Supporting Online Coordination of Learning Teams through Mobile Devices

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Abstract

One important field of application of mobile computing systems is that of supporting online learning teams working together to accomplish a common learning goal. The traditional web-based online learning systems used to support online teams are being extended to support mobile clients and thus many of the features of collaborative learning should also be available to mobile clients. In this work, we present a prototype of a web-based application supporting mobile clients with features of coordination through a common contacts information and calendar of tasks to support different pedagogical models based on collaborative learning. The main objective is to support online mobile clients with ongoing changes in the web-based system and thus to shorten the time-to-know and time-to-response among mobile clients during the team work. Additionally, our system is meant for mutual support of members as well as to support decision taking regarding learning task accomplishment. The system is based on event definition related to workspace artefacts (contacts, tasks, etc.) that observe and inform about the changes in the system. We present the main requirement analysis, the building blocks of the architecture for efficient event management and the prototype implementation that facilitates the collaborative learning activity.

1. Introduction and Motivation

Over the last decade, we have witnessed an explosion of mobile devices and wireless technologies for communication and for sharing many types of informational resources. While this has dramatically transformed our society in the way we communicate, create, retrieve and share information, collaborate and socialize each other, the application of these technologies to certain sectors of society is still in its infancy [1], [2]. Education, in the form of electronic learning and teaching, is still far from making the most of mobile technologies to support the day-to-day classrooms and enhance collaborative learning experiences and processes, however, great research efforts are increasingly being made to incorporate mobility in this domain [2].

One of the most relevant implications of mobile learning is the inherent collaborative processes arisen during the learning activity. Computer-Supported Collaborative Learning (CSCL) has become a mature research field in educational technology that focuses on the use of information and communications technology (ICT) as a mediation tool within collaborative methods of learning [3], [4]. In developing on-line environments that support collaborative learning, several issues must be taken into account in order to ensure full support to the online learning group. One key issue is mobility in correspondence with the current mobility of groups of learners and the widespread of mobile devices and wireless technologies [2], [5].

Mobility is seen by researchers and pedagogues as a new opportunity for education since it provides more chances for learners to personalize their collaborative learning process [6], enhance the social interactions, learn more effectively and more autonomously, and collaborate with other peers and teachers at anytime and from anywhere, inside and outside the formal collaborative learning context [5]. Indeed, both the capabilities of mobile devices and their wide context of use contribute to their propensity to foster collaboration [2]. Mobile devices can easily communicate with other devices of the same or similar type, enabling learners to share data, files and messages. They can also be connected from anywhere and at any time to a shared data network, further enhancing possibilities for communication. These devices are also typically used in a group setting, and so interactions and collaboration will tend to take place not just through the devices but also at and around them as well.

A great variety of challenges arise though using mobile devices for group learning, ranging from technical - how to manage such devices with very small screens and keywords, which do not Facilitate easy access to text input and impede or annotation [7] - to Educational - Such as learning how to Coordinate

978-0-7695-4687-2/12 $26.00 © 2012 IEEE
DOI 10.1109/CISIS.2012.189
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small groups in the classroom [8]. And yet mobile collaborative learning is about supporting groups of people for both formal and informal collaborative learning activities in which they are willing to participate [9], seamlessly, with a greatest success paradoxically occurring at the point where they do not recognize it as learning at all [10]. However, just having advanced mobile devices does not implicitly imply to improve the task performance and coordination, thus needing specific and flexible software to support the context and goals of the tasks [11].

The context of this work is mobile technology that support work activity in learning groups with the aim to improve the group and individual task performance and ultimately the group learning process [12],[13]. Despite the incorporation of mobile technology in this context is not new current tools commonly used to support event and notification-based, task-oriented systems [11] tend to base their functionalities on managing information, such as study group tasks, the members assigned to tasks and task status. However, such tools are often combined with functionalities from different areas, creating complex systems that are hardly mobile tuneable, or they happen to be programmes that provide a very basic set of information and have, therefore, gaps when supporting complex tasks.

In order to overcome these limitations, in this paper we propose to create a system that can manage, organize and present information appropriately and fully supported by mobile technology. The ultimate research goal is to speed up the performance of a study group and as a result improve the collaborative learning process. To this end we first take into account the basic premise that all members of the study group should be aware of the work of all the others [14]. Then we focus our design methodology on the requirements for designing event-based mobile applications in order to facilitate further developments [11]. Last but not least, a relevant issue considered in our methodology is usability, which will have an impact on the subsequent usefulness of the application developed and on its user interface as well as the overall performance [7]. Although there are many guidelines for achieving a usable interface, not all of them are applicable to any systems. They must be selected and put into the specific context to work [10].

This work is framed within the context of the Open University of Catalonia, specifically in the Master’s project within the area of web applications for collaborative work [15]. The next sections define a proposal for designing and implementing a support system using mobile devices for learning groups that allow students to organize themselves and resolve their various tasks more effectively (constructivist approach), encouraging debate and discussion on how to resolve them.

The paper is structured as follows: Section 2 presents the main concepts and system requirements. Section 3 specifies the system architecture and logics. Section 4 addresses how the system has been implemented. Finally, Section 5 concludes the paper summarizing the main ideas.

2. Main Concepts and Requirements

The system presented in this paper is aimed at the management and administration of information derived from the events produced by users. According to the Oxford dictionary, an event is defined as “an occurrence happening at a determinable time and place”. Two important concepts can be drawn from this definition: the fact that an event is conditioned by time and by place. In the context of our study, an event comprises all important occurrences happening in the system at certain moment (time) that derive from the interaction of the members of a study group (place).

We define next the main concepts and entities of the system on which our development is based:

- **User**: any student or tutor interacting with the system.
- **Contact**: user connected through the application with another user.
- **Message**: An event resulting from the interaction of several contacts in a conversation.
- **Milestone**: unidirectional event that one user sends to one or more of his contacts and which becomes most important at a particular point in time.
- **Task**: the work which demands effort from the users involved in carrying it out.
- **Work Group**: A set of two or more users who exchange information and/or perform a task.

For the sake of our work, we describe further the central concept of events in this context. The events produced in the system can occur in different ways and can be classified as follows: (i) events arising from the task, contacts and work group management, (ii) events produced by message management, (iii) events derived from managing milestones (creation of user, group or task milestones) and (iv) notifications of new events, among which there are new message notifications and new milestones. Finally, we also consider the events produced by upcoming milestones and tasks that will begin or be completed soon.
From the above information we next present the main requirements of our system:

- Speed up the exchange of information between members of a work group [12].
- Organize information on tasks and work groups in an orderly and logical manner.
- Create a mobile interface that facilitates navigation.
- Create an event model that enables fast access to information and facilitates related actions.
- Use currently widespread, free technologies to develop the system.
- Design the system based on scalability and maintenance.

In addition, the requirements include the management of the information about the aforementioned main entities of the system (e.g., users, contacts, groups, tasks, etc.). Next, we present the design of the system from the concepts and requirements presented in this section.

3. Design of the Application

The design of the application revolves around two fundamental contexts: technological (mobile environment) and functional (task resolution by study groups). From these contexts, a number of factors determining the design emerge, such as the changing environment that characterizes mobile devices, technology constraints derived from the hardware of these devices, and the information needs of a study group. Considering these factors, we organize this section into four parts: architecture, technology platform, and interface design.

3.1. Architectural Issues

For the sake of our development, we considered both an event-driven architecture (EDA) and a component-based development (CBD), which both allow for a decomposition of an application into loosely coupled software components and the events produced by the system are transmitted among these components [16]. Components also allow developers to focus on the functionalities required by the system by hiding the internals of the component.

Following this architectural view, the system’s components were decomposed in typical 3-layer architecture, namely the data access, business and presentation layers. Each layer represents a set of elements with common features and that requires the elements of the layer immediately below (see Fig. 1).

This architectural view was intended to accelerate the system's adaptation to new requirements of the environment, reduce complexity and facilitate the insertion and assembly of new components. Most importantly, the internal organization of the three layers also reflects a certain criteria, such as keep consistency in the distribution of files and content, and maintain a direct correspondence between templates and tasks that generate their data. In addition, we structured the presentation and business layers on the basis of a number of the key concepts initially described (contact, event, group, task, user, etc.).

3.2. Technological Platform

The system is designed to make implementation as simple as possible, so the technological platform consists of widespread and well-known technologies. Specifically, the platform is based on client-server model and is composed of a web server with Apache server and MySQL database. Communication between client and server is through wireless internet connection (see Fig. 2).
3.3. Data Model Design

One of the most important parts of the system lies in the data structure. This structure determines the complexity of obtaining and managing data. In order to facilitate future maintenance and extension of the system, the data model was oriented towards the mentioned main concepts and requirements (see Section 2). To this end, each set of functionalities was addressed separately in the data model forming a set of data sub-models, namely users and contacts, group, task, milestone and message.

In addition, a common requirement in learning group systems is the sharing of great amounts of data among many users. As a result, consistency becomes an issue. In order to avoid accidental deletion of data and also keep data consistency, specific procedures were considered and designed as part of the system’s data model. Hence, when a user tries to execute a deletion operation on shared data the system triggers a procedure to check whether this data are not shared by any other user.

3.4. User Interface

Mobile devices are characterized by a limited processing power and bandwidth, and also small screens, being the latter a main concern when designing the system’s user interface [17]. To deal with these issues we used the framework of jQuery Mobile\(^1\) to address compatibility between different mobile browsers and bandwidth limitations. This allowed us to build an application using web programming, which is compatible with most smartphone platforms. Further, we leveraged the small libraries of the framework purposely designed for mobile device interfaces. Finally, we addressed the issue of small sizes of mobile screens to show only the information essential for the task in progress.

Furthermore, in the context of our work, these are a number of factors related to usability aspects of the application [8] affecting also the design of the user interface, as follows:

- Frequent use of the device for simultaneous multiple tasks, making it easy for the user to forget what he or she was doing.
- The difficulty in writing long texts.
- The need for useful, concise and quick information.

To alleviate the above problems and difficulties, the interface was designed based on the following considerations: (i) accessible global menu that offers quick access to the major groups of functions (see Section 2 and also Fig. 3); (ii) avoid unnecessary steps thus reducing the burden placed on the user’s memory and the complexity of the actions; (iii) images specifically designed to provide more information while saving room on the screen.

4. Implementation Issues and Prototyping

The system designed in the previous section offered a number of distinctive solutions to meet relevant requirements not found in current applications supporting group learning with mobile technology. In this section, we move on the implementation of these solutions by presenting two main system’s characteristics: the adaptation to the template system for mobile environments and the system’s exploitation.

4.1. Template System Adaptation

As mentioned in Section 2, two important system’s requirements are to facilitate maintenance and scalability. To this end, we set up a properly adapted template to provide a number of advantages, as follows:

- Increase the relationship between a template and the task that generates the data.
- Facilitate invoking tasks and templates.
- Facilitate scalability by keeping the necessary changes to a well-defined folder (data, business and presentation folder).

In order to show how these requirements have been met the next example presents various templates and tasks invoked:

```
/ Index.php? task = group.groups_list &
template = group.t_groups_list
```

This example shows how a template is invoked using parameter "template = group.t_groups_list" and how it calls up the task that loads data through the parameter "task = group.groups_list". When calling the task, the code indicates that task "groups_list" from the set of tasks called "grup," must be loaded;

\(^1\) http://jquerymobile.com/
the call to template indicates that the template "t_groups_list" from the set called "group" must be loaded. Note that both the set of templates and the set of tasks (group) have the same name in order to maintain a correlation between template and task. It is also worth mentioning that most of the work of loading tasks and templates resides in the file located in the root called "index.php". This file contains the initial programme and is responsible for masking the URL treatment process.

4.2 Using the System

This section describes the basic system’s usage. Based on the development described in previous sections, the most important features presented here were devised to improve performance of a learning group. Some of them are presented here:

• Information management at four levels: personal information, contact information, work group information and task information.

Fig. 4. Group contact and task message notification.

• Division of the system functionality into permanently accessible groups, which correspond to the major concepts initially defined (see Fig. 4).

• Notification of the various types of upcoming events and new events (see Fig.4, Fig.5 and Fig.6).

Fig. 5. Group task and contact milestone notifications and tasks with a start and end.

Fig. 6. Notification of upcoming milestones.

• Forums level at contact, group or task levels (Fig. 7).

• Possibility of defining milestones at contact, group or task level.

• Flexibility to assign work groups or contacts to a task.

Fig. 7. Message sent by user "user5" to group "group5-6-7" and contact response from "user6".
5. Conclusions and Future Extensions

This paper shows an example of a system designed to support learning groups on mobile devices, which has been designed based on their functional and technological context. An innovative set of features intended to complement those that typically appear in this type of systems was presented. Although the system was designed based on a given context (task solving in learning groups) and a certain degree of freedom in its use, its usefulness will be determined by how each learning group uses it.

Since much of the development effort was spent on the design, the system presents several points that could be improved. To this end, we plan to extend the system with an interface adapted to computers. This would allow the system to be accessed from both mobile devices and computers. The combination of these two areas would allow members of a learning group to stay informed on an on-going basis.

Finally we plan to enhance the usefulness of the system by updating the system’s information by push. This kind of updating would permit more fluid and natural conversations among the members of the learning group.

Acknowledgements.
This work has been supported by the European Commission under the Collaborative Project ALICE "Adaptive Learning via Intuitive/Interactive, Collaborative and Emotional System", VII Framework Programme, Theme ICT-2009.4.2 (Technology-Enhanced Learning), Grant Agreement n. 257639.

6. REFERENCES