M2Learn Open Framework: Developing Mobile Collaborative and Social Applications

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***Abstract*— This paper presents M2Learn framework as an open platform, which facilitates the development of mobile learning and ubiquitous applications. The main features of this framework are: (a) transparent management of multiple location-based technologies including GPS and cell towers; (b) identification of objects through RFID; (c) support for motion sensors (e.g., G-Sensor); (d) interoperability with Moodle e-learning platform; and (e) support for widely accepted e-learning standards, including LOM for learning objects, and IMS-QTI for assessment. To demonstrate the benefits of the M2Learn system, a MobileTwitter microblogging application had been developed. The benefits of the application relying on the M2Learn's infrastructure are discussed and experience in designing the system presented.**

Keywords - mobile learning; collaborative learning; M2Learn framework; microblogging.

I. INTRODUCTION

Mobile computing is one of the fastest growing technology industry areas worldwide. Mobile device adoption rate in western countries is 90%, with the youngest generations as the leading users [1]. One of the reasons for this success is the improvement in the devices' technical features and their low prices. The new generations of mobile devices have wider and touch screens, built-in digital cameras, and support Wi-Fi and 3G web connectivity. Most devices are equipped with GPS (Global Positioning System) receivers, RFID (Radio Frequency IDentification), NFC (Near Field Communication) readers or smartcards. All these new embedded technologies make a platform for the new generation of applications to be used in all kinds of environments. These applications are context-aware and benefit from the internet connection anytime anywhere.

There is a significant body of research witnessing these devices can be used is education in order to enhance the learning and teaching processes. Coupled with the proliferation of mobile devices, this causes the increase of the demand for mobile learning application development. Due to heterogeneous nature of the devices, frameworks which ease the development tasks have emerged. These systems are created to decrease the inherent complexity of the technologies brought into the mobile learning development. In this paper we present such a framework named M2Learn and an exemplary application for microblogging, which can be used to support a diverse set of learning and teaching scenarios.

The paper is organized in three main parts: introduction (chapter II), which describes how social interaction can improve the learning experience; architecture description (chapters III and IV), where an open framework to simplify the development of mobile applications is described; and finally the results; where an application built over the proposed framework is shown.

II. ENHANCING LEARNING EXPERIENCES WITH SOCIAL LEARNING

The term „Web 2.0" was introduced in 2005., denoting a shift in perception of the World Wide Web, which becomes regarded as a lot more than just a passive source of information - it becomes a platform, a user-oriented environment where people interact and actively participate in content creation [2]. One of the most important and well known components of the Web 2.0 concept is the so called "social software." [3]. Examples of social software can be found in tools and applications such as wikis, applications designed for collaborative work allowing a number of users to edit online content; blogs; online diaries; podcasting, a new type of online media transferring using syndication feeds; sites like del.icio.us [4] and Flickr [5], which use a concept called "folksonomy," a style of a collaborative categorization of content using tags; content sharing tools such as YouTube, MySpace and RSS, allowing users to subscribe to a website's content and receive notification each time the page changes; e-portfolio applications etc.

The impact of the Web 2.0 concepts on e-learning is summarized in the term e-learning 2.0 [6]. Tools like wikis, blogs, podcasting, e-portfolios etc. are used both in formal education and informal learning. The rise of importance of student-centred learning can be noticed: the learner is no longer a passive consumer of information but an active and engaged participant in the learning process who creates his or her own content and constantly interacts with other users.

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Control of the learning process has been placed „into the hands of the learner," communication and collaboration being the key components [6].

In the era of pervasive and ubiquitous computing, where learning is not restricted to one single place and has become integrated into our daily lives, the importance of mobile learning is rapidly rising due to the numerous possibilities mobile devices have to offer as means of supporting the learning process [7]. Due to their unique characteristics they provide new possibilities for interaction, collaboration amongst learners, informal learning and are, in the same time, user – centred and personal. Therefore, they naturally coexist and supplement the idea of e-learning 2.0.

III. OBJECTIVES: TOWARDS AN OPEN FRAMEWORK FOR THE DEVELOPMENT OF MOBILE LEARNING APPLICATIONS

Mobile devices present an attractive tool for learners since they integrate several well known functionalities: videogames; watching videos; communication via mobile devices; and collaborative technologies (e.g., blogs, wikis, mash-ups and social networks). All these, supplemented with an adequate learning activity design, transform learners from mere listeners towards active participants in the learning process engaged in interaction in the way are already used to. Therefore, learners feel more motivated and engaged in learning.

M2Learn project makes a step further in the state of the art design of mobile learning applications. It supports the development of innovative mobile learning applications that complement and enrich learning experiences encouraging learning "anywhere, anytime", improving the social interactions, providing personalized educative experience to each learner, and reaching to places where traditional or on-line learning cannot reach. M2Learn middleware is devoted to helping mobile learning best supporting education, complementing traditional and on-line learning instead of replacing them, thereby promoting blended approaches.

The main contributions of the M2Learn should be: it is an open framework which simplifies and facilitates the development of complex mobile learning applications both "lowering the floor" (i.e., makes it easier for designers to build applications) and "raising the ceiling" (i.e., increases the ability of designers to build more sophisticated applications). The M2Learn's framework should:

- Provide an interface towards some services in the existing e-learning platforms (currently Moodle). This feature allows external applications, such as mobile learning applications and games, to interact with the services. Currently, the supported services are focused on collaboration, communication, and assignments methods.
- Gather students' e-portfolio from an external e-learning platform regardless the application source (e.g., games, mobile applications, e-learning platforms, and etc).
- Enable transparent sensor data acquisition, supporting location GPS, cell towers, Wi-Fi; identification through RFID; and motion recognition thanks to accelerometers, and digital compasses.
- Be released as source code, under a GNU GPL v3 licence.

It is our main goal to create a framework with inherent reduced inner complexity of location techniques, easy accessible learning services, context-awareness and management of e-learning resources, facilitating the development of m-learning projects within educational institutions.

IV. THE M2LEARN FRAMEWORK

Successful adoption of mobile devices in education requires the development of applications which adequately support mobile learner. Thus, authors have committed to create the M2Learn framework, supporting the development of the new generation of mobile learning applications [8]. Being scalable and reusable, the framework supports plug-and-play configuration by the consistent use of standards and definitions of public interfaces. This allows for adding of new services to the system without changing the software structure (Figure 1).

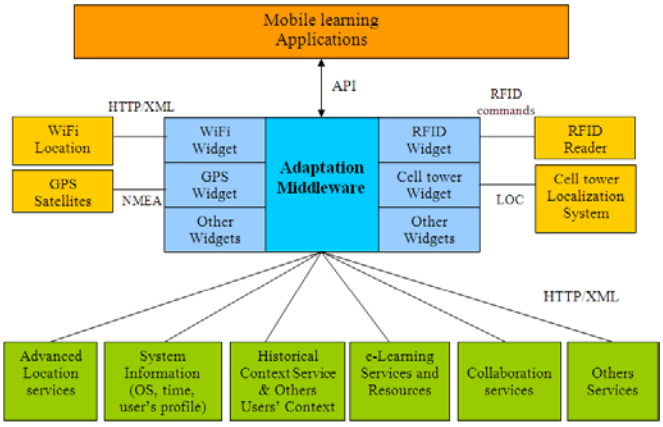

Figure 1. M2Learn architecture includes location technologies and integrates various services, some of them coming from e-learning platforms.

The framework supports user-driven collaboration and communication by integrating content into blogs, chats, and forums already supported by the existing e-learning platforms in organizations (at this stage only support for Moodle had been developed). M2Learn promotes the P3 social networking (i.e., People-People-Place) driving the participation in mobile social learning-oriented communities, mainly due to its interface towards e-learning platforms and location technologies [8].

A. A Context-aware approach

M2Learn provides easy access to sensors and multi-modal interfaces (e.g., accelerometers), having the potential of improving student engagement in content and activities. It enables invisible switching between various location-based technologies (e.g., GPS, cell towers-triangulation, WiFi) and supports the "Internet of Things" paradigm by integrating a RFID reader management module. All this sensor data is aggregated into users' context and complemented with the

access to services devoted to translating identifications (e.g., coming from RFIDs) or latitude and longitude coordinates (from GPS or cell towers) into an area name (e.g., room, building, street, city, and country) which can then be associated to services or contents. The contextual information can be also used to simplify the development of augmented reality applications since developers use the provided API (location and motion) to acquire the information to be superimposed to the camera images.

All the contextual information (e.g., location, time, profiles, schedule, surrounding people or preferences) can be used to personalize the access to content and services. The M2Learn framework includes a module for content and service discovery based on spatial and temporal variables (associating resources to time and places); yields personalized context-aware search results and integrates mainstream and social media through the use of data feeds (RSS).

B. *Towards integrated learning services and mashups*

The M2Learn framework supports fundamental e-learning standards, such as LOM for Learning Objects and IMS-QTI for assessment. It is able to communicate with the services offered by the existing e-learning platforms such as calendar, chat, forum, blog, assignments, and wiki. Logs from external applications can be used to put together students' e-portfolios and triangulate it with the educational experience coming from a mobile application, game, or an e-learning platform.

What is more, the framework allows the creation of mashups by offering its contextual information through an external publicly available interface. Figure 2 represents an example of such an environment where two mobile applications are built on top of the M2Learn Framework interact via the services offered by an e-learning platform. These applications compile contextual information from different sensors and send it to the Context Hub, which then distributes it to the rest of the group or other external applications to support the creation of mashups. A key element in this ecosystem is the Contextual Service Directory which provides information about the available services for each user according to the location and time.

This architecture simplifies the development of mobile learning mashup applications considerably. For example, users will be able to create a mash-up system using the predefined location information APIs instead of dealing with intricacies of the NMEA protocol and GPS protocols; or dealing with complex communication mechanisms through a serial port with an RFID controller in order to read information from an RFID tag and interpret it accordingly.

As an example of added value and the ease of use, users will be able to create a mobile blog using the services provided by an e-learning platform, but they will not need to create any web service in the language of the platform or understand how the database is structured. They will be able to reuse simple existing interface with information and services provided by the M2Learn middleware.

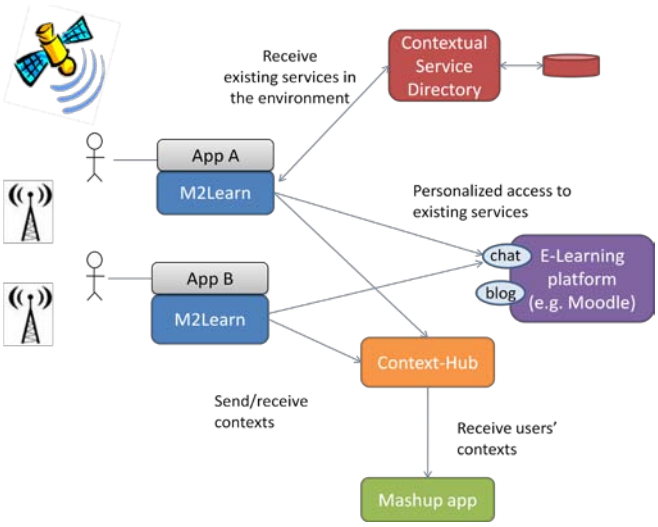

Figure 2. Overview of a mobile ecosystem built on top of the M2Learn Framework.

Although the M2Learn framework is already developed and deployed, mobile learning applications that rely on it are currently being designed. It has to be noted that every new mobile learning application cannot be conceived as an isolated entity, but as a live ecosystem of both services and users. With M2Learn this is indeed possible since it facilitates the coexistence of multiple users that interact, collaborate and communicate with each other minding group's context.

V. DEVELOPING A MICROBLOGGING APPLICATION USING THE M2LEARN FRAMEWORK

In order to evaluate the ease, effectiveness and the appropriateness of the M2Learn framework, 7 students taking a distance learning course in mobile programming were each assigned a task of developing an application using different kinds of mobile technologies (i.e., Web, .NET, Android). All these applications have one thing in common: they are based on the M2Learn framework and reused its APIs in order to build higher level application services.

One of the applications deals with microblogging and is inspired by ever-so-popular web service Twitter [9]. It is based on M2Learn's context aware modules and is connected to an e-learning platform. From an educational point of view, the application could be used for out-of-the-classroom activities in which students microblog their opinions or answers in different context and locations. Students collaborate *in situ* depending on the task assigned by the teachers and are latter debriefed in the classroom by the teachers who reviews their contributions through an e-learning platform

The MobileTwitter microblogging application created by the students encapsulates the following functionalities: (a) a user is able to post a message; (b) the posted message is

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stored into the central server space; (c) other users are able to read the message by connecting to the system.

These mechanisms are similar to the well known web service Twitter. In order to put the educational benefits in the first place the following modification were introduced. Each time a user posts a message the application automatically associates a location tag with it. The location appears regardless of the position of users posting the message – they can be indoor or outdoor. As an example, a microblogged sentence ”I’m going to start the practice!” is transformed into “Sergio@Juan del Rosal 12, Madrid: I’m going to start the practice!” prior to the submission into the centralized online repository. In this case M2Learn framework is used to contextualize student generated artifacts and to store them into the Moodle platform ready for the teacher and students post-activity debriefing session. Throughout the process, all the activity is logged into the M2Learn platform step-by-step contributing to building students’ e-portfolios.

The MobileTwitter application is composed out of three main modules: configuration, message publishing (used by the students in order to send messages), and message review (reviewing others’ messages) (Figure 3).

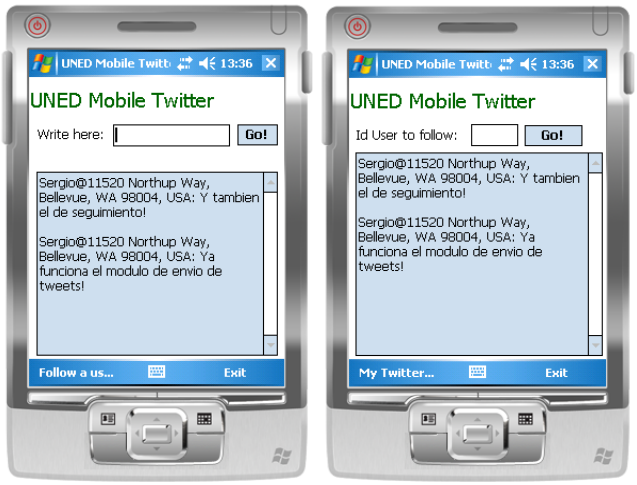

Figure 3. The MobileTwitter microblogging application developed by the students of Mobile Programming distance learning course

VI. CONCLUSION

The paper presented M2Learn framework which provides an infrastructure for the development of mobile learning applications. The infrastructure makes the use of context-aware information (such as location information) straightforward and the access to external e-learning repositories much easier due to the definition of externally accessible interfaces.

These benefits can be used by the developers of mobile learning system in order to build mobile learning applications quicker and to benefit from the centralized online repositories which not only store user artefacts, but which automatically create on-line user portfolios and aggregate contextual information to provide higher level application services. As an example we present a microblogging application built on top of the framework making use of the contextual information in enhancing mobile learning experiences.

The authors nevertheless acknowledge that the design of learning environments should lead the development of mobile learning applications. In that sense, M2Learn framework can contribute by structuring and simplifying the usually troublesome mobile learning activity design procedure.

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