APPLICATION OF MODERN INFORMATION TECHNOLOGIES IN MEDICAL EDUCATION

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Abstract: Paper summarizes the application of modern information and communication technologies in medical education at some of the leading universities in the world and in Serbia. In addition to opportunities provided by ICT in the education of medical students and medical workers, it is pointed out the importance of applying these technologies in a personalized and lifelong learning in the field of medical science. A preview of specific software is given, as well as general e-learning tools, adapted for medicine teaching.

Keywords: E-Learning, Medical education, Medical software

1. INTRODUCTION

As modern education presumes continuous improvement and more efficient learning, appropriate information and communication technologies (ICT) provide possibilities of richer and more dynamic teaching/learning process. Application of mentioned technologies does not serve for its own purpose, but rather pose a service of realization of education tasks in more creative manner. It requires teacher's competences in used technology and methodical analysis of learning contents and models of technology claim. With proper usage of modern ICT, a possibility of active teaching is raised, resulting in new knowledge quality, acquired through learners own activity.

Medicine is a specific area, whose achievements are directly influencing peoples life quality and the need for education modernization should be prioritized.

Next chapter gives preview of used technologies on medicine faculties some of the leading universities in the world. Modern information and communication technologies that are used in medical schools in the country are presented as well.

2. PREVIEW OF ICT USAGE IN MEDICAL EDUCATION

Tools and approaches may be classified in two categories: general e-learning tools applied in medical education and specific tools, developed especially for medical subjects.

General tools

Mobile technology is increasingly being used by clinicians to access up-to-date information for patient care. These offer learning opportunities in the clinical setting for medical students that are recognized by many leading universities such as Brighton and Sussex Medical School, The School of Medicine at the University of Leeds, Cardiff University, etc.

Brighton and Sussex Medical School (BSMS) became the first UK medical school to introduce the widespread use of PDAs by its students. BSMS have initiated a program called MoMEd (Mobile Medical Education at BSMS) which study the impact of mobile devices (PDAs, smartphones) containing learning resources (eg: books, clinical guidelines, drug formularies) on student learning in the clinical environment. [1]. BSMS loaned their final-year students PDAs with a suite of software on an SD memory card known as DrCompanion [2]. The resources included the British National Formulary (BNF) and textbooks such as the Oxford Handbooks and Netter's Anatomy. The instant access to information whilst in the clinical setting gives the students a better framework for understanding and storing the new information, and allows more efficient retrieval for future use. Resources on the PDA were seen as a useful additional tool for students to have, and they seen it as a supplement rather than a replacement for their traditional learning strategies [3].

The University of Leeds the Faculty of Medicine and Health [4] working with five Yorkshire Universities and School of Medicine funded ALPS CETL center [5] which besides Mobile Learning has developed experience in the areas of e-portfolio implementation and the development and use of Skill and Competency Maps (Image 1). A fundamental part of the ALPS Program was the creation of generic assessment tools for use in practice. The tools include sections on self reflection, interprofessional peer and practice assessor feedback and where appropriate, service user and career feedback. When students complete assessments they are automatically uploaded into the e-portfolio section of the ALPS Mobile Assessment Suite where they can be measured against the competency maps. The students' work is then assessed and a process of feedback, discussion and work planning can begin between student and tutor.
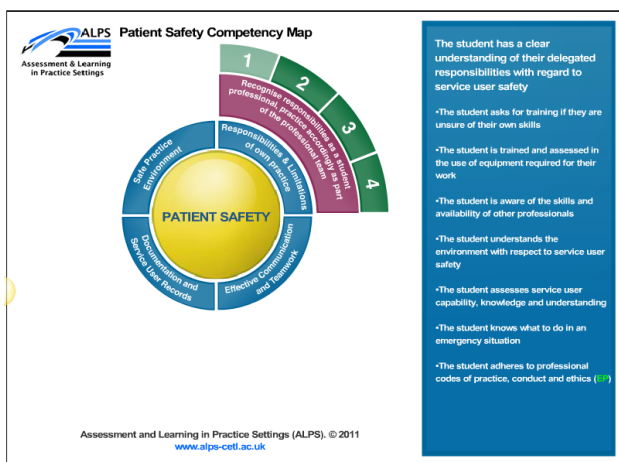
Image 1: Example of Common Competency Map

A few years ago virtual world called Second Life (SL) [6] has been recognized as a potential education tool. Many universities built virtual islands where their students learn about native and foreign languages, mathematic, chemistry, physics, etc. Each year the number of universities that uses SL rises. Ann Myers Medical Center, e-Learning Faculty of Imperial College London, University of Auckland, Virtual Neurological Education Centre, Centers for Disease Control and Prevention, are just some of the universities that recognized SL as a tool that can be applied in medical education.

The Ann Myers Medical Center [7] aims to educate medical students and nurses in Second Life through interactive and clearly visualized case presentations. During such a case presentation, physicians describe a patient's history and share images with students while they discuss what kind of tests they would order in a real life situation and what the possible diagnosis can be [8]. The Center has different medical units such as Intensive Care Unit, Emergency, Intensive Burn Unit, etc. In Intensive Care Unit students can simulate a patient examination by listening to cardiac murmurs or lung sounds. Students can also set number and data (BPM, oxygen saturation, temperature, blood pressure) on a pulse-oxymetar by themselves, making medical exercises can become even more realistic.


Image 2: Unit for breast cancer awareness

Faculty of Medicine of Imperial College of London [9] created a spectacular and useful Second Life tool in medical education.

Image 3: Imperial College London Virtual Hospital

At the reception, students have to ask permission to see a patient. They can check the patient's history through a text file (Image 4). If students answer the test question regarding differential diagnosis, they can purchase investigations. There is also score system so that medical students can see what they are doing right or wrong while examining a virtual patient
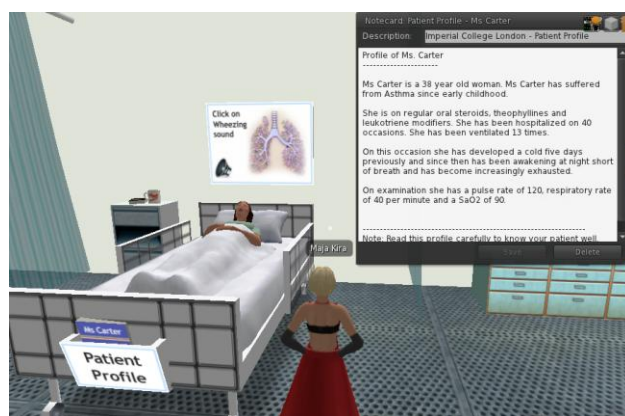
Image 4: Examining the patient profile

For students and medical staff in Great Britain is realized program of e-learning application in Health. Through modern information and communications technology,

program provides materials for learning that integrates audio and video materials so as animations and so-called "Real-life" scenarios. Image 5 shows example of one such course that provides assessment of learned material.
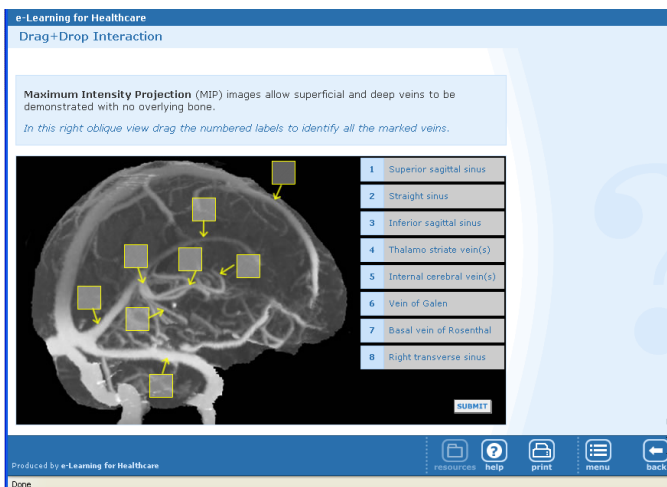

Image 5: Example of assessment within online course

University of Liverpool Faculty of Medicine has special group (e-learning support unit –elsu) [10] for support in information and communication technologies application, in research and teaching. Group works on continual teaching enhancement using e-learning, blackboard learning management systems for collaborative learning, etc.
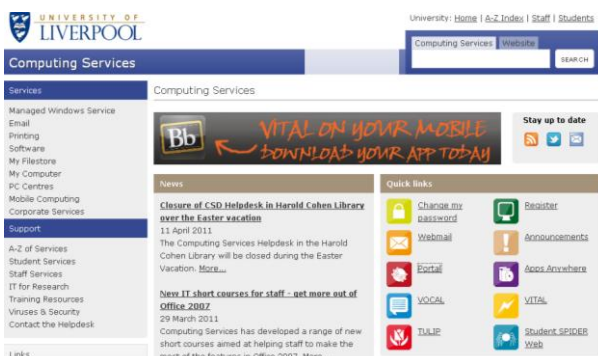

Image 6: Preview of e-recourses on Medicine faculty of Liverpool University

Medical faculties form Serbian universities integrated online courses in their curricula. In most cases online courses are carried out through Moodle platform [11], as one of the best open-source LMS platform. Moodle allows application of many different activities, some of which are collaborative. This kind of teaching complements traditional teaching and provides possibilities of richer and more dynamic teaching/learning process. Figure 7 presents the Moodle learning management system at the University of Belgrade Medicine faculty.

Image 7: Preview of moodle system on Medicine faculty in University of Belgrade

Since year 2003 medical faculties of universities in Serbia have been organized continuing education [12], [13], [14], [15]. Program enables developing of knowledge, skills and professional competence. Among others, it involves modern information and communication technologies in order to maintain and improve the quality of health workers and students.

Beside projects directing and education in domain modern IT application in medical education, there are various web-discussion groups (forums) online. Such forums may be labeled as non-formal e-learning tools, providing collaboration between interested parties, as well as aggregating various useful resources (news, video-materials) [16][17].

A preview of education content repositories is given in [18].

Specific tools

Nowadays applying clinical knowledge and the development of skills to diagnose successfully and treat patients effectively is very difficult due to cost-containment and patient safety issues. For this reason some universities involved simulation technology in their curricula.

Vanderbilt University School of Medicine [19] has developed Center for Experiential Learning and Assessment (CELA) [20] which mission is to provide an educationally rich environment for training healthcare professionals to practice safe, effective and compassionate clinical care. During their studies, students use simulation of various medical treatments and procedures along with "standardized patients" and video cameras in order to improve skills. Patient simulation provides the ability to repeatedly practice a wide range of clinical scenarios. Because simulated clinical scenarios are completely replicable and highly standardized, it is much easier to review and evaluate performance. Simulation experiences can be videotaped and reviewed by trainees to further facilitate learning and permit assessment of process and style as well as outcome. Current simulation technology is sufficiently realistic to

be a surrogate for actual patient care. Image 9 shows an example of a simulation within Vanderbilt University School of Medicine.

Image 9: Room for simulation

The Stanford School of Medicine and its affiliated hospitals (Stanford University Medical Center – SUMC) were one of the first to use techniques, technologies and applications for immersive and simulation-based learning (ISL) [21]. Simulation modalities [22] which SUMC uses are categorized in the following way: Virtual reality and Visualization, Desktop Simulations and Virtual worlds, Mannequin-based simulations and Standardized Patient Actors. These simulations represent set of techniques that immerse students into virtual world. Students are encouraged to use some interesting applications of interactive visualization software for teaching 3D structures (such as anatomy or molecular structure) using virtual reality techniques in ways that maximize learning. The future plans for Stanford University Medical Center is fully integration of ISL techniques into the curriculum of medical students. Integration will enliven and enrich the learning of health and human disease and of pathophysiology and pharmacology.

NYU School of Medicine introduced their students to online 3D interactive virtual human body called the BioDigital HumanTM [23]. Beside traditional use of human cadavers in anatomy instruction, students use BioDigital HumanTM, in way that they both view and interact with realistically simulated 3D organs and other anatomical structures. This immersive, virtual reality represents great supplement to traditional medical education.

Apart from these tools that are already integrated into universities curricula there are a number of specific medical software that are and could be applied in Medical faculties and other medical education institutions. In that way future doctors and other medical staff will be familiarized with software that is used in hospitals and other health care institutions. Some of the software are described in following text.

PEPID [24] is medical software designed for use on hand-held computers on the Palm™, Pocket PC™, and similar platforms. It puts a wealth of information right in the hands of all medical professionals because it is up-to-date on the latest clinical and drug references available, and

can instantly perform functions and calculations with complete accuracy that otherwise would take time and effort. Pepid has been used by staff and students in the library at the University of Alberta in Edumont. In the United States, it has also been adopted by many institutions including the Harvard Medical School and Caregroup.

MOSAIQ [25] is Oncology Information Management System designed to manage the complete spectrum of oncology treatments in a single patient record. Its basic purpose is to help medical oncologist to efficiently plan, accurately order and carefully monitor treatment the patient. Mosaiq provides complete picture of patient care by its ability to integrate with external diagnostic and laboratory systems.

The main features of Mosaiq include the following:

- Review, prescribe, dispense, treat and document patient data in a single database solution
- Immediate notification of drug interactions, allergies and dose limits
- Streamline and improve order accuracy with fast processing of multiple chemotherapy orders on regimen-designated cycle days
- Integrated Pharmacy dispensing with dynamic worklists to manage and plan workload throughout the pharmacy, providing easy tracking of patients scheduled for treatment
- Integrated Scheduling for fast and efficient patient appointment management and tracking
- Electronically document chemotherapy and other medication administration, supporting multiple sign offs
- Easily connect departments, multiple sites and networks

In the expansion of specific medical software, special place takes electronic medical record software. Orthopedics, like most departments of a hospital or healthcare facility have gained countless benefits from the electronic medical record software strategically designed for the orthopedic workflow [27].

The overall goals may be the same as other departments in a hospital, in terms of patient care and streamlined revenue procedures, but some operations are highly specific to orthopedics. Specific features for orthopedics workflow in an electronic health record system include the following:

- Disability issue notation
- Extensive imaging capabilities of the skeletal system
- Interfacing capabilities with EMG and x-ray equipment
- Permanent impairment notation capabilities
- Reporting for litigation attorneys
- Work status reports

These are just some of the workflow specific features of the EHR system as it relates to orthopedics. Many

operations can be designed specifically for the clinic or orthopedic department.

3. CONCLUSION

Recent advance in IT and communication technologies has its effects to significant changes in sector of health protection, heavily influencing medical diagnosis, healthcare management and medical education. Usage of computer and Internet took an important share in curricula, as well as in lifelong learning in this area, becoming an international trend. Experiences of world universities as well as Serbian ones show direction of current usage of mentioned technologies in teaching and suggestions and possibilities for their application.

There is a plethora of e-learning tools involved in medical education world-wide. It is shown that it is possible to engage technologically enhanced learning through standard e-learning platforms or with specialized tools. However, there is still lot of space left for improvement and popularization of these technologies in Serbia, in order to break barriers and acquire benefits.

ACKNOWLEGMENT

LITERATURE

[1] Brighton and Sussex Medical School. Medical Education. Available at: http://www.bsms.ac.uk/research/our-research/medical-education/

[2] MedHand International AB. Available at: http://www.drcompanion.com/index.php?site=drc&width=1245&height=706&

[3] Davies, B. et al, *Mobile Medical Education (MoMEd) - how mobile information resources contribute to learning for undergraduate clinical students - a mixed methods study.* Medical Education 2012, 12:1 doi:10.1186/1472-6920-12-1. Available at: http://www.biomedcentral.com/1472-6920/12/1

[4] Leeds institute of Medical education - Technology Enhanced Learning. Available at: http://www.leeds.ac.uk/medicine/prof_dev/tel.html

[5] Assessment and Learning in Practice Settings. Centre for Excellence in Teaching and Learning. Available at: http://www.alps-cetl.ac.uk/ALPS.html

[6] *Second Life.* Available at: www.secondlife.com

[7] The Ann Myers Medical Center. Available at: http://ammc.wordpress.com

[8] Webicina. Available at: http://www.webicina.com/medicine-in-second-life/what-is-second-life/

[9] Imperial College London. Faculty of Medicine. Available at: http://www1.imperial.ac.uk/medicine/teaching/elearning/

[10] University of Liverpool. Faculty of Medicine – learning technology & web communication unit. Available at: http://www.liv.ac.uk/ltwc/index.htm

[11] Moodle. Available at: http://moodle.org

[12] Medical Faculty University of Novi Sad. Center for continuing medical education. Available at: http://www.medical.uns.ac.rs/kontinuiranaedukacija.php

[13] Medical Faculty University of Belgrade. Center for continuing medical education. Available at: http://www.mfub.bg.ac.rs/sr/centri/centar_za_kontinuiranu_medicinsku_edukaciju/index.dot?

[14] Medical Faculty University of Nis. Center for continuing medical education. Available at: http://www.medfak.ni.ac.rs/centar_za_kme.htm

[15] Faculty of medical science University Kragujevac. Center for medical education. Available at: http://www.medf.kg.ac.rs/studije/cme/index.php

[16] Doktor.rs. Available at: http://www.doktor.rs

[17] Stetoskop. Available at: http://www.stetoskop.info

[18] Ruiz, J.G., Mintzer M.J., Leipzig R.M, *The Impact of E-Learning in Medical Education*, Academic Medicine, Vol. 81, No. 3 / March 2006, pp 207-212, http://journals.lww.com/academicmedicine/Fulltext/2006/03000/The_Impact_of_E_Learning_in_Medical_Education.2.aspx

[19] Vanderbilt University. School of Medicine. Available at: https://medschool.vanderbilt.edu/

[20] Center for Experiential Learning and Assessment. Available at: https://medschool.vanderbilt.edu/cela/

[21] Center for Immersive and Simulation-based Learning. Available at: http://cisl.stanford.edu/at_stanford/

[22] Center for Immersive and Simulation-based Learning. Simulation modalities. Available at: http://cisl.stanford.edu/what_is/sim_modalities/

[23] NYU Langone Medical Center. Available at: http://communications.med.nyu.edu/media-relations/news/medical-students-nyu-school-medicine-use-interactive-virtual-3d-cadaver

[24] Pepid. Medical Information Resources. Available at: http://www.pepid.com/press/read_news.asp?Id=73

[25] ELEKTA. Medical Oncology Software. Available at: http://www.elekta.com/healthcare-professionals/products/elekta-software/medical-oncology.html#

[26] EHRSCOPE. Orthopedic Specific Electronic Medical Record Software Benefits and Implementation Process. Available at: http://www.ehrscope.com/orthopedic-specific-electronic-medical-record-software-benefits-and-implementation-process