Facilitating Learning in Isolated Places Through an Autonomous LMS

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Abstract. Current research argues that eLearning and mobile learning are forms of learning that could take place outside the classroom and the traditional learning environments. In addition, recent advancement in technology and increased use of smart devices permit students to carry with them a kind of portable smart device. Inevitably, sooner or later, these devices will become integral educational tools, such as pencils and books, while learning outside the classroom will continue to gain popularity as another form of learning. Ubiquitous learning aims to stimulate the wide use of ICT in Education and the enactment of autonomous digital resources for Outdoor learning. Technology could provide innovative ways of conducting outdoor courses, encompassing knowledge and physical activity. This paper presents the eClass-Pi system that facilitates outside the classroom eLearning and m-learning educational processes. It provides all the functionalities of a typical Learning Management Systems as well as synchronous and asynchronous teaching, portability and energy autonomy.

Keywords: Learning outside the classroom · Mobile learning
Blended Learning · Hybrid courses · Digital and educational tools & practices
Educational strategies

1 Introduction

Recently in the field of education the old-fashioned style of teaching has been abandoned. Teachers have begun to embrace new and more interactive ways of learning by asking for more active student involvement. A key role in this development has been the evolution of technology, reaching a point where education is now easier to provide individualized information anytime, anywhere, and on any device [1, 2]. On their part, teachers observed and explored the potential impact of this emerging technology on students, helping them to learn better in a dynamic environment [3].

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More specifically, eLearning made a spectacular introduction to the academic world and changed it radically. It is widely known, in many forms and types, such as online learning, cyber learning, virtual learning, mobile learning and is described by a majority of authors as access to learning experiences through the use of technology. Watson and Kalmon [4] simply defining eLearning as "*providing instruction and content that includes a combination of educational modes, delivery methods and technologies, learning theories, pedagogical dimensions, mainly through the Internet*".

There are many innovations developed in the recent years that support and assist eLearning. For example, teachers can easily share information with students that have access to exercises, can start a discussion or further research and elaborate their assignments online [5]. Other learning innovations include the gamification and ludification of the educational processes where learning is transformed into playing with the use of smart devices, field teaching, 3D printing rewards and feedback, giving students more motivation, collaboration and interest in the learning process [6–8]. Furthermore, recent reviews and studies show that portable mobile devices, used in outdoor informal environments (e.g. backyards, rural areas, nature centers or parks) support outdoor and field based education and stimulate knowledge acquisition outside the classroom [9]. These innovative implementations in eLearning can be hosted, integrated and provided through Learning Management Systems. This study proposes and presents the eClass-Pi system that facilitates educational processes outside the classroom. It provides functionality similar to Learning Management Systems (LMS) as well as Blended Learning.

The paper is divided as follows. Section 2 presents the findings on the literature review conducted. Section 3 introduces the development of the autonomous LMS eClass-Pi and presents a use scenario of learning outside the classroom and Sect. 4 concludes the paper.

2 Background

Outdoor education is often referred as a synonymous to education outside the classroom, adventure education, outdoor learning, outdoor school, expeditionary learning, experiential education, and environmental education [10]. Education outside the classroom is a concept, that is currently enjoying a revival due to the recognition of its benefits [11]. Interactions that support learning outside the classroom are made more accessible by using portable devices which are equipped with essential features of personal computer. According to [12], *"The mobile devices can connect to Internet through wireless communication technologies creating a spectrum of educational opportunities and a new type of student-technology partnership in learning"*.

Mobile technologies and the Information and Communication Technologies (ICT), in general, will not change the teaching principles and the educational process. However, it is the pedagogical practices of teachers which can be facilitated using ICT [13, 14].

Nowadays, there is an increasing demand for Learning Management Systems (LMS). Educational institutions integrate these systems since they provide significant benefits and facilitate the educational process [15]. Choosing the right LMS is a crucial decision for an educational institution since it should consider all the features it needs

to offer via system platform. The most powerful and popular LMSs across the world are Moodle [16], Blackboard [17] and Canvas [18]. These systems can provide the necessary features to conduct and manage a course, through a modern user interface. Beyond the ordinary use of Learning Management Systems, they could also be used in a different approach such as offline-portable LMS. This approach serves outdoor activities in isolated or rural places, where internet connection is limited. In our literature review for related work we have found some efforts and preliminary projects that could support a USB based LMS edition to cover teachers' course conducting needs. Such preliminary products are the StratBeans ATUM [19], the ATutor [20] and the NetDimensions Talent Slate [21].

3 An Autonomous LMS: The eClass-Pi

Teachers through portable LMSs can create offline courses and offer them to their students, implementing an eLearning environment for practicing education outside the classroom. The eClass-Pi autonomous LMS system facilitates educational processes outside the classroom. Unlike the previous mentioned portable LMS, our system uses a single-board computer instead of USB based installations. In more detail, it provides functionality similar to a traditional LMS augmented with synchronous and asynchronous learning services (Blended Learning), portability, energy autonomy and database synchronization mechanisms.

3.1 System Analysis

To achieve an outdoor activity, we implement the eClass-Pi system that satisfies requirements such as portability and energy autonomy. Our system uses the Open eClass LMS which is developed by the Greek Universities Network [22] and an implementation of a database synchronization mechanism with the server which hosts the institution's LMS. However, we designed our system in such a way that any other LMS can be supported by the hardware used. Table 1 summarises the main requirements that our system fulfils.

Table 1. eClass-Pi functional & non-functional main requirements

Portability	It is the most basic and necessary feature of systems that support outdoor learning. Portability is mandatory in order to facilitate course teaching in different locations, habitats and surroundings. eClass-Pi meets this strict requirement and supports full portability
Energy Autonomy	Energy autonomy is a principal element of systems that facilitates learning in rural or isolated locations. eClass-Pi along with portability, supports energy autonomy with the use of a power bank with integrated solar panel. The idea is to combine portability and energy autonomy to serve long-term course sessions in detached places

(*continued*)

Table 1. (*continued*)

Use of existing learning infrastructure	Our implementation hosts the Open-Source eClass LMS. It is an academic effort with a community of experienced researchers, developers and academic staff. It is provided to the majority of universities and institutes around Greece facilitating the educational process. Open eClass has a variety of features (modules) such as file exchange, exercises, assignments, gradebook, attendances, analytics, teleconference and forum which are accessible through an easy-to-use environment
Two different instances of the LMS	Our implementation must support two different installations of a LMS. The first installation is the main LMS environment of the educational institute which is installed on a web server and the second installation is a limited LMS installation on a portable computing system
Course Synchronization	The system must support synchronization features. In more detail, our system must implement a synchronization algorithm in order to achieve bidirectional data flow between the two LMS instances (base and portative)

3.2 System Architecture

Our proposed architecture of eClass-Pi (Fig. 1) consists of two main settings. The two settings represent the "Indoor" and "Outdoor" installation of the LMS respectively. On both LMS installations, we have installed LAMP [23] which is an open source Web development platform that uses Linux (OS), Apache (Web server), MySQL (RDBMS) and PHP (OO-scripting language) which are suitable for building webpages and applications. We have named "base-LMS" the setting that is on the institutions main server and "portative-LMS" the setting that is on the portable device supporting the outdoor learning activities.

base-LMS: That corresponds to the main institutional LMS installation. For testing purposes, we could not use the official institutional LMS. Our needs for LMS hosting is fulfilled through the Okeanos virtual compute and network service offered by the National Network for Research and Technology (GRNET) [24]. Our academic network provides us a virtual machine with one CPU core, 4 GBs of RAM, and 40 GBs of disk storage.

portative-LMS: It is a limited LMS installation on a portable computing system. We used a Raspberry Pi 3 Model B [25], a developer board, provided by the Raspberry Pi Foundation which is a low-cost computer system with a 1.2 GHz 64-bit quad-core ARMv8 CPU, one GB of RAM and flexible storage depends on MicroSD card. It also has a built-in Ethernet port, Wireless LAN module, Bluetooth low-energy (BLE) and four USB ports. To connect users (mobile devices) to the Raspberry Pi server, we customized the source files of the operating system by converting the board's Wi-Fi receiver to a transmitter, creating that way a private ad hoc network.

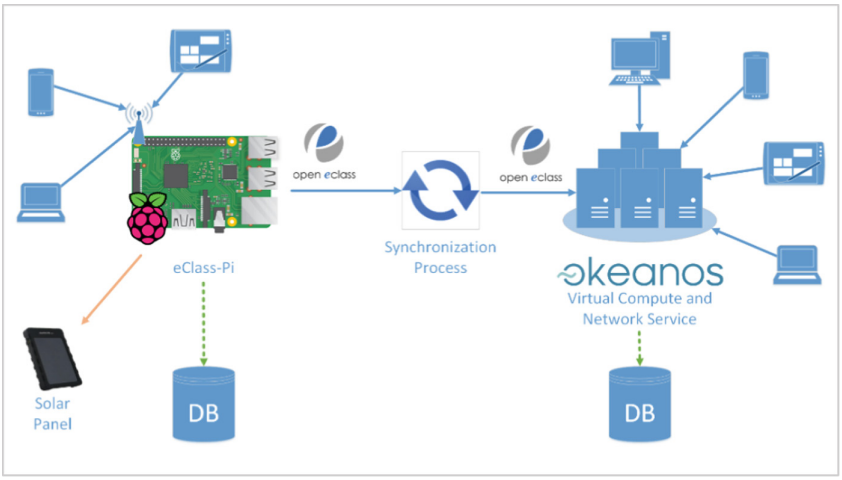

Fig. 1. The eClass-Pi architecture.

The communication between the two LMS-Stations is established through HTTP requests. Since, Raspberry Pi is a complete, portable computer system that can act as a server and it is difficult to assign a static external IP address, our system performs the GET and POST method requests exclusively from the Portable-LMS-Station. To achieve this, our system should be connected to a LAN (802.3) or WLAN (802.11) network. Alternatively, a 3G/4G USB Broadband modem could be used to achieve connectivity.

3.3 The eClass-Pi

The UML activity diagram of our system (Fig. 2) presents all available actions offered to users for outside the classroom (outdoor) courses. eClass-Pi supports two different user roles, namely the "Teacher" and the "Student". In the case that the connected user

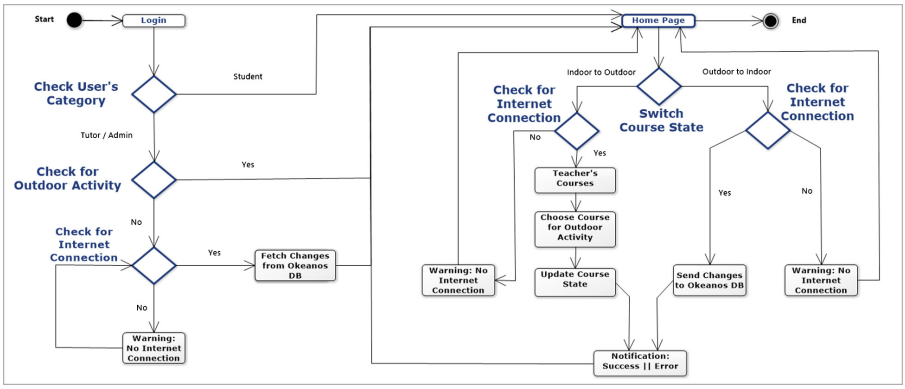

Fig. 2. The eClass-Pi "Indoor" & "Outdoor" activity diagram.

is of role "Student" then she/he can have access to the educational material of a course and the available modules to perform different tasks such as: exercise resolve and digital material upload (e.g. snapshots, textual comments, etc.).

On the other hand, if the connected user is of role "Teacher", she/he can perform different tasks such as: carry out the lecture that will take place outside the classroom, fetch the latest course's changes from the base-LMS installation, monitor course data transfer to and from the remote database and choose the lecture of his desire to be performed outside of the classroom by setting course's status to "Offline" in the base-LMS. With the latter action, the course becomes invisible and inaccessible to any user of the base-LMS installation, preventing new entries that would lead to duplicate records and inconsistency problems between the two LMS installations (base and portative). Moreover, the course is ready for the outside the classroom learning activities which can be carried out without the use of internet connection. Upon completion of the outdoor educational activities and in order to synchronize the two LMS installations the user with the role "Teacher" sends all new data produced, from the portative-LMS database to the base-LMS database and restores the course status to "Online" i.e. visible. Synchronization of the two LMS installations (base and portative) requires the eClass-Pi portable device to be connected to the internet, otherwise, a warning message will be displayed to the user.

3.4 The Use Case of Plant Physiology Laboratory Course Outside the Classroom

To illustrate some of the concepts described so far and to provide insight into the features of eClass-Pi, we will briefly describe a representative use case scenario emphasizing on teaching a laboratory course outside the classroom (Exhibit 1).

Exhibit 1: Let us assume that we have imported teachers, students, and courses from the base-LMS installation to the portative-LMS installation and we are ready to provide, support and exercise a course outdoors. In our indicative scenario the connected user, is tutor "John Doe" which is tutoring the above imported courses and has the rights to create and initiate an outdoor activity. John Doe can manage the "Plant Physiology" course from his office and prepare an exercise for student's evaluation (Fig. 3) on the base-LMS. Once the eClass-Pi is booted, he should fetch all the associated records. Then, the preparation is completed and he can change the status from "Indoor" to "Outdoor" in "Plant Physiology" course (Fig. 4) that he tutors in our use case scenario.

While the course is still in a "Indoor" state, it is available and accessible from any user in the base-LMS. When the course is set to "Outdoor", we notice that in the base-LMS, it becomes invisible to users in order to avoid any conflicts in "Plant Physiology" (Fig. 5). In the end of the outdoor activity, Mr. John Doe should restore the state of the course to "Indoor" to synchronize the remote database with the latest changes (Fig. 6). The process demands an internet connection, otherwise the state can't be restored.

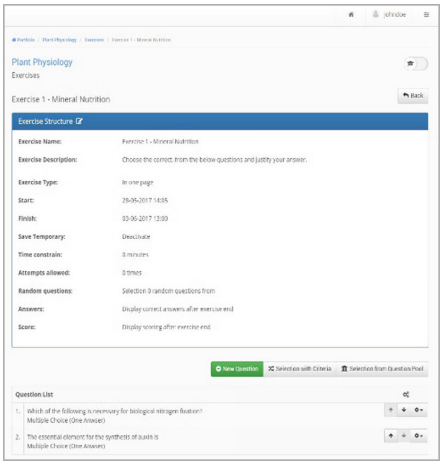

Fig. 3. Exercise creation.

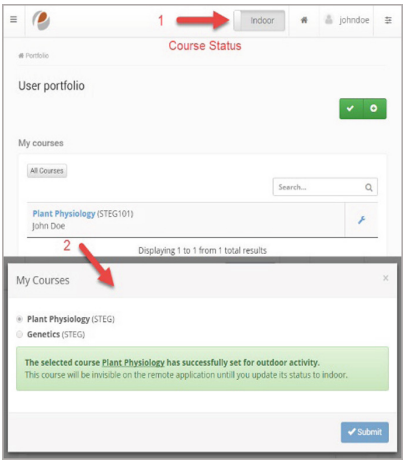

Fig. 4. Change course status.

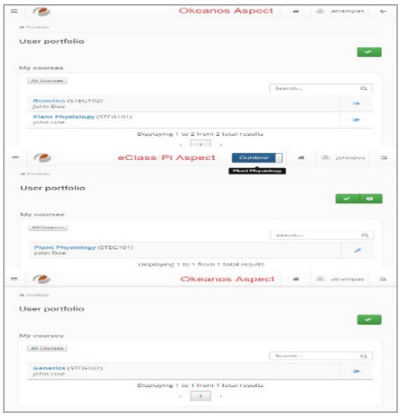

Fig. 5. Okeanos & eClass-Pi aspects.

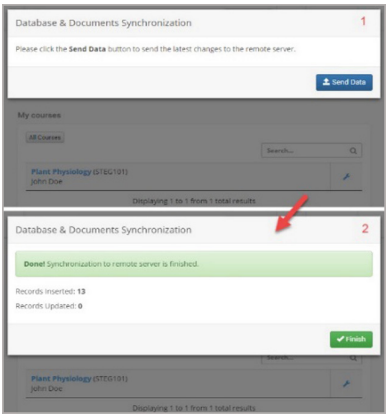

Fig. 6. Send records in Okeanos.

4 Conclusions and Future Work

In this paper, we have attempted to sketch the organizational underpinnings of the eClass-Pi – a pilot effort aiming to build an autonomous and portable LMS for facilitating learning in rural or isolated places. Our primary design target is to set up a fully operational LMS system on a portable computing system such as the Raspberry Pi that is energy autonomous and supports specific course activities and synchronizes to the base-LMS installation of an educational institute which resides on the institute's main server. We have implemented the eClass-Pi that offers a fully energy autonomous and portative-LMS. Using eClass-Pi, we can provide hybrid courses which satisfy

synchronous learning in environments that lack energy sources and internet communications and asynchronous learning inside educational institute environment. In specific scientific sectors, the eClass-Pi can offer significant improvements in practical education as it gives students the possibility to bring technology outside the classroom, interact with surrounding artifacts and engage the environment in the learning process in isolated places. Our ongoing work covers a variety of issues of both technological and educational engineering character. Some of the issues to be addressed in the immediate future include synchronization conflicts with databases' records, system features restrictions and limited user's connections based on hardware. Evolving our work, we are going to evaluate how the promotion of democratic dialogic behavior and democracy could be promoted through a system such as eClass-Pi.

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