

An eLearning Approach to Integrate Hospital Information Systems in Medical Education

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Abstract- elearning systems are advanced systems that are used to improve students' learning capabilities as well as their accessibility by utilizing information and communication technology tools. These systems usually involve activities to increase the interaction among students and between instructors and students. eLearning systems enable students to extend their learning beyond the borders of the classroom by using online and offline learning technologies. In medical education, eLearning systems require special design because of the nature of medical education which requires more practical sessions, and more student involvement in medical procedures and operations. In order to provide medical students with a productive eLearning system, the system should be able to provide them not only with access to text books and lectures materials, but with real life cases including medical history, lab results, radiology images, and other patient related information. These resources would improve the student diagnosis and treatment skills and leverage their learning outcome.

The objective of this paper is to discuss the approach adopted in The College of Medicine and King Saud University Hospitals to design and build a medical eLearning system to provide medical students with access to information they need, and how the goals of such system can be achieved by

designing a medical portal for integrating medical information systems such as hospital information system, picture archiving and communication system, lab system, and operation rooms integration and control system with the eLearning system.

In conclusion, eLearning systems designed for medical education should consider overcoming space limitation, and simplify medical information access in addition to help in overcoming other medical education challenges. In addition eLearning system should improve student involvement in medical procedures and operations, and access of life cases with special attention in handling the privacy and security of patient data.

Keywords- eLearning, eLearning System, Medical Education

I. INTRODUCTION

Education has evolved from a material based process where the instructor (teacher) focused on presenting information to students with no regard to the differences in their learning capabilities, and on the other side, student had the role of a receiver, to a learner (student) centered process where students are able to learn at their own pace, and the instructor role changed to being a mentor guiding students to acquire knowledge and improve their learning skills. In addition, the rapid evolution and growth of information and communications

technologies (ICT) has led to the development of new services and applications that created value in almost every aspect of life. Education fields have witnessed major development because of ICT services and applications. [1]-[2]-[3]

eLearning systems are educational systems that utilize ICT resources including Internet, computer networks, multimedia and other resources to enhance the learning process and provide students with the necessary tools to acquire knowledge and professional experiences.

There are many approaches to implement eLearning systems including distance learning which enables students in different continents to obtain graduate and post graduate degrees remotely and with no need for attending lectures physically. In addition eLearning systems can also be used in conjunction with traditional learning (blended or integrated learning) to expand the resources available for students, and help them focus on their learning objectives. [3]-[4]

The introduction of information and communication technology tools in medical education has made significant changes in the way medicine is taught. [3]. In addition it made it 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 better manage and utilize eLearning systems, and to gain more from the online information, and the Internet. [5]- [6]

It is apparent that the revolution of ICT and advances in computer capacity and eLearning systems can significantly be utilized to enhance and improve medical practice and education. Computer applications in medical education has been developed to enhance traditional education 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 the student and

he/she is evaluated 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 "visit rounds" are replaced by patient computer simulated programs; as well as searching the Internet for medical information. [3]-[5]-[7]

The objective of the current study is to discuss the approach adopted in The College of Medicine and King Saud University Hospitals (KSUH) to design and implement a medical eLearning system to provide medical students with access to resources they need, and how the goals of such system can be achieved by designing a medical portal for integrating medical information systems such as hospital information system, picture archiving and communication system, and operation rooms integration and control system with the eLearning system. KSUH represents the College of Medicine, King Khaled University Hospital, King Abdulaziz University Hospital, and King Fahd Cardiology Center. The number of students in these colleges is over two thousands, and the number of college Academic staff is over four hundred.

II. CHALLENGES OF MEDICAL EDUCATION

Medical education adds more challenges to the traditional educational process. Medical education aims to provide students with the necessary skills and knowledge they need to perform their future tasks as physicians in the most efficient and effective way. Furthermore, medical education is not restricted to undergraduate students; the continuous medical education is an essential component of medical career development and in the evaluation of medical practitioners. [8]

In order to satisfy the needs of students and practitioners, medical education provides students with basic sciences courses such as

biology, anatomy, and physiology, as well as practical experience including participating in live patient cases, live operations, and grand rounds. In addition, developments in medical education has also resulted in the creation of problem based learning (PBL) where students are gathered in small study groups which focus on examining a true or simulated case and try to find an accurate diagnosis and treatment for this case. [9]

The nature of medical education presents some remarkable challenges including:

- Limited space: Wards, clinics, and operation theaters have limited space for students. The space limitation can prevent many students from attending important operations and procedures and decrease their chances in participating in examining live cases which can degrade their skills and practical experience.
- Patient security and safety: Health Insurance Portability and Accountability Act (HIPAA) as well as other security regulations attempt to secure patients' data and care for their privacy. [10] This security may be threatened by students' unsupervised and unauthorized activities during accessing patients' data and medical history. These threats may affect the medical institution reputation and may even lead to legal prosecution [11].
- Limited access to patient data: As noted before, access to patient data can lead to serious problems. Therefore, students' access to patient data is usually restricted which prevent students benefiting from having all the required data for precise diagnosis and full practice experiences.
- Problem Based Learning requirements: PBL requires the acquisition of an extensive and integrated knowledge base that is readily recalled and applied to the analysis and solving of patient problems. It also requires students to take responsibility of their own learning activities, and it encourages collaboration between students. The nature of PBL requires resources to be readily available for students, and requires more interaction between students than traditional educational models. These requirements

are not always easily provided in educational institutes.

These challenges can deprive students from building and improving skills they need for a successful medical career and can consequently cause serious threats to their future patients. Therefore, solutions should be suggested and applied to overcome these limitations. The next section explains how eLearning can help to eliminate and overcome these limitations and support students with medical skills acquisition and development.

III. ELEARNING IN MEDICAL EDUCATION

In addition to the above challenges, medical education is a practice based education. Medical students will never be competent unless they are provided with appropriate practice in the form of live cases, clinical procedures, radiology images examinations and diagnosis, patient medical history review, and other basic medical practices.

eLearning can play an important role in medical students' educational practice, enabling them to acquire the necessary medical experience. [3] Medical eLearning systems should provide the following benefits:

- Improving student-faculty interaction by enabling student to interact with faculty from any place using a portal, learning management system (LMS), and smart classroom technologies.
- Improving student-student interaction which is essential in PBL and in student collaboration by using LMS and discussion boards. [12]
- Overcoming the space limitation problem by providing students with real cases and operation theater attendance benefits through modern technologies such as video conferencing, online live and on demand sessions, and simulations. This allows more students to participate in the examination of important cases and to attend and review

more operations and clinical procedures during their academic years.

- Preserving patient security and safety by limiting the access of students to patients' medical records and possibly hiding patients' personal data.
- Supporting PBL by providing students with structured knowledge base through the Internet, online libraries, and accessing published articles and studies.
- Enabling students to learn at their own pace from anywhere by using distance learning tools such as LMS. This will enable students to take responsibility of their own learning and help them to become lifelong learners.

In order to utilize the full benefits of, eLearning systems e.g. LMS and video conferencing they must integrate with existing hospital information systems to be able to provide students with the required medical data and to help them analyze clinical cases in the most appropriate way. This integration represents a true challenge in adopting eLearning in medical education.

IV. INTEGRATION CHALLENGES

Integrating eLearning systems with existing health information systems faces many difficulties. One major difficulty is the diversity in these systems, and the different protocols adopted for communicating with other systems.

For example, most used healthcare systems comprise a hospital information system (HIS) holding patients' information including their demographic data, lab results, and allergies. Students should use this system in order to access basic patients' information. Modern HIS systems usually use the HL7 protocol [13] which is used for communications between medical systems.

Picture archiving and communication system (PACS) [14] is a system that works closely with radiology information system (RIS) to capture, store, retrieve patient radiology images, and prepare reports regarding these images. The PACS system data is required by students in attempting to

diagnose a case that requires the examination of radiology images. These systems use DICOM and HL7 protocols to communicate with other systems. [15]

Electronic medical records (EMR) system holds all patients' history including prescriptions, diagnosis, lab results, discharge reports, and other patients' clinical history data. Patients' history represents an essential source of information required by students to correctly diagnose a case. This system is a database based and mainly requires interfacing with its database to retrieve data.

As shown in Figure 1, diversity in healthcare systems complicates the integration with eLearning systems, and in line, complicates the eLearning systems themselves which may cause problems in operating these systems and hence may cause deficiencies in the educational process instead of improving its quality.

In addition, one of the challenges facing integration is to protect the privacy and confidentiality of patients' information. The concern here is to prevent private or sensitive data from being unveiled, unnecessarily, to students. Students may need to access patients' clinical information and medical history anonyms without the need to reveal patients' identity in most cases, furthermore patients' sensitive data should always been restricted from access by any unauthorized person. This requires special care when planning the integration to handle these constraints.

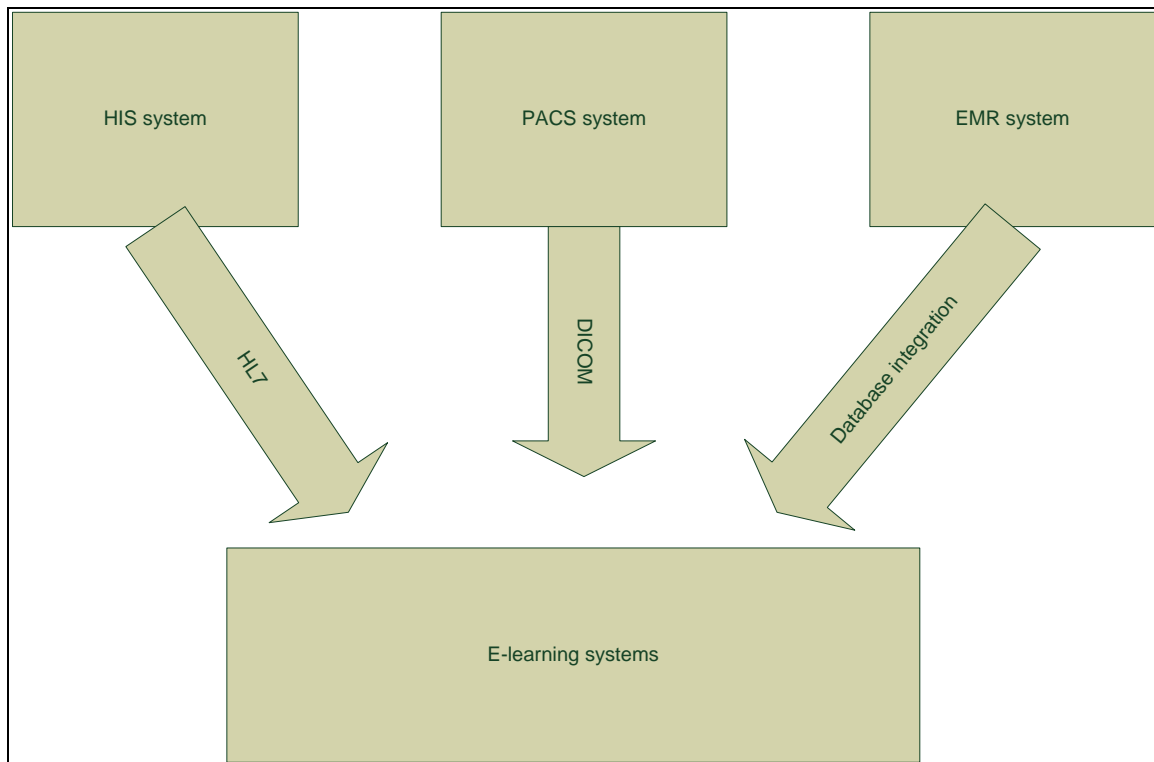


Fig. 1 Integration between healthcare information systems and e-learning systems

V. IMPLEMENTING INTEGRATION BETWEEN SYSTEMS

In order to solve the issues facing the integration between medical and eLearning systems, a careful design of the interface between the two types of systems is proposed. The main goals of this design include:

- Minimizing the number of interfaces between systems will sequentially decrease the complexity of the integration, and thus will improve the efficiency and performance of the eLearning systems.
- Interfacing unifications between the different systems will greatly simplify the integration process, and will lead to decreasing the cost and duration of this integration.
- Handling the privacy and security of patient data can be controlled through the integration itself. This means that only the necessary information will be passed from the medical systems to the eLearning systems.

In order to achieve these goals, a new layer can be added to the interfaces shown in Figure 1. This layer will unify all the communication protocols of the medical system into a single layer that can be interfaced with eLearning systems. As shown in Figure 2, this layer is composed of a medical portal with an integration engine. Medical portals have been used in healthcare systems for many years, and have proven their efficiency in unifying the interfaces between different medical systems and in unifying the interface to users of these systems.

Using a medical portal has many advantages including simplifying system integration, and freeing the eLearning system developers from dealing with complex medical interfaces to communicate with a database application, the medical portal will enable them to focus on the development of the eLearning system itself, and in improving the efficiency of the system.

The design of the portal itself is of great importance, since it will be an important

gateway link between the eLearning systems and the existing medical systems. In order to design such a portal the following points should be taken into consideration:

- The medical portal should gather information from all medical systems; these data can either be gathered periodically or when requested by the eLearning system.
- The portal should have a clear database topology to simplify the interface with the eLearning systems. It should gather data from those different systems using different interface components and write it on the unified database repository.
- The portal should be flexible enough to provide the eLearning systems with the capabilities to retrieve different data based on the requirements of the case

under study and the design of the study material provided by the faculty member.

- The portal should have the ability not to pass patients' private information to the eLearning system in order to protect patient privacy and security of data.

Once these design guidelines are applied, integration can be easily established between medical and eLearning systems, providing the students with a powerful system capable of providing them with exact information and enabling students to improve their analytical and diagnosis skills.

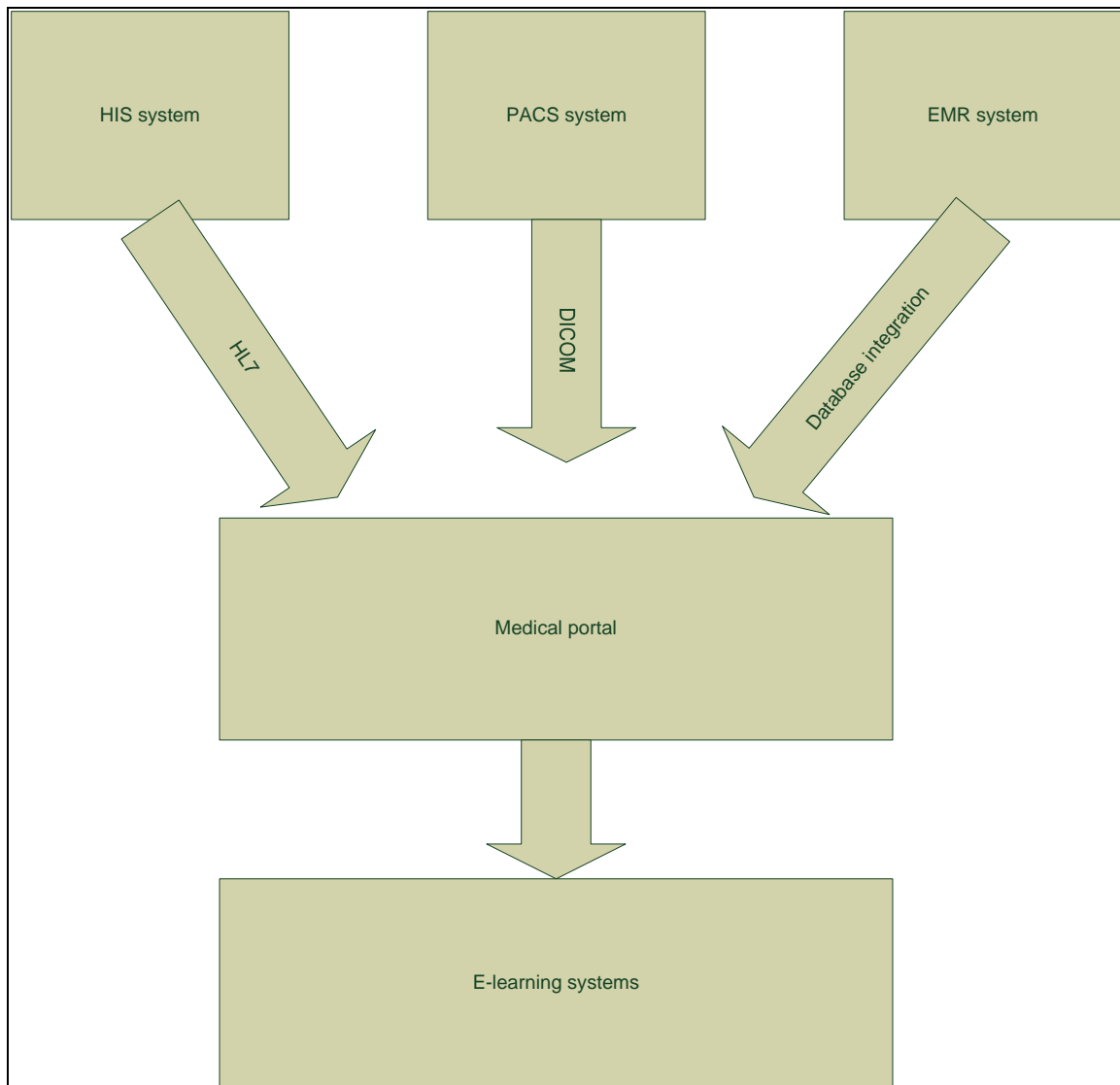


Fig. 2 Integration using medical portal

VI. CONCLUSIONS

eLearning systems adoption has greatly increased recently, for example in year 2005, almost 3.2 million students had one or more online course in the United States. [16] A growing number of universities across the world are now offering many eLearning courses that require either zero or very little student attendance. eLearning systems can also be used in conjunction with traditional learning (blended or integrated learning) to expand the resources available for students, and help them focus on their learning objectives. [3]- [4]

King Saud University Hospitals (KSUH) started to implement a modern state of the art an eLearning system. The system will be used to assist and support the current hospitals and college systems to provide students with tools to improve and manage their learning experiences, and assess their learning outcomes. It aims to combine their database of patient cases with the eLearning systems to provide medical students with all data they need to succeed in their field. [3]

Medical education and practices includes live cases, radiology films diagnosis, live operations, and other practices which represent an essential part of medical education. In order for an eLearning system to be successful in medical education, it needs to address both theoretical and practical sides of medical education and provide students with a similar level of life practice participation. Integrating eLearning systems with existing medical systems is not a trivial process; it is always faced by many challenges and obstacles.

This paper discussed the approach designed by King Saud University Hospitals in planning eLearning systems, and integrating them with existing medical systems. This approach proposed a solution to the problem of integration by utilizing a medical portal to work as an interface layer between the eLearning system and the medical systems. This layer greatly

simplifies the integration, and improves the efficiency of the eLearning system. This approach is also useful in securing patient information privacy against illegal access and at the same time providing students with sufficient data to analyze, and diagnose their cases.

The study considered the requirements and challenges of medical education and eLearning, proposed strategies and techniques to satisfy these requirements and overcome challenges. It expressed how these strategies and techniques are utilized in designing KSUH eLearning system. In conclusion, eLearning systems designed for medical education should consider handling the privacy and security of patient data, overcoming space limitation, and simplify medical information access in addition to other medical education challenges.

For future study, the effect of these system on the performance of medical students need to be examined to assess the value of such systems in enhancing medical education and helping students in construction and improving their skills, and hence their performance as physicians in the future.

REFERENCES

- [1] Chen, Kinshuk, Wang; "Cyber Schooling Framework: Improving Mobility and Situated Learning"; *Fifth IEEE International Conference on Advanced Learning Technologies*; Taiwan, 2005.
- [2] Whitis GR; "A Survey of Technology-Based distance Education: Emerging Issues and Lessons Learned"; *Association of Academic Health Centers*, 2001; Washington DC.
- [3] Albarrak AI; "Designing E-Learning Systems in Medical Education: A Case Study", *International Journal of Excellence in Healthcare Management*, 3 (1): 1-8, 2010.
- [4] Hayashi; Tominaga; Yamasaki; "Blended learning contents for university education"; *The 7th International conference on Information Technology Based Higher Education and Training*, 2006.
- [5] Albarrak AI, "Assessment of Medical Informatics Skills of Undergraduate Medical Students at College of Medicine", King Saud University.

- Journal of Administrative science*. 7 (1), 1-10, 2010.
- [6] Albarrak A; "Medical informatics in undergraduate medical study"; *Technology and Health Care*; Volume 13, Issue 5; Pages: 356 – 357, December, 2005.
- [7] Kathleen Scalise & Bernard Gifford. Computer-Based Assessment in E-Learning: A Framework for Constructing “Intermediate Constraint” Questions and Tasks for Technology Platforms. *The Journal of Technology, Learning, and Assessment*. Volume 4, Number 6, June 2006.
- [8] Albarrak AI, Abdulrahman Alsughayr and Alia Alzawawi.” Attitude of general practitioners toward online continuing medical education.” *Egyptian dental journal*, 55: 1513-1519, 2009.
- [9] Koh, Khoo, Wong, & Koh; “The effects of problem-based learning during medical school on physician competency: a systematic review”, *CMAJ* 178 (1):34-41, 2008.
- [10] Wilson J; "Health Insurance Portability and Accountability Act Privacy rule causes ongoing concerns among clinicians and researchers". *Ann Intern Med*, 145 (4): 313–6, 2006
- [11] Caroline N. McCubbin; “Legal and ethico-legal issues in e-healthcare research projects in the UK”; *Social Science and Medicine*; Volume 62, Issue 11, Pages 2768-2773, June 2006.
- [12] Anderson; "*Modes of interaction in distance education: Recent developments and research questions*"; Moore, M. G. & Anderson, W. G. (eds.), *Handbook of Distance Education*; Lawrence Erlbaum Associates, 2003, N. J, USA.
- [13] Robert H. Dolin, MD, Liora Alschuler, Calvin Beebe, Paul V. Biron, Mlis, Sandra Lee Boyer, Daniel Essin, MD, Elliot Kimber, Tom Lincoln, MD and John E. Mattison, MD ; “The HL7 Clinical Document Architecture “, *Journal of American Informatics Association*; 8:552-569, 2001
- [14] Samuel J. Dwyer III. A personalized view of the history of PACS in the USA. In: Proceedings of the SPIE, "Medical Imaging 2000: PACS Design and Evaluation: Engineering and Clinical Issues", edited by G. James Blaine and Eliot L. Siegel.; 3980:2-9, 2000.
- [15] W. Dean Bidgood, Jr., Steven C. Horii, Fred W. Prior, and Donald E. Van Syckle; “Understanding and Using DICOM, the Data Interchange Standard for Biomedical Imaging”, *Journal of the American Medical Informatics Association*, 4:199-212, 1997.
- [16] The Sloan Consortium, “*Growing by Degrees: Online Education in the United States, 2005*”; <http://www.sloan-c.org>.

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