computer applications. E-learning systems enable students to extend their learning experiences beyond the borders of a classroom by using both online and offline learning resources. Such activities usually increase the interaction among students and between instructors and students. Because of the nature of medical education, e-learning systems require specialist design to accommodate more practical sessions, and more student involvement in medical procedures and operations. To provide medical students with a productive e-learning experience, an e-learning system should be able to provide students, not only with access to text books and lecture materials, but with both simulated and real life cases including medical history, lab results, radiology images and other patient related information. These resources improve the students’ diagnosis and intervention skills, leverage their learning outcomes and improve their learning capabilities at the same time as improving their accessibility by utilizing ICT tools [6, 7].

History

The use of computers in medical education has been in continuous development since the early 1960s. Its adoption however, has been limited by the programming process of entering data through punch cards and the limitations of relatively primitive computer languages. Although the earliest attempts to apply computer applications in medical education started in 1961, major developments in computer-assisted instruction occurred in quick succession in the late 1960s at several American medical colleges. Different terms such as “computer-based learning”, “computer assisted education”, “computer assisted learning; CAL” have been used but the differences were basically semantic. Ohio State University started a CAL application in 1967 as a one-terminal, one course system. In 1969 the program was incorporated into the evolving Independent Study Program in the basic medical sciences and was called "TES" (Tutorial Evaluation System). Production of lessons was to a great extent assisted by the development of the COURSEWRITER III; a computer program that allowed an instructor to enter text in response to computer guidance without any need for programming skills. Simultaneously, the Massachusetts General Hospital Laboratory of Computer Science began developing simulations of clinical encounters. Employing a computer language developed for the purpose and a well-designed instructional strategy, these simulations became highly sophisticated. By the middle of the 1970s, the
Massachusetts General Hospital laboratory had developed more than 30 simulations with multiple cases within each simulation [8].

The University of Illinois developed a different type of simulation model that was termed “CASE” (Computer-Associated Simulation of the Clinical Encounter). A common feature of these systems was that they ran on mainframe computers, accessible over telephone lines and with the capacity to time-share. The National Library of Medicine in 1972 sponsored a consortium to share these educational resources, paying the costs of access via a national computer network. The Massachusetts General Hospital, Ohio State University and the University of Illinois served as hosts. More than 150 institutions participated in this program. In 1984 an explosion of activity, that continues to date; was undoubtedly prompted by the advent of the personal computer [8].

Modes of E-Learning

There are many approaches to implementing e-learning systems including distance learning which enables students in different continents to obtain graduate and post graduate degrees remotely with no need to attend lectures in person [9].

Creating e-learning material involves several components. Once content is developed, it must be managed, delivered, and standardized. Content comprises all instructional material structured in a meaningful way. Material could be linked to a specific learning objective as a part of a specified curriculum. Examples of the instructional materials include tutorials, PowerPoint™ presentation slides of lectures, case-based learning, hypermedia, and web links. Content management includes all the administrative functions (e.g. storing, indexing, and cataloging) needed to make e-learning content available to learners. Examples include portals, repositories, digital libraries, learning management systems, search engines, and e-portfolios [10-12].

Content delivery may be either synchronous or asynchronous. Synchronous delivery refers to real-time, where all learners receive information and communicate simultaneously. Examples include teleconferencing or videoconferencing, Internet chat forums, and instant messaging. While in asynchronous delivery, the transmission and receipt of information do not occur simultaneously, the learners are responsible for pacing their own self-instruction and learning [13, 14].

A concept related to e-learning prior to the birth of the Internet was multimedia. Multimedia uses two or more media, such as text, graphics, animation, audio, and video to produce engaging content delivered by computer. A detailed definition of multimedia is “the combination of various digital media types, such as text, images, sound and video, into an integrated multi-sensory interactive application or presentation to convey a message or information to an audience” [15].

Applications of E-learning in Medical education

Due to the advantages of e-learning in medical education i.e. increased accessibility to information, better updating solutions, personalized training, better distribution, standardization of content, better efficiency in achieving knowledge and skills, it has been used more frequently in the last decade. The technological advances and the Internet contributed to the development of the e-learning resources. In addition, repositories and digital libraries for access to e-learning materials were established. Students greatly appreciate the facilities offered by e-learning (easy access to materials, navigation, interactivity, friendly interfaces). But they do not consider it as a replacement for the traditional learning which has its own advantages [16].

E-learning offers opportunities for flexible teaching and learning while enhancing the possibilities for more individualized and self-directed learning. Technology mediated education modes have been used to overcome geographic restrictions. Enhanced capacity for interactive teaching and learning is another advantage of e-learning. It is believed that e-learning is better suited for problem based education, and can also be cost-effective. Studies have demonstrated that technology mediated learning can provide cost savings for both learners and providers [17]. Technologies used in e-learning can vary from a simple audio-tape or a DVD to sophisticated multi point videoconferencing facilities supported by simulation and online applications. In fact, international organizations such as the United Nations (UN) and the World Health Organisation (WHO) have acknowledged e-learning as a useful tool in addressing education needs in the healthcare sectors in developing countries. The United Nations’ Millennium Development Goals have articulated the significance of use of ICT to address education and health problems in developing countries [18, 19].

Integration of e-learning into traditional medical education can be effective in addressing most medical education challenges [1]. There are various examples of successful integration of e-learning modes in medical programs around the world. Technology has been effectively used to deliver learning material, enhance communication and administration; there is also evidence that e-learning has been useful in providing health and medical education [20, 21].
Preclinical & Clinical applications

The introduction of e-learning tools into medical education has made significant changes in the way medicine is taught. It has become mandatory for the medical students and teachers to have advanced ICT skills to help them achieve their goals in learning and practice and to be able to manage and utilize e-learning systems, and to gain more from the online information and the Internet [4]. Computer applications in medical education have been developed to enhance traditional education strategies, and to provide new methods of learning. For undergraduate students, asynchronous delivery of curriculum for self-learning and to augment traditional classroom and lab sessions has been developed. Computer-based learning can be applied in many ways such as drill-and-practice with immediate evaluation by multiple choice questions; simulated cases with self-assessment; synchronous videoconferencing for small group teaching; clinical training where the common “visit rounds” are replaced or supported by patient computer simulated programs; simulation and animation applications; as well as searching the Internet for medical information; telemedicine; web-based teaching tools and virtual reality [22-24]. In addition, medical students are provided with appropriate practice in the form of live cases, clinical procedures, radiology image examinations and diagnosis, patient medical history review, and other basic medical practices [1].

Continuing Medical Education for health professionals

Health professionals need to regularly update their knowledge of changes and advances in medical sciences, technologies and techniques. This activity is often called continuing professional education (CPE) or continuing medical education (CME). The overall use of online CME remains limited [25]. CME is usually acknowledged as an indispensable part of the working life of physicians and health professionals. The use of the Internet and its related technologies that augment knowledge and performance can be integrated into CME programs. Compared with conventional learning, e-learning has the advantage that participants can choose the place and time themselves. Within a clinical context, the effect of Internet-based CME programs is comparable to traditional CME approaches [26-28].

Internet-based CME is a response to the challenges of globalization and high demands in medical practice. Online learning has a significant role to play in CME, offering personalized and flexible learning [24]. Core elements in constructing an e-learning program include a bank of reusable learning objects, a virtual practice, and a set of learning outcomes and self-assessment activities [28-30]. In the last decade many countries have legislated for the revalidation and recertification of medical practitioners within their health systems. Two principles underlie CME: professional development is a process of lifelong learning in practice, and professionals must be able to demonstrate they are clinically competent in their roles.

Simulation

Virtual world software applications in education 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 applications are Second Life (Linden Lab) [31], ProtoSphere™ (ProtonMedia) [32], OLIVE™ (Forterra Systems) [33], the Croquet Consortium™ [34], and Open Wonderland™ (Open Wonderland Foundation) [35]. In these on-line worlds, users choose an avatar (or virtual character) and interact in a three Dimension (3D) environment with other on-line users controlling the character’s movements, actions and voice. Educational institutions, including medical schools and health organizations, are developing educational activities to be taught to students in this environment. Recently there has been growing interest by medical and public communities in using Second Life™ for public education, out-reach and training [36, 37].

Virtual models for e-learning are defined by the European Commission as computer programs that simulate the action of real devices and systems which help students to improve their theoretical knowledge and practical skills. According to ToroTroconis M. et al [36], “virtual reality” is a computer simulation that creates an image of a world that appears to our senses in much the same way as we perceive the real world, or “physical” reality. Virtual reality is a medium by which people can share ideas and experiences. A virtual patient is defined 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 [38].

Other virtual patient definitions include a broader range of techniques for medical educational purposes:

- Artificial patients or animal models (computer simulations designed to teach biochemical or physiological principles on simulated models) [39]
- Human patient simulators (mannequins or interactive models reflecting human appearance, pathology and physiology)
- Simulated patients (patient information simulated and stored in a database for student use)
- E-patients (use of real patient cases with different names to maintain anonymity, e.g. electronic health record information)
• Virtual world patients (patient is a virtually generated character — an avatar — living in a virtual world environment) [40].

Blended learning approach

Blended learning, a fairly new term in education, is an approach that combines e-learning technology with traditional instructor-based education. The term blended learning may be new, but the concept is familiar to most educators. Faculty, administrators and learners find that multimedia and e-learning enhances both teaching and learning. There has been a general trend in education towards the blended learning approach employing both e-learning, and traditional face-to-face classroom teaching with self-directed learning. This enables medical educators to design programs that use the most appropriate learning modalities and technologies to stimulate and promote an effective learning process. Examples includes a lecture supplemented with an online tutorial, a group assignment using a wiki, surgical procedures (e.g. laparoscopy) via video streaming or the use of virtual online patients and robot technology [41].

Ease of delivery is the most often cited advantage of e-learning; it includes accessibility, easy updating, personalized instruction, distribution, standardization and accountability. Accessibility refers to the user’s ability to find what is needed, when it is needed. Improved access to educational materials is crucial, as learning is often an unplanned experience. As updating electronic content is much easier than updating printed material, e-learning technologies allow educators to revise and update content simply and quickly. In an e-learning environment, learners have control over the content, learning sequence, pace of learning, time, and interactions, thereby allowing them to tailor their experience to meet their learning objectives. Internet applications allow the widespread distribution of digital content to learners simultaneously anywhere and anytime.

New and advancing technologies provide enormous opportunities for curriculum designers, teachers, students and patients to engage in exciting and innovative learning experiences. 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. A limited access to computers and communication technologies, and unreliability and unavailability of information technologies (IT) infrastructure may mean that medical students have fewer opportunities available to them. The selective use of e-learning as part of a blended learning curriculum enables medical students to engage with high quality teachers and doctors around the world in both real time and at 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. The huge benefit of e-learning is that tomorrow’s doctors will be digital natives, working to care for patients living in rural and remote areas. These patients will have access to screening, preventive care, medical treatment and management delivered in new ways by doctors who are familiar and confident in using a range of technologies as part of their everyday practice [42, 43].

However, students do not see e-learning as replacing traditional instructor-led training but as a complement to it, forming part of a blended learning strategy. Many universities are now developing full suites of undergraduate and postgraduate programs in blended curricula that can, in part, 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 also involve face-to-face and practical sessions, deemed essential for subjects like medicine, that require learning complex practical, clinical and communication skills underpinned by an extensive knowledge base.

To complement the traditional teaching, interactive tutorials are developed on a teaching website or what is called a Virtual Learning Environment (VLE). The VLE can contain, for example, clinical cases which are in a problem-based learning (PBL) format that closely resemble real-life medical scenarios. Cases mainly cover the common cardiac and respiratory scenarios, they may also include other common emergencies such as stroke and gastrointestinal hemorrhage. Links are also available to useful educational sites and current clinical guidelines are provided with each case via national or international organizations.

VLE or learning content management systems are a multi-user and multi-mode environment where learners may create, store, retrieve, 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, who are geographically separated from the main campus or learning centre [20, 44].

Over the last few years, teaching software has been developed, that allows real-time and interactive learning to take place in a virtual on-line classroom environment. Examples of virtual classroom teaching software includes Elluminate Live!™ [45], Wimba™ [46] and DimDim™ [47], which allow the use of video and audio and can record PowerPoint™ slides and sessions on the Internet. Students have the ability to answer and ask questions via real-time text and audio, and follow the instructor’s pointers on the PowerPoint™ items on the screen. These can contain text or images which can be manipulated by the instructor or students depending on the pre-set permissions [48].

There is a huge shortage of qualified medical educators worldwide and universities have used virtual classroom teaching software and learning management systems to involve a network of internationally based on-line faculty in
course delivery, teaching basic and clinical sciences over the Internet. Employing the latest technology and software, high quality on-line lectures are delivered to students locally and remotely [49, 50].

Discussion

Traditionally, education has been based on attending classes day after day, listening to a lecturer providing the necessary course work information, and going through exams to assess knowledge. Education focused on the material itself rather than the learner. The evolution of the e-learning environments and systems has changed the way medicine is taught. Medicine, as a complex multidisciplinary field, has been implementing computerized technologies, with e-learning being a central point of the process in many cases. These technologies include web-based education and virtual reality (e.g. high fidelity human simulation). Web-based learning (WBL), for instance, can serve to deliver educational programs efficiently to physicians who may be located far from each other and remote from full-time medical school faculty [51].

The International Virtual Medical School (IVIMEDS; http://www.ivimeds.org) and the Virtual Campus of King’s College of the University of London (http://www.kcl.ac.uk/schools/medicine/about/learning/vc.html/) are examples of e-learning training at undergraduate, residency, and continuing professional levels. The IVIMEDS consists of more than 30 partners in about 15 countries. They have agreed to share curriculum maps that link learning content and assessment, learning resources including illustrations, video clips, animated diagrams, medical images, and virtual patients that simulate authentic, high fidelity patient problems. The Virtual Campus of King’s College offers web-based systems that provide learning and administrative support to medical, dental, and health sciences students. As more and more institutions seek cost-effective approaches to optimizing the capacity of e-learning in medical training, there is no doubt that these virtual universities will have an increasing appeal in the coming years [52].

Mobile health (mHealth) [53] and Moodle [54, 55] are examples of mobile health applications which can be defined as the practice and delivery of medical and public health services by mobile technology such as mobile communications devices (mobile phones and PDAs — personal data assistants), computers, communications satellites, and patient monitors. The rapid rise in mobile phone penetration and the spread of these economical technologies means that these technologies can be used 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 wide range of such devices and technologies, particularly when working in rural or remote areas of the world.

There is an increasing integration between traditional 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. iPhone™ and Blackberry™) or PDAs for use in a hospital or clinical environment with wireless networks, where bulky laptops are not as practical. The availability of medical software and applications for these devices, such as the e-textbooks (digital copies of medical textbooks), clinical skills videos (stored as a library for review), medical reference guides (e.g. PubMed), 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) have made m-learning into an attractive, easy, flexible and cost effective option [56].

It is apparent that the advances in ICT and the developments in computer ability and e-learning systems can be used to improve significantly both medical practice and education. Computer applications in medical education have been developed to enhance traditional educational strategies, and to provide new methods of learning. For undergraduate students, computer-based learning can be applied in many ways such as drill-and-practice where the material is presented to a student and evaluation is conducted immediately by multiple choice questions. Discrimination learning, where the student is asked to differentiate between two apparently similar sets of clinical findings, and clinical training where the common ground rounds are replaced/supported by patient computer simulated programs; as well as searching the Internet for medical information are all examples of ICT supported learning. In addition, conventional educational content types also are still utilized in other areas, such as lecture notes, books, lecture presentations, examination questions, practicals, scientific papers, graphs, images/videos, and simulators. Other educational content types unique to medical education are teaching files, virtual patients, evidence based medicine documents, objective standard clinical examinations, clinical guidelines, anatomical atlases, electronic traces of images, and others [1][57-59].

E-learning is not only great for learners but also for instructors as they can easily update information, it saves them time and it provides a standard for education programs. In addition, e-learning, when used as a support for a traditional lesson, can be seen as a tool which provides more effective education for people who have the same basic skills or share the same background information. Improvements and the widespread use of computers, the Internet and other forms of communication technologies have increased the use of these tools for educational purposes.

E-learning systems designed for medical education should overcome space limitations and simplify access to medical information in addition to helping to overcome other medical education challenges. E-learning systems should improve student involvement in medical procedures and operations, and access to life cases while paying special attention to handling the privacy and security of patient data.
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