APPLICATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN MEDICAL EDUCATION

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الخلاصة : إن إدراك وجوب أن تؤدي تقنيات المعلومات والاتصالات دوراً هاماً ومتزايد في مجال التعليم الطبي يعتبر عنصراً رئيسياً في تعليم الأطباء في القرن الحادي والعشرين . ويشمل استخدام الحاسب الآلي في التعليم الطبي تقنية الإنترنت والمعلوماتية الطبية والتعليم عن بعد والطلب الاتصالي.

ويجب أن يبدأ التأقلم والتكيف مع هذا التطور في التقنيات من المدرسة الإبتدائية . ويجب أن تقوم كليات الطب بإدخال دورات المعلومات الطبية في فترة مبكرة جداً من المنهج الطبي . ويحتاج الأساتذة إلى دورات تعليم طبي مستمر منتظمة لإعداد أنفسهم وتحديث معلوماتهم ومهاراتهم لتواكب الظروف المتغيرة. كما يجب إعداد بنيتنا التحتية لتتماشى والتطورات الحديثة مع مختبرات الحاسب الآلي ومختبرات المهارات الأساسية وأنظمة الدائرة التلفزيزنية المغلقة والغرف الدراسية والتجهيزات التعليمية المشابهة ووسائل الاتصال المستخدمة في التعليم عن بعد . إن القوى العاملة الحالية التي تشمل الأطباء وهيئة التمريض والفنيين وأمناء المكتبات والإداريين يحتاجون إلى تدريب ومن خلال ذلك فإنه يجب التركيز عند اختيار وتوظيف قوى عاملة جديدة اشتراط أن يكون هؤلاء ذوي معرفة ودراية تامة بتقنية المعلومات .

إن عضوات هيئة التدريس اللاتي يقمن بالتدريس في أقسام طالبات الطب في الجامعات السعودية لديهن هدف خاص لاستخدام أدوات التقنيات المتوفرة من أجل مصلحة ومنفعة الطالبات . وهذه الورقة تلقي الضوء على هذه المواضيع بصورة مفصلة كوسيلة لإعدادنا لمواجهة نحديات القرن الحادي والعشرين .

مفتاح الكلمات : التعليم الطبي ، تقنيات المعلومات ، المعلوماتية ، التعليم عن بعد ، الطب الاتصالي.

The recognition that information and communication technologies should play an increasingly important role in medical education is a key to educating physicians in the 21st century. Computer use in medical education includes, Internet hypermedia/multimedia technologies, medical informatics, distance learning and telemedicine. Adaptation to the use of these technologies should ideally start from the elementary school level. Medical schools must introduce medical informatics courses very early in the medical curriculum. Teachers will need regular CME courses to prepare and update themselves with the changing circumstances. Our

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infrastructure must be prepared for the new developments with computer labs, basic skill labs, close circuit television facilities, virtual class rooms, smart class rooms, simulated teaching facilities, and distance teaching by tele-techniques. Our existing manpower including, doctors, nurses, technicians, librarians, and administration personal require hands-on training, while new recruitment will have to emphasize compulsory knowledge of and familiarity with information technology. This paper highlights these subjects in detail as a means to prepare us to meet the challenges of the 21st century.

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INTRODUCTION

The parting gift of the 20th century has been the unparalleled advances in information and communication technologies. Without exception the advent of computers has revolutionized every part of our lives. The question being posed is whether we, teachers and the students of medical schools are ready to meet the new challenges that have arisen? How do we prepare for them? Before these questions can be answered we must look at what this new century has offered at the various stages of medical education, basic, clinical and postgraduate levels.

Medical education as a whole has undergone tremendous changes. The concept of 'teaching' has been replaced by that of 'learning', 'self learning' to be precise. Students are no longer spoon-fed, given handouts and a lot of information to be absorbed. With the ease of access to information, students must be seekers rather than receivers of knowledge. All inform-ation required is just a click away. How does this translate into practice? I shall first discuss the advances available in inform-ation and communication technologies.

INTERNET HYPERMEDIA/ MULTIMEDIA TECHNOLOGIES

The advent of the World Wide Web (WWW) and Graphical User Interfaces (GUI) such as Netscape have made the Internet a powerful medium of instruction and learning. The Internet and hypermedia/ Multimedia technologies can have a profound impact on the way training is delivered and received. Hypermedia technology is used to create individual groupings of related information, and provide the ability to branch instantly to the selected content and back to the original document.

The advantages of using the Internet are to enrich one's knowledge particularly in the 21st century. It is easy for teachers as well as students to collect information. Files stored easily on the hard disk can just as easily be retrieved. It is convenient and environmentally friendly. These files can be shared by all members of a class and enough time allocated for discussions to give students greater opportunity to learn.

The disadvantage of the net is the vast quantities of information that students must wade through. They have to be guided to choose the right material. The teaching must be student-centered. Effectiveness of teaching is measured not by how much of the intended materials the students learn. The amount of student interest in the subject is very helpful in motivating them to learn and information technology (IT) is certainly a very useful means.[1]

Multimedia technology incorporates different technologies of computer, CD-ROM, telecommunication, CD player, video camera, and combines them into a powerful communication center. The Internet provides fast high capacity digital transmission of data, still images, and full motion videos over the worldwide telephone network. The Internet and hypermedia/ multimedia technologies enable real-time, interactive communication among educators and students. An interactive video component allows them to view work and exchange information simultaneously. These functions coupled with virtual reality and simulation provide a powerful active learning environment, and the opportunity to apply information and knowledge in real life situations while maintaining interest.

The terms "Computer Aided Teaching" (CAT) and Computer Aided Learning (CAL) now being used influence both the teachers and learners.[2] Three main questions must be dealt with: (1) What actions must be taken to establish multimedia techniques? (2) How does the technical scenario look like to provide an adequate technical infrastructure for multimedia? (3) What organizational infrastructure can support multimedia in teaching and learning?

The first question can be answered by acquiring and evaluating available CAT- and CAL- programs, by designing and programming own CAT- and CAL- programs, and distributing these programs through CD ROMs. The technical limitations are obvious. Frequently used products without license restrictions should be made available to users by an appropriate server because of the easier technical handling and higher access speed. There should be electronic lecture halls and electronic seminar rooms in the university for multimedia supported lectures. These lecture halls offer the following services:

online- access to computers for calculations, simulations, and graphic representations. The computer monitor can be projected by a beamer on to a screen in the lecture hall, and there should be online access to central servers holding videos, CBT-software, etc. The lecturer has an interactive white board at his disposal. There is video-conference-system available for live-conversations with external discussions transmitted it into the lecture-hall. Videoconferences can be used to transfer lectures to another venue within the same university or other universities increasing the inter-university cooperation with live videoconference between two lecturers on the same subject in different universities. Computer Supported Cooperative Work (CSCW) or Electronic White board and a digital video-library can be used to set up a service, called "Lecture on Demand. These technologies should be adopted for teaching and learning in the medical schools.

The second question of technical scenario-can be dealt with by having technical infrastructure like a high speed network with a big bandwidth, multimedia labs for the design of own CAT -and CAL – products, video servers to store lectures, parts of it or other video information for supporting university education and electronic lecture halls.

The organizational infrastructure is needed for efficient support of multimedia techniques. Like the library, computing centers, media centers and every potential user of the media should form part of this. A permanent multimedia workgroup should consist of the representatives of the different faculties, library, computer and administration. The work group would be responsible for progress of the multimedia concept, planning and implementation and integration of new multimedia techniques, and coordination of all tasks concerning multimedia aspects in the university.

Multimedia has an important role not only in teaching and learning but also in research, patient administration (keeping electronic patient record (EPR) and hospital information and communication systems.[3,4] Keeping EPR-system has a lot of advantages such as the reduction of written materials, representation of information by means of a graphic patient record, direct access to time dependent media like X-ray films, and the possibilities of integrating other media such as videos or voice information to patient records. However, there are obstacles to be overcome such as: old habits, change in perception (the professor is not a teacher but a learning facilitator), time required for multimedia preparation for teaching (the real integration of multimedia techniques means a fundamental change of teaching methods), and support of teachers in preparing multimedia requires a lot of manpower and financial input.

MEDICAL INFORMATICS

Many new areas of learning are becoming increasingly important, not the least of which is medical informatics- the application of computers, communications and information technology and systems, to all fields of medicine-medical care, medical education and medical research. It is important area for most health care professionals to gain and maintain knowledge in this area since the impact of information technology is becoming so significant in health care.[5]

Professionals in health care are life long learners. They must keep up with new information to perform their jobs effectively. There are a growing number of programs in different fields of health care, as evidenced by a catalog of distance learning programs and books on medical informatics: computer applications in health care.[6,7] Distance learning can contribute to

lifelong learning in medical informatics and has the potential to revolutionize education in the same way as other medical informatics application are fundamentally changing the health care. Many universities in the US run a graduate certificate program in medical informatics delivered by distance learning. The recognition that computers should play an increasingly important part in medical education is a key element in educating physicians in the 21st century. However, their use must be seen as more than multimedia instructional programs and must include medical informatics applications as part of clinical practice.

Computer learning experiences for medical students include computer-aided instructions, learning about computers and their applications, the use of computers as a tool and as a mechanism for information management, decision support and communication. It also includes the knowledge, skills and attitudes involved in seeking, manipulating and using biomedical information.[8]

The medical informatics applications should be incorporated as a routine part of the student's daily activities. This is best done by integrating activities of medical informatics activities with the relevant basic science and clinical activities, rather than teaching them as a separate course on information management.[9]

DISTANCE EDUCATION

Distance education is usually defined as education that takes place when distance or technology separates the teacher and the learner.[10] The education modes are print correspondence, audiographics, instrumental television, videotape, teleconferencing, and a computer conferencing, IRC, MOO and MUD, email and list servs, and www. Choosing a mode depends on educational need or goal.[11] It may be divided as asynchronous or static education, and

synchronous or dynamic (real-time) distance education.[12]

Asynchronous or static distance education

Asynchronous distance education means that the students and instructors are not required to be present at the same time. Students don't have to be gathered together in the same location at the same time. Rather, they may choose their own instructional time frame and gather learning materials according to their schedules. Delivery modes of asynchronous distance education include email, video/audio tapes, web pages, CD-ROMs, fax and traditional postal mail. In this category, I will discuss asynchronous distance learning by video/audio tape, the Web, and the interactive CD-ROMs/DVDs.

Video/audio tapes

Courses on video/audio tapes are relatively old modes of delivery of distance education. With video tapes, students have the opportunity to attend classes without actually being present and have the flexibility of watching it at home or in the library. Courses taught in medical schools and grand rounds (CME seminars) are frequently taped for students to review, and for continuing education purposes. Video/audio recording is simple, inexpensive and can be done by the institution's media center or by the instructors themselves. These are widely used to complement medical education.

ME on the World Wide Web

The World Wide Web offers physicians and other health care workers an inexpensive method of obtaining CME credits without going to time-consuming medical conferences and seminars. Courses available on the Web range from anatomy, radiology and pathology to clinical case studies. It is easy to put courses on the Web, as hypertext markup language (HTML) which is easy to learn and browsers are free. Anyone who has a computer and Internet access may take the course on the Web. With Multimedia on the Web, the courses are more like live lectures.

Interactive CD-ROMs/DVD

Interactive CDs/DVDs are widely used in medical education. Courses on CD/DVDs can be found on almost all medical disciplines from basic medical science to clinical medicine. Image intensive disciplines such as anatomy, radiology, pathology and dermatology benefit most from this kind of platform. In medical schools, instructors use interactive CDs mainly for basic medical sciences. In some medical schools, students are required to study certain subjects on CD-ROM and take examinations on the computer. These strengthen the knowledge they have acquired in the classroom or the clinical setting. Courses on clinical medicine are usually designed for CME purposes. Most courses on CD/DVDs have searchable and printable transcripts, and are accompanied by images, original presenters' audio narration and interactive test questions.

There are four crucial advantages of asynchronous distance education. First, it provides the desirable flexibility. The teaching material can be accessed at any time and any where. Second, it has time advantages; it allows the learner time to ponder over ideas, check references and refer back to previous messages and take any amount of time to prepare comment. Third, it also creates a situated learning environment. Learners can easily integrate the ideas being discussed on the course with the working environment, or access resources on the Internet as required on the job. And fourth, it is cost effective. It requires low-end computers to operate so

global access is more equable.[13] However, the lack of student teacher and student-student interaction may limit the learning process. This is especially true in medical education, as it requires not only teacher-student interaction, but also physician/student-patient interaction.

Synchronous distance education
Synchronous distance education includes: satellite videoconference, desktop videoconference and multi-user domain object-oriented (MOO).

Satellite videoconference is usually a one-way video and a one-way audio with a telephone number available for questions. Satellite videoconference is used to cover mass education.

Desktop video conferencing technology has become more and more popular. Desktop videoconferences may be a one-way video and a two-way audio or a two-way video and audio. Video conferencing technology is used to simulate the classroom environment for distance learners. The system supports spontaneous interactive lectures, question and answer sessions and discussions with the students. Many medical schools with multiple affiliated hospitals are taking advantage of this technology.

Multi-user domain, Object-Oriented (MOO) allows users to connect from anywhere in the world and enables them to communicate with others in real time (as opposed to the delayed communication of email). Although, MOO is basically text-based, participants may "make speeches" and "move around" through certain MOO commands. Instructors may use a Web interface over the MOO to interact with their participants. Courses delivered over the MOO require less overhead cost than those via videoconferences.

There are four advantages of synchronous distance education. First, it helps stimulate motivation. Second, it encourages cooperation and group recognition. Real time interaction helps to develop group cohesion and the sense of being part of a learning community. Third, it offers a good feedback. It supports consensus and decision-making in group activities. And fourth, it has the pressure of pacing. Synchronous events encourage students to keep up-to-date with the course. It provides a discipline to learning which helps to prioritize their studies. However, it requires user training and coordinated schedules. The cost of the technology is another disadvantage.

In summary, when applying the different approaches, personal learning styles and the larger educational context determine what is most appropriate. The pressure of modern life makes most people demand programs that allow them to fit their studies into their many other commitments. However, it is also true that most people find synchronous interaction very beneficial for their learning. Obviously synchronous interaction will have more problems in global education than asynchronous distance education, because of the vast differences in time zones.

TELEMEDICINE
Telemedicine is defined as the use of telecommunications technology to deliver medical diagnosis and patient care to sites that are distant from the provider.[14] This includes health care delivery, diagnosis, consultation, treatment, education and transfer of medical data. Telemedicine uses a large array of technologies to distribute health care and educational services, including plain old telephone service (POTS), cellular systems, integrated services digital network (ISDN), T-1 and T-3 lines, satellite, and terrestrial microwaves. Besides health care delivery, telemedicine is widely used for distance learning and

continuing medical education for community health providers who do not have access to information and CME opportunities in an academic setting. Examples include Virtual hospital, a project of the National Laboratory for the Study for Rural Telemedicine at the University of Iowa,[15,16] which delivers CME course over the Web and VFA Health care Telemedicine which delivers CME conferences to its network members and teaches surgery to undergraduate medical students by Super Janet network.[17]

Well-known examples of telemedicine include: teleradiology (radiographic images are transmitted to radiologist for interpretation), telepathology (a pathologist can look down and in some cases, control a microscope located several hundreds miles away), telepsychiatry (a real-time tele-medicine application that is offered routinely as a service in USA and Australia), and surgical telemedicine (used for post-residency surgical education). From educational perspective, video-conferencing may supplement supervised hands-on training in the instruction of a new procedure. From a clinical perspective, remote patient evaluation, consultation, triage decision and non-operative treatment are considered acceptable applications of remote surgical practice.[18] Teledermatology, home telenursing, and minor injuries telemedicine are also in practice.

Benefits of Telemedicine

Improved quality of care
Telemedicine alters the professional isolation of many rural based physicians by giving them immediate access to colleagues at academic medical centers and allows for a real time, interactive education for the referring physicians. It provides enhanced decision making through the collaboration of the involved parties. It provides access to health care in previously underserved area. It also improves specialty care to remote locations, which cannot afford specialists. It accelerates diagnosis and treatment.

Distance learning
Telemedicine is widely used for distance learning and CME for the community health providers who don't have access to information and CME opportunities in an academic setting.

Reduced cost
One of the obvious means of reducing cost in medicine is the often-reduced necessity for travel in telemedicine. Travel cost can apply to patients traveling for specialty care or to health care professionals traveling for CME. Both of these services are provided locally through Telemedicine. It can also reduce costs by decreasing the duplication of services, technologies and specialists.

Limitations of telemedicine
As the distance between two locations increases, time lag is introduced. This increases feed back latency and after a point renders real time surgery impossible. Instead of cable link, one can use satellite links to overcome this problem. The advent of broadband ATM networks speeds up the process. High pilot scheme costs and bureaucracy in governmental medical regulations may slow down the extensive use of this technology which relies on an amanuensis during telecommunication. However, experience shows that rapport is quickly established. Over dependence on technology that may be unreliable is another disadvantage. Clinical risks associated with telemedicine must be managed.

HOW TO PREPARE OURSELVES FOR THE CHANGES?
It will be unfair on the students if this change is suddenly inflicted on them as

soon as they enter the medical school. The use of this new technology should, therefore, start early, at the school level. Elementary education must be directed towards thinking and analyzing concepts instead of the current memorizing and recall. Information available on the web is likely to be as vast as an unchartered ocean. Unless one knows what to look for and where to look, one is sure to get lost. If students are prepared from elementary school, they will find themselves completely at home when they enter the medical school. For the student in the elementary school this may be at least ten years away. For students who have or are about to leave, the school situation is more pressing. Medical schools must introduce information technology courses very early in their curriculum. In parallel to that, students who enter the medical schools in Arab countries are unprepared to be taught in English. They have to cope with a curriculum that includes courses in English in the first year. The same could be done with information technology. As a matter of urgency, current medical curriculum must be modified accordingly to include these compulsory subjects to begin with which could be offered as electives at a later stage when students who come to medical schools are more mature.

What about teachers? They too need regular CME courses to prepare and adapt to the changing circumstances. As a matter of fact, these courses must be made compulsory like the first aid and advance trauma life support (ATLS) courses. Regular workshops will be necessary to keep pace with the current and future advances.

Means of implementation locally
The basic requirements include the following: (a) Suitable technical infrastructure for information technology: This infrastructure includes a local audiovisual station and a network with a band width sufficient to transmit sound and vision of an acceptable quality (usually a 384kbits/s by integrated services digital network for ordinary teleconsultation, teleeducation and teleconferencing). To transform microscopic images, satellite transmission can be used. Facilities such as computer labs, basic skills laboratories, close circuit television facilities, virtual class rooms, smart classrooms, simulated teaching facilities, distance teaching by tele-techniques and many more should be added without delay. Our old fashioned libraries will of course remain as archives, but the Internet and web libraries will have to be added. (b) The professional and managerial infrastructure should include organizations capable of developing, introducing and evaluating medical informatics, telemedicine and of managing telemedical sessions, both locally and with external situations. This should include doctors, nurses, technicians, librarians, secretaries, administrative personnel, etc. Those already in their posts will require a hands-on in-service training. New recruitment will have to emphasize compulsory knowledge of, and, familiarity with information technology. (c) Appropriate funding: initially, extra funding will be required for the establishment of these technologies of medical informatics and telemedicine.

Changes in the curriculum: Medical schools have long recognized the need to revise their teaching methodology, but have been slow to change.[19] The recognition that computers should play an increasingly important role in medical education is a key element. The computer can make information processing and management faster, more efficient, more extensive, more interactive and in some cases, make possible activities that could not be performed any other way. They should be made part of the

curriculum. They should be viewed as more than multimedia instructional programs and must include medical informatics applications that are part of clinical practice.[20]

The health care delivery system itself is undergoing rapid changes. The goals of our curricula should be based on the projected needs and anticipated roles of the physicians in the 21st century. The physicians of tomorrow are likely to work in a managed care environment as a direct patient care provider and a coordinator of physician extenders. The organizational structure will be different from what currently obtains. It will require coordination of clinical data and utilization of consultants and physician extenders.

To prepare students to function as information managers, the following five changes in the physicians' roles have been suggested:[21-23] (a) Managing the health care needs of the population, (b) Increased diagnostic and therapeutic responsibilities for the primary care physician, (c) Practicing medicine in a cost-conscious environment, (d) Increased external monitoring of physician practices, and (3) Integrating generalized practice in a larger system.

Implications for students and faculty

Students' attitudes toward their education may have to change. They will have to learn to search for information as well as manage it. They will have to acquire the skills to access electronic information. The medical informatics and its applications should be incorporated as should be integrated into the relevant basic science and clinical activities and form part of the students' daily routine rather than be taught as a separate course.[8,20,24-26]

With all this technology students are assisted to become independent information seekers, and proficient users of computer technology. The changing role of physicians in a new health care environment provides a stronger impetus than ever before for these ideas to be incorporated. By making the preparation of students as medical information managers a primary goal, there is a strong rationale for the inclusion of medical informatics application in the curriculum.

I have already referred to the courses on information technology. The concept of integrated teaching and self-learning will be greatly facilitated by these advances in information technology. The emphasis should be on applied sciences rather than pure basic sciences. The interaction will have to be problem oriented rather than old-fashioned system-oriented. There will be no compartmentalization. As patient's problems transcend the boundaries of systems and organs, the concept of management will have to be changed, to make it problem-based. These developments will naturally lead to changes in evaluation techniques. With the help of computer technology evaluations could be made more objective and subjectivity reduced to the minimum.

CONCLUDING REMARKS

We have just entered in 21st century; what future decades hold in information technological advancement may be beyond our imagination. We have to prepare ourselves for all the challenges. Unless we adapt to these developments, we will be in danger of being left behind. Let us face it. Preparation for tomorrow's knowledge starts today, so let us begin and modify our curricula and infrastructure, and introduce the acquisition of knowledge and practice of information technology right at the school level.

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