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E-LEARNING ENVIRONMENTS IN MEDICAL EDUCATION: HOW PERVASIVE COMPUTING CAN INFLUENCE THE EDUCATIONAL PROCESS

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As pervasive computing is integrated incrementally with all facets of everyday life, it is reasonable to expect that its further proliferation may influence educational activities as well. Several such arguments have been thoroughly discussed in literature and several projects have been developed. However, little work has been done to investigate how pervasive computing can influence the medical educational process using e-learning platforms, and the prerequisites for such endeavours. In this piece of work, a theoretical framework that puts the use of pervasive computing along with the special needs and requirements of Medical education utilising e-learning environments is proposed. To this extend likely problems and difficulties that may arise are discussed together with the social consequences that may be provoked.

Keywords: continuing education; SCORM; Healthcare LOM; SCORM for Healthcare; POCKET SCORM; pervasive devices; PDA; mobile learning

1 INTRODUCTION

During the last decade processes in medical education have started to become enriched with electronic learning and other Computer Science features and tools. In the meantime, pervasive computing has been gradually integrated in all facets of everyday life including the education process.

Lots of projects regarding the use of pervasive computing in e-learning have been developed. Some of them examine the exploitation of common devices such as projectors, microphones and cameras in order to record educational sessions in real time and to allow students to follow the educational process from a distance, trying to integrate the traditional activities within a classroom with the tele-education ones (Abowd, 1999), (Shi, 2003). Furthermore, the use of mobile devices for e-learning entails the use of the appropriate standards, and the creation of an environment for self-motivated learning (Chang, 2002), (Lin, 2004).

One of the problems that appeared as a result of embedding pervasive computing in medical education within e-learning, concerns the integration of the Sharable Content Object Reference Model (SCORM) for Healthcare into pervasive devices, the use of WEB 2.0 tools within pervasive Healthcare education environments, and the prerequisites for such endeavours.

To fill in the gap, we propose herein a framework that integrates standards like SCORM for Healthcare and the mobile SCORM equivalent, Pocket SCORM, into any pervasive device, allowing the reusability and the interoperability of learning context accompanied by Web 2.0 tools such as podcasts, vodcasts, blogs and wikis. The aim is to demonstrate the process of distance medical education can be influenced by the use of pervasive computing environments, but also to establish a set of directives in order to protect technical and human entities from potential malefic attacks.

The remainder of this paper is structured as follows. In Section 2 we provide a brief account on related work. In Section 3 the concurrent route of e-learning environments and pervasive computing is described, while in the following section the framework is introduced. The prerequisites for the existence of this framework are given in Section 5, followed by discussion on key issues of concern and future work.

2 SETTING THE SCENE

Pervasive computing was initially discussed as a new way of thinking about computers (Weiser, 1991) taking into consideration the human world and giving the opportunity to computers to be hidden in the background while being an integral but invisible part of people's life. Three concerns were firstly issued for pervasive computing: (i) low cost and low-power computers with equally convenient displays; (ii) software for pervasive applications and (iii) networks that act as platforms of intercommunication among all (Dritsas, 2006), (Langheinrich, 2002).

Low-power computers were firstly replaced by mobile devices and then by wearable and pervasive devices consuming low energy and having high autarchy extended with invisibility. The software for pervasive applications has taken the bun of classical graphical user interfaces and implicates natural human forms of communication such as handwriting, speech, pen-based or free-form interaction (Fitzmaurice, 1995) and sensors attached to computational devices so as to provide management and manipulation in physical ways (Harisson, 1998), (Abowd, 2000). Communication and collaboration of the heterogeneous and different environments that interfere in pervasive computing has been also a major issue when demanding ubiquity, invisibility, interconnectivity and co-operation between pervasive devices, as well as, memory affiliation.

As pervasive computing is incrementally integrated with all facets of everyday life, it is reasonable to expect influences on educational activities as well. Numerous efforts within projects were made to create environments that capture as much of the university classroom experience as possible by automating the production of online lecture notes with electronic whiteboards and other gadgets and tools such as, embedded microphones, cameras and projectors in the ceiling during the real-time lessons (Abowd, 1999). Then a Smart Classroom by the use of Smart Space and similar means gave the teacher the opportunity to be away, bridged the gap between tele-education and traditional classroom activities in terms of teacher's experience and seamlessly integrated these two separate educational practices (Shi, 2003). In another project (Chang, 2002), a wireless platform was developed where an ad hoc classroom accompanied by the eSchoolbag system was built, allowing the communication between teachers' and students' with devices such as desktop PCs, laptops and PDAs in order to create a self-motivated learning environment. Electronic subsystems were also created such as PowerPoint broadcasts, text transmissions, voice and Image transmissions etc so as to complete the application ranges required for all kinds of devices.

In the mean time, e-learning environments undertook a crucial part in the educational process by means of collaborative tools for synchronous and asynchronous communication such as chat, forum, e-mails, as well as, document exchange tools, file management, etc.

Furthermore, international standards of learning material were specified in order to meet the portability and interoperability between the different e-learning platforms. SCORM (SCORM, 2004) adapted requirements regarding accessibility, adaptability, affordability, durability, interoperability, and reusability. It was based on widely accepted technology standards such as XML and JavaScript and it was adopted by a large number of providers, institutions and corporations worldwide. The standard was initially organized by the Advanced Distributed Learning Initiative (ADL), but several other studies proposed extensions or changes in order to fit in special needs of every educational process. In order to fulfil the needs of medical education, the MedBiquitous Consortium - which is the ANSI-accredited developer of information technology standards for healthcare education and competence assessment - proposed a specification called SCORM for Healthcare (Smothers, 2005).

SCORM for Healthcare extended the Learning Object Metadata (LOM) standard in order to provide custom vocabularies for some metadata elements. That LOM profile was called Healthcare LOM (Smothers, 2007). SCORM for Healthcare was actually a version of SCORM implementing Healthcare LOM. The requirements for medical education that were not included in the existing LOM have been addressed by extending the LOM standard by a Healthcare Metadata category using custom vocabularies. To incorporate the use of mobile devices in the e-learning purposes, a modification of SCORM, called Pocket SCORM (Lin, 2004), was designed and tested on Pocket PCs; its main focus was on connection mechanisms, courseware import and export and learning records buffering.

The latest collaborative and e-learning tools which are frequently met in the e-learning platforms are wikis, blogs, podcasts, vodcasts and blikis. These are called Web 2.0 tools and they increasingly interfere in the educational process. They use RSS (Really Simple Syndication) and the users can easily access them through Internet Explorer (version 7 and above) or Mozzila without the need of using a special program. Consequently, they can be easily embedded or added in existing e-learning environments. In medical education they have been well received due the sternness of their features. As Boulos et all (Boulos, 2006) conclude in their paper "if they are effectively deployed, they could offer a way to enhance students', clinicians' and patients' learning experiences and deepen levels of learners' engagement and collaboration within digital learning environments".

All these tools facilitate the collaboration on the Web through suitable Web Collaboration Environments. Furthermore, Mobile learning, taking place across different locations by the use of portable devices and technologies, derived from the evolution brought about by mobile computing. Portable devices such as laptops, Pocket PCs, Personal Digital Assistants (PDAs), smart phones, or just simple mobile phones advance the e-learning operability and enhance its use in everyday life. International standards ensure portability and organization of learning material, while standardization of learning object metadata provides the context for an effective and flexible e-learning environment which can be adjusted for various needs and requirements.

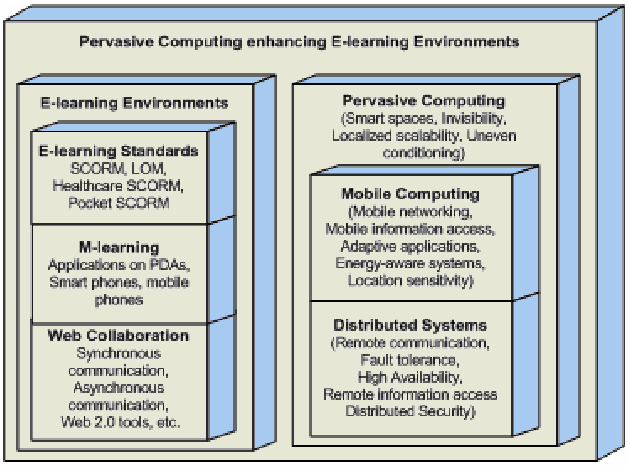

FIGURE 1. Pervasive computing meeting e-learning for medical education: standards, tools, and issues of concern

Figure 1 illustrates the above issues in an attempt to merge the developments in e-learning and pervasive computing within the field of medical education.

Finally, we have to mention that one of the most critical points in advancing e-learning is the audience itself. Medical doctors compose one of the most demanding audiences in the educational process, as the nature of their education necessitates a considerable combination of theory/knowledge and clinical practice.

3 THE RATIONAL AND THE FRAMEWORK

The majority of e-learning environments provide the necessary features for theoretical education. More advanced technologies, such as podcasts and vodcasts, wikis, blogs, blikis, and real time conferencing tools and Web Collaboration Environments contain features that advance interactivity and enable the fulfilment of more practical education targets. Such technologies also provide the ability to the user-teacher to constrain the role of the user-student so as to avoid "information vandalisms" thereby imposing barriers for the deterioration of information quality. But how can such options become integrated with the SCORM standard and more specifically to SCORM for Healthcare by the simultaneous use of pervasive devices?

All mobile and pervasive devices with some computational power and a manipulated interface can be easily adjusted to use Pocket SCORM (Lin, 2004). As the modifications on SCORM do not influence the elements of SCORM that exist on the Server, the only requirement is the installation and configuration of (i) the Pocket SCORM run-time environment (RTE) into pervasive devices, (ii) the PC Dock - which is a layer between Pocket SCORM RTE and the SCORM LMS server –so that a connection with the local LMS server can be established, and (iii) of the local LMS Server so that all the course material can be stored (in a Data Repository), when the connection is unavailable.

When the standard SCORM for Healthcare is used on a wired PC, it allows Web 2.0 tools to be embedded as Metadata by the use of Healthcare LOM. Metadata can be associated with Assets such as images, documents or video and audio streams providing suitable information about the Assets independently of learning content including the information of title, description, etc. and allow external search. The Asset Metadata can be applied both to <resource> elements (Asset resource) and to <file> element which can be met as child element of <resource> within an Sharable Content Object (SCO) (Figure 2).

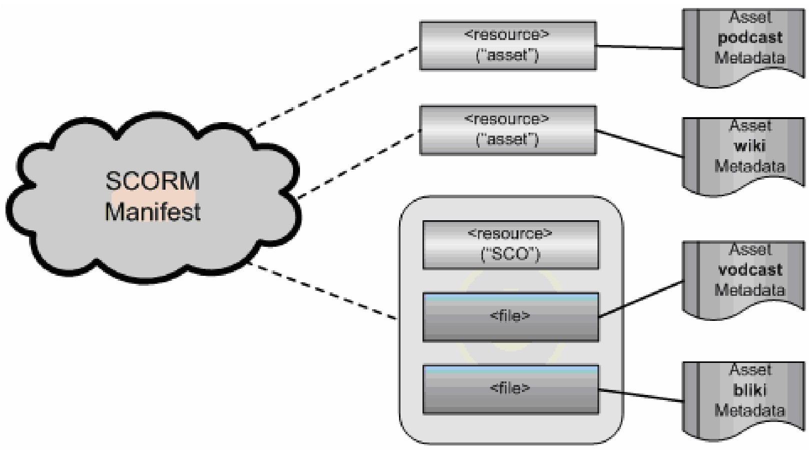

FIGURE 2. Asset Metadata for Web 2.0 tools in SCORM

The Healthcare LOM includes all the categories of LOM, therefore the "Technical category" as well. The Technical category is composed by some elements including Size, Location, Requirements etc. Location, is a string and may be used to access the learning object; it usually represents its physical address. SCORM for Healthcare on the web server side can cooperate without problems with Pocket SCORM on the pervasive devices' side because it uses the same basic functions as SCORM (Figure 3).

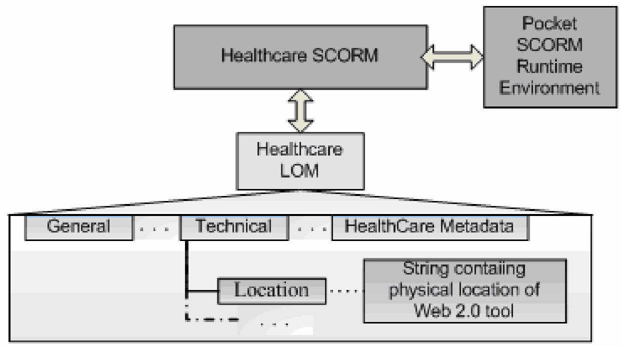

FIGURE 3. Integration Scheme for SCORM for Healthcare, Pocket SCORM and WEB 2.0 tools

Regarding podcasts or vodcasts as Healthcare LOM, once a stream of data is initialized they will start to be loaded into the wired PC, and be projected through a suitable software. In case of wikis, blogs and blikis the page will be loaded and used in a dynamic mode. The same procedure could be followed in case of a wired pervasive device, with only one difference; the data would be initially loaded into the local LMS server and then to the Pocket SCORM RTE, so as to be viewed through the software viewer of the device.

The case of wireless devices, such as most pervasive devices, is much more complicated. Podcast and vodcast require a stream of data to be sent to the device in-real time and the capacity of memory to be high enough for the transaction to be successfully established. While the wireless pervasive devices are on-line the problem is solved because the speed of data transfer is suitable for this operation. In case of non-connectivity the data should be stored earlier in the Data Repository of the device. Furthermore, the amount of stream data does not allow the whole stream to be stored, but only the first part. The solution to this problem is the break of the stream into parts by the external WEB LMS server before retransmitting it to the pervasive device and sending the parts in a chain until the device sends a message of full memory. When the user finishes viewing a part, it is being deleted from the Data Repository and in the first online chance a message is sent so that the following parts that are waiting to the web LMS server are transmitted one by one.

Regarding wikis, blogs, and blikis, the process is easier. The pervasive device requests through the Healthcare LOM one of the above tools and when the connectivity is available, the page is stored into the Data Repository. If any changes occur only the added or changed content is transmitted to the web LMS server, which is responsible to add the content in the tool and retransmit it, including the changes so that the user of the device takes a feedback.

4 FRAMEWORK REQUIREMENTS

The prerequisites of this framework can be dealt within two different dimensions. The first one is the technical and the second depends on the individual person’s privacy and anonymity.

Technical prerequisites are set due to the features of the devices that are used. Mobile devices or pervasive devices in general need a “pervasive SCORM”. In case of mobile devices a Pocket SCORM has been proposed (Lin, 2004), which can be also applied in the pervasive devices the user uses with few modifications. For example, if we have sun glasses with computing power and a screen on the glass and want to provide a vodcast, the pervasive device should support Pocket SCORM or a similar architecture with some navigation controls which may be in the rim of the sun glasses.

Furthermore, pervasive devices (including mobile devices) have limitations on computation power, memory resources and energy. All of the three limitations/constraints are elaborated daily and their operability advances. In the proposed framework, the download of learning objects and learning object metadata follows the prototype of Pocket SCORM, stores all the necessary data in the pervasive device when the wireless connection is available, and uses them along user demands. To this extend, special cases of LOM which need high bandwidth and a lot of memory, such as podcasts and vodcasts will follow the same protocol and will be stored in the device, but they have to be separated into smaller entities in order to fulfil the preconditions.

On the other hand, for the data that are spread throughout pervasive devices and include for example patients’ sensitive data, one has to ensure that no leak would occur and the anonymity and privacy will be retained or kept within the specific e-learning community. E-learning platforms’ designers make a strong effort to ensure that the sensitive data will remain within the e-community. They use the RBAC model in software design and Hyper Text Transfer Protocol Secure (HTTPS) in order a different default port (443) and an additional encryption/authentication layer between HTTP and TCP to be used in addition to cryptographic protocols: Transport Layer Security (TLS) and Secure Sockets Layer (SSL) which provide secure communications on the Internet for such things as web browsing, e-mail, Internet faxing, and other data transfers.

In addition, human entities should be protected by the malefic attackers and secure their privacy and anonymity about their personal data, such as their IP address, their location etc. There exist many protection mechanisms (Lederer, 2002), (Lessig, 1998), (Adams, 1999) (Langheinrich, 2002), (Jendricke, 2002), (Muhtadi, 2002), (Beresford, 2003), (Beresford, 2004), (Nguyen, 2002), (Jiang, 2002) in the form of an abstract context, a protocol or a technology proposed for this issue, but most of them were not clearly designed for pervasive devices, resulting to the lack of full anonymity and privacy. Nevertheless, Dritsas et all [6] refers to the privacy threats that were identified in a pervasive environment and presents a set of principles for ensuring privacy in this context (Notice, Choice and consent, Proximity and locality, Anonymity and pseudonymity, Security, Access and Resource).

5 DISCUSSION AND FUTURE WORK

The framework presented herein enables the use of SCORM for Healthcare in pervasive devices. It provides the use of WEB 2.0 tools in all kind of pervasive devices giving the opportunity to the medical learners to learn and study while being away from the class and take advantage of the time pressures and the time they are “on the move”. What is more, it enhances the medical learning procedure concerning the medical doctors being in rural areas where the chances for enhancing the knowledge acquisition are limited.

The theoretical framework that sets the use of pervasive computing along the special needs and requirements of medical education utilising e-learning environments can boost the knowledge and advance the willing of e-learning participation with the selection of learning contexts that fulfil the learner's interests. However, the framework could be demolished unless appropriate prerequisites are set corresponding to the simultaneous development of pervasive computing and e-learning environments. The protection of privacy and anonymity are prominent issues, and despite of the numerous protection mechanisms that have been proposed, there is a clear design lack in the case of pervasive devices. Nevertheless, the use of such mechanisms is essential in order to reassure the security of personal data such as name, location, etc and patients' data that are used for educational purposes in web e-learning platforms, as well as, in pervasive learning environments.

In conclusion, our ultimate intention is to implement a system based on this framework so as to be able to research the practical problems and difficulties that may arise during the implementation. Of course, the feedback of the learners themselves will judge where the actions undertaken by the framework and its implementation will assist in reorganising the learning process suitably well, while at the same time meeting the real needs that arise during the medical educational process.

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