# Integrating Mobile and Ubiquitous Computing in a Smart Classroom to Increase Learning Effectiveness

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*Abstract*— **Learning has matured from a tethered delivery strategy offered through mail into a delivery strategy mediated by electronic devices (E-Learning) [4], and now we witness a robust mobile learning strategy delivered wirelessly to students in a smart classroom. Technology has afforded these students the opportunity to interact with classmates and educators anytime, and anywhere. In this paper we propose an approach to design a smart classroom integrating well-established (in our present society life) different mobile and pervasive technologies that facilitate the access to the multimedia content of the course. This vision of this work is to use this technology in question to supplement the face to face learning in order that the instructor delivers his knowledge in an efficient manner. In this work we illustrate different tasks involved in our smart learning environment and show how these are tackled efficiently like educator/student attendance and the interaction between the educator, the students and the different artifact of the smart classroom.**

***Keywords— M-learning, smart classroom, E-learning, ubiquitous computing, cloud computing.***

## I. INTRODUCTION

Nowadays, we live a mobile revolutionary era. Wherever one looks, evidence of mobile penetration is irrefutable: PDAs, MP3 players, smart handhelds, tablets, and laptops abound [2]. No demographic is immune from this phenomenon. From toddlers to seniors, people are increasingly connected and are digitally communicating with each other in ways that would have been impossible only a few years ago.

Educators and administrators of conventional education institutions face a daunting question: As society becomes increasingly mobile, how can institutions best educate, support, accommodate students equipped with cutting-edge mobile devices in order to facilitate and/or augment their learning beyond the conventional classroom?

M-Learning [3] research and development efforts continue to move rapidly, ostensibly to create a learning environment that can keep pace with the demand of mobile learners who regularly use mobile devices to access multimedia content [6]. The result of these efforts is the design of a fully mobile integrated platform that delivers course content, available for playback at anytime and anywhere convenient to students. This platform administrates a smart learning environment commonly called smart classroom [1].

## II. RELATED WORKS AND OUR CONTRIBUTION

The notion of a smart classroom is not a new concept; it arises from the general concept of smart spaces [7], [15]. This latter allows an actor to seamlessly access the best available services and resources in the changing environment he currently evolving in [9]. In communication, a smart space uses a wide range of communication technologies such as wireless sensor networks, UPnP networks and ubiquitous computing [19], [20]. Different works have been carried out on the design of smart spaces oriented to different areas such as private smart space for home or business [17], [16], [13], to learning [10], [11] and to health monitoring and medical domain [8], [14]. The additional contributions of our work compared to the previous E-learning environments is the fact that our idea of learning framework rests on the integration of the tablet equipment as a foundamental device to access digital content in anytime and anywhere manner. This device is used and adapted for education ranging from elementary school to post-secondary school. Unlike the previous contributions, our proposition of smart environment integrates well established cutting-edge high technologies in the social life of people in the sense that it puts the digital technologies in the service of the user without any excess of virtuality [12], [18] that makes a proposed idea as an utopian idea or an uneffective idea at a present time. The second contribution of our work is the integration of service oriented paradigm more specifically cloud computing paradigm to use an infrastructure as a service (IaaS) such as blocks of storage to back up school data (lecture resources, student workspaces), a platform as as as service (PaaS) such WebCT and Moodle platforms and software as a

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service (SaaS) such as email and free tools of communication like Skype or MSN and also data analysis applications.

This paper is structured as follows: Section 3 discusses the model of the smart classroom and the tablet used by the student that allows him to access the digital content of the lecture, he is attending to; also to communicate with other different actors and artifact of the smart classrom. In Section 4, we present the formalisation of the platform that manages the proposed smart learning environment. In Section 5, we brievly discuss the assessment of this model of smart learning environment that uses the m-learning to complement the face to face learning compared to the traditional face to face learning the only learning technique used in education. Finally in Section 6, we achieve this work with some concluding remarks.

## III. OUR MODEL OF M-LEARNING IN A SMART CLASSROOM

In this section we present our mobile learning approach operating in a smart classroom. In the last years there has been a wide range of mobile devices equipped with different type of communication (Bluetooth, WIFI, WiMAX etc). School educators need to target the growing list of available electronic resources in order to provide a rich technology-based learning environment that fosters flexibility, connectivity, and collaboration while engaging students by making learning fun!!.


Figure 1. The writing tablet in Mesopotamia

Recently, in the market, there has been the apparition of a plethora of tablets of different manufacturers and with reasonable costs. The philosophy of our M-learning approach is to set the high performing digital technology to the service of the user while respecting most of the traditional leaning techniques. In the beginning of writing, the human being in Mesopotamia and Egypt used to use this kind of tablet (Fig. 1) to learn, and ironically after thousands of years it seems that we are back to the tablet as a mean to convey learning.


Fig. 2: The model of a tablet and its content used by an elementary, mid, secondary-school student.

Different telecommunication and computing device manufacturers have designed different tablets, sometimes customized to a range of different user profiles. They have designed highly performing tablets for specialized users as well as tablets specifically targeted to elementary school children. The tablet of our M-learning environment in a smart classroom, we present here is dedicated to a mid-school student (Fig. 2). This latter uses the tablet to access different workspaces corresponding to different lectures. The content of each workspace is organized following the content resources of each lecture that the student can have access to. If, for instance, we consider the physics lecture, the student can access to information resources that are set and updated by the physics educator like lecture notes, encyclopedia, labs, exams and quizzes with their solutions etc.

The student can also have access to the equipment of the classroom like the smart board with the permission afforded by the educator. The permission can also be allowed for the student to access workspace contents of other lectures such as


Fig. 3: The model of an educator slider tablet with its content

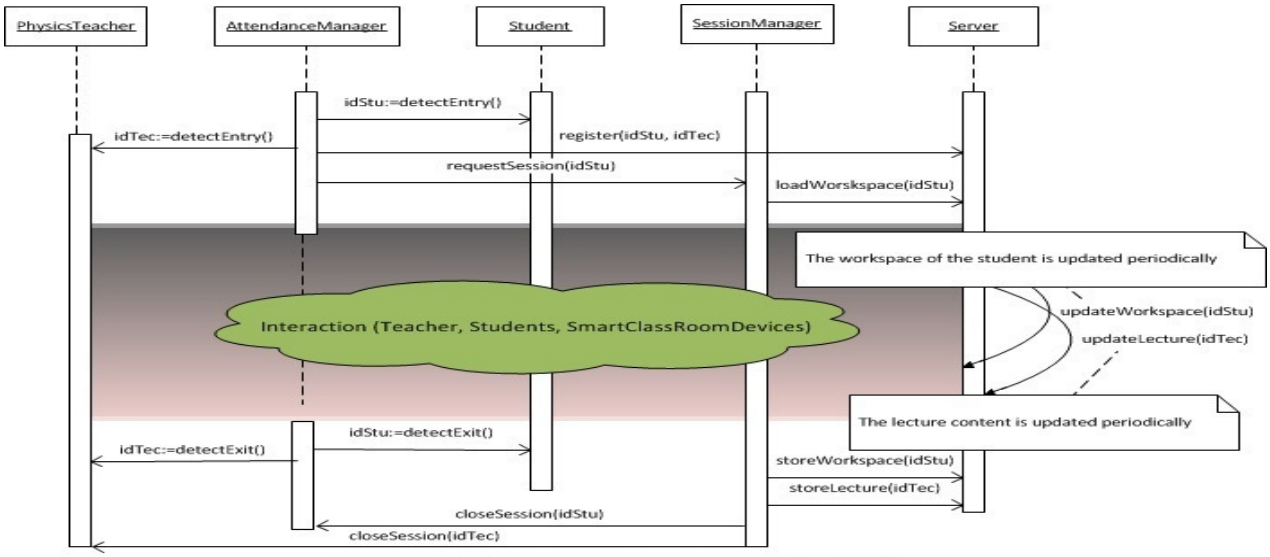


Fig. 5: The sequence diagram of our smart learning environment

mathematics or biology.

The content of the slider tablet used by the educator is roughly similar to the one used by the student. Indeed the workspace of physics lecture can be similar to the one defined for the student with the specific difference that the educator can have access and control on all students workspaces (Fig. 3). The educator has the privilege for instance to view the workspace of any student attending the lecture in the smart classroom and control his work. He can open a working session on the smart board and involving any particular students in a working group.

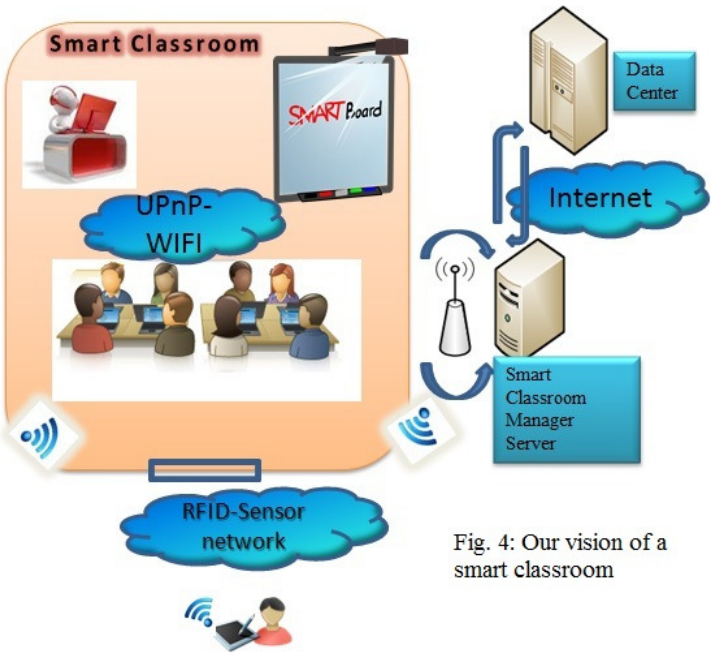


Fig. 4: Our vision of a smart classroom

## IV. THE MANAGEMENT OF M-LEARNING IN A SMART CLASSROOM

The model of the proposed learning in the smart classroom (Fig. 4) is based on a mixture of face-to-face learning (such as group activities) and M-learning. With M-Learning ubiquitous devices and the huge electronic course content library, a remaining concern that needs to be addressed is the hosting and delivery of a course multimedia content. The courses multimedia contents are stored/updated in storage servers and then backed up in a data center. The storage infrastructure along with analysis applications can be afforded, using a cloud computing solution [21], [22], [23], [24]. These services are governed via the school servers which host the platform that manages the behavior of the different actors of our smart classroom involving the school administration.

In Fig. 5, we present a sequence diagram that shows how the actors (students, educator), also the constituents of the smart classroom such as the smart board and the services of the management server. When a student/educator enters the smart classroom, the sensors detect the RFID tag of the user's tablet. This ID is then registered in the platform management server. The student gets automatically his workspace loaded from the server hard disc drive and passes to an active status and accessible by the corresponding student. Afterward, the educator and the students along with the allowed artifact of the smart classroom enter in a session of interactions. At the end of the lecture, the updated course content is stored as well as the workspace of the student in the server. As soon as the student/educator exists out of the classroom, he immediately gets back his private tablet environment. In this case we should note that he can access at anytime anywhere any course content through a platform such as WebCT or Moodle.

In Fig. 6 we point out the sequence diagram formalizing the interaction of the educator with some selected students (forming a working group) via the smart board. The educator

first activates the smart board. He writes an exercise on the smart board, and then he invites three students to solve the exercise by giving them writing privileges on the smart board directly from their places. The educator can at anytime comment/manage the solution progress, and at the end he closes this group work activity.

## V. ASSESSING THE EFFECTIVENESS OF THIS LEARNING APPROACH

The learning approach we proposed consists in supplementing the traditional face to face learning with M-learning in a smart classroom environment. Hence the presence of the educator in the classroom is important unlike other learning approaches where the educator is a virtual entity. So as previously addressed, in this learning approach, the digital technology and more specifically the mobile and pervasive technologies are integrated in order to enhance the performance level of the student. To assess the effectiveness of this learning approach we need to set some metric factors which are:

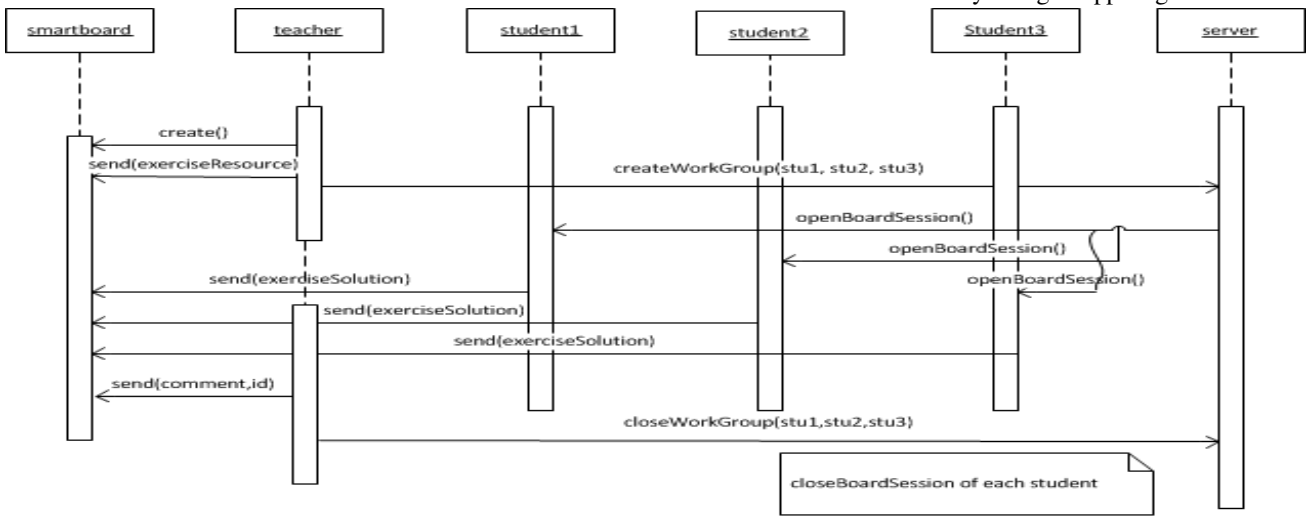


**Fig. 6: An interaction session involving the educator, a group of students and the smart board.**

1) the student performance,
2) the easy-to-use of the technology and
3) the information security.

The student performance can be evaluated on a sample of students through quizzes. Technology easy-to-use is also a criterion that can be evaluated via the question "How much effort do you need, to use the M-learning". The qualitative answer can be one of this set {too much, much, average, less, no}. Finally we consider that the system that manages the access to information resources and specially the student grades service is an open system that must be attacked by malware users. This issue can affect the learning effectiveness of the approach and must be treated.

## VI. CONCLUSION

Investments in smart spaces, and the widespread availability of Bluetooth, wireless-fidelity (Wi-Fi) and RFID communication techniques, the shrinking costs of data hosting/storage solutions, and the availability of a variety of inexpensive smart handheld devices like the smart tablets, led to our work that consists in designing a smart classroom where M-learning try to completes efficiently the face-to-face learning. Effectively in this work we showed how we can merge different well-established technologies in our society[1] in order to enhance the learning performance of students. We showed prototypes of workspaces that can be implemented in a tablet of a mid-school student and also in highly connected and performing computing device of the educator. The student can access to different multimedia course contents, and cooperate efficiently with the different actors of the smart classroom. Using the cloud computing paradigm, the proposed platform that manages the proposed smart classroom and its actors, stores/updates periodically the students workspaces. Persistent data (workspaces and courses contents) is backed up in a data center as a service afforded by Google App Engine or Amazon Simple Storage Service (S3) and where analysis techniques can be carried out.

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