

# The Design and Development of Mobile Workflow Learning Application

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## Abstract

Workflow Learning is the adaptation of WfMS (Workflow Management Systems) from the business domain in the learning domain. A Workflow which is made by participants, actions, documents and a set of procedural rules, can be adapted in a learning environment, the actors involved in the learning process are the participants, the learning activities are the actions, the artifacts students can produce are the documents and the relationship among the learning topics are the procedural rules. The aim of this research is the implementation of a Software Reference Architecture for WfLMS (Workflow Learning Management Systems) with Mobile, Cloud and Collaborative functionalities in order to design and develop a mobile application for WfLMS. The Reference Architecture was the result of applying the Workflow Management System Reference Model in conjunction with Mobile, Cloud and Collaborative Architectural pattern solutions. The implementation of the Reference Architecture resulted in a mobile WfLMS for the iOS platform.

Keywords: m-learning, workflow learning, collaborative, cloud, reference architecture, mobile.

## 1. INTRODUCTION

In learning environments team collaboration face the same challenges as in business scenarios and without proper management team collaboration can become more an obstacle than a solution, Workflow Learning is the adaptation of WfMS from the business domain in the learning domain (DePree et al. 2011). Cesarini et al. (2004) support the e-learning process with a WfMS and makes a perfect adaptation of the learning process as a Workflow, explains in a simple way that a Workflow which is made by participants, actions, documents and a set of procedural rules, can be adapted in a learning environment, the actors involved in the learning process are the participants, the learning activities are the actions, the artifacts students can produce are the documents and the relationship among the learning topics are the procedural rules. The aim of this research is the implementation of a Software Reference Architecture for the design and development of WfLMS with Mobile, Cloud and Collaborative functionalities. The Reference Architecture is the result of the application of the Workflow Management Systems Reference Model (Aalst & Hee 2004; Hollingsworth 1995), in conjunction with Mobile, Cloud and Collaborative Architectural pattern solutions.

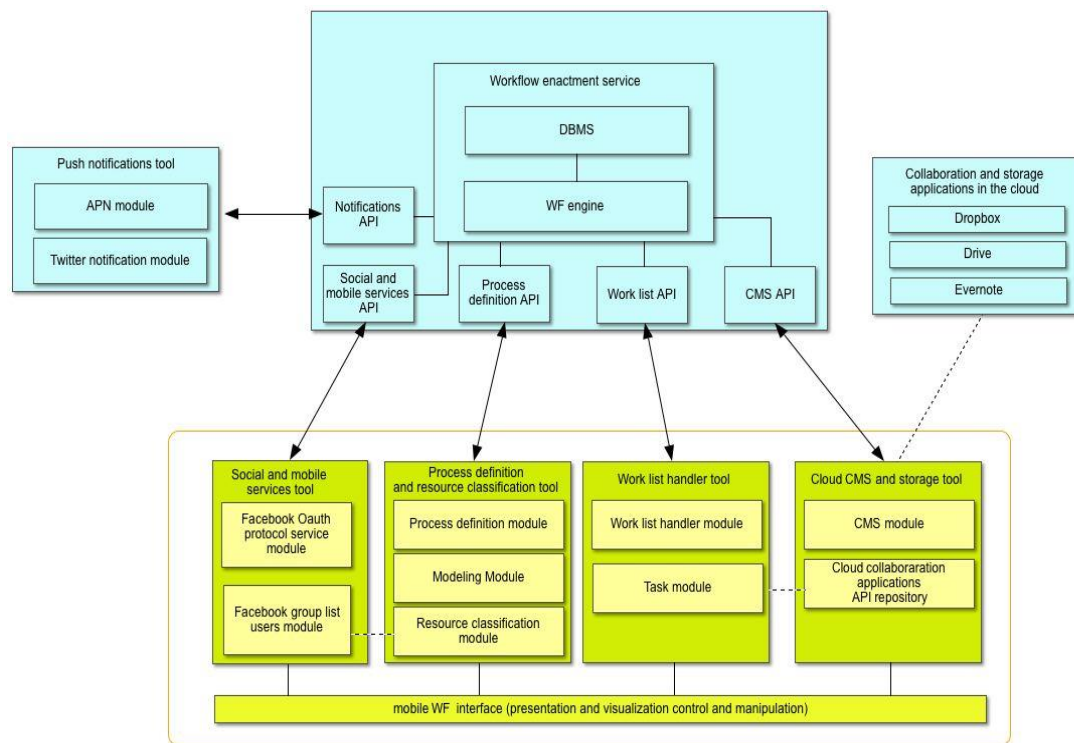
## 2. A SOFTWARE REFERENCE ARCHITECTURE FOR A WORKFLOW LEARNING MANAGEMENT SYSTEM

The Software Reference Architecture in this research is for the design and development of a WfLMS with mobile, cloud and collaborative functionalities (see Fig. 1). The Reference Architecture has been adapted in order to provide the best WfLMS solution, taking advantage of the cloud, mobile and collaborative functionalities for the learning environment. The yellow functionalities of the architecture in the Figure 1 are implemented all together as a mobile application with any of the of the mobile architecture patterns (native, hybrid, web, etc.) proposed in (Frieze 2012). Next we describe each of the software modules of the Software Reference Architecture and their functionalities.

### 2.1. Workflow Enactment Service

The Workflow Enactment Service is the central part of the WfMS (Aalst & Hee 2004; Hollingsworth 1995), this software module through the Workflow Engine functionality is in charge of the creation,

management and execution of the Workflow instances. In this module is also the Data Base Management System (DBMS) in order to store information related to each of the Workflows instances managed by the Workflow Engine. It also contains the API's for the correct communication and operation with the other software modules of the system. This software module was implemented with cloud computing patterns through the private implementation model (Subashini & Kavitha 2011; Mell & Grance 2011; Esayas 2012; Aceto et al. 2013) together with the Software as Service model (Xu 2012; Harman et al. 2013; Park & Ryoo 2013; Fernando et al. 2013). The API's were implemented as RESTFul services (Arroqui et al. 2012; Jamal & Deters 2011; Mohamed & Wijesekera 2012).



**Figure 1.** Software Architecture of a WfLMS.

## 2.2. Notification Tools

This module contains the notification tools for keeping the user updated about the state of the Workflow Learning instances, tasks and activities where the user is collaborating. Push notifications and Twitter were used as the principal notification tools. This module was implemented with cloud computing patterns using communications as a service (Khan et al. 2013) and collaboration patterns implementing social media as communication and notification services (Hansen et al. 2011; Kim et al. 2010), the notification tools are necessary for the collaboration and interaction between users and are an essential functionality for communication and coordination in a mobile collaborative architecture (Neyem et al. 2012).

## 2.3. Collaboration and Storage Applications in the Cloud

This module is the repository of the cloud collaborative applications and the storage management applications in the cloud. Google Drive, Dropbox and Evernote are the mobile cloud applications for supporting the collaboration in the WfLMS. This module was implemented with cloud computing patterns using software as a service and storage as a service (Harman et al. 2013; Park & Ryoo 2013; Fernando et al. 2013), collaboration patterns were implemented according to the layered architecture

for mobile collaboration applications proposed by (Neyem et al. 2012) where mobile collaborative applications are the principal support for the collaborative interaction between the users in order to reach the goals of the group. The collaboration and notification module fulfill the requirements proposed by (Herskovic et al. 2011) for the WfLMS to be a mobile collaboration system.

## **2.4. Mobile Services Tool**

This module contains the API's for accessing the mobile services available in the cloud, in that way the mobile workflow learning application can extend its functionalities. The functionalities that social media services offer are key for the collaboration in the WfLMS. The Facebook Connect service is implemented as an authentication method, in that way the user can Login using its credentials from Facebook and collaborate with other users in the WfLMS with the same user identity that has on Facebook. The open social service is also implemented and allows Facebook users to access its content and contacts inside a third party application, in this way the user avoids the necessity of having to make new connections again inside the third party application with the people that already is collaborating with him in Facebook. In the WfLMS the user can use their contacts from Facebook as human resources in order to assign them roles and tasks inside the learning activities of the Workflows. This module was implemented with collaboration patterns using social media as collaboration services (Kim et al. 2010) and Single Sign On (Riesner et al. 2013).

## **2.5. Process Definition Tool**

This module provides the functionality for creating the process definition of the Workflows, a process definition contains all the information related to the Workflow in a format that can be interpreted by the Enactment Service. With this tool the user creates the Workflows and configure the conditions for when to start and finish the Workflow, creates the activities and tasks that the users must execute, selects the kind of user that must execute the tasks, adds relevant information related to the Workflow, models the logical order in which the tasks are going to be executed. The user has a resource classification tool for the selection of the users that are going to be part of the Workflow, this tool makes use of the mobile services module.

## **2.6. Work List Handler Tool**

This module provides the functionality for the administration and management of the Workflows, also for the presentation of the work items that the user has to execute in each one of the Workflows. In the task module the user can select work items in order to load the detailed information of the Workflow and the current activity that is being executed. From the task module the user can launch the mobile collaborative applications and the cloud content management system tool.

## **2.7. Cloud Content Management System Tool**

This module contains the API's for connecting with the storage services in the cloud (Dropbox, Drive and Evernote), in order to provide the functionality of a content management system (CMS) in the WfLMS, all the content is stored in the cloud and the user utilize the CMS functionality for associating the content stored in the cloud with the tasks and activities of the Workflows. The functionalities of the cloud storage services like session management, data synchronization, access rights and sharing of the content extends the functionalities of the CMS module. This module was implemented with cloud computing patterns, using software and storage as a service (Xu 2012; Harman et al. 2013; Park & Ryoo 2013; Fernando et al. 2013), and collaboration patterns for the coordination of the mobile users when accessing the content in the cloud (Neyem et al. 2012).

## **3. IMPLEMENTATION OF THE SOFTWARE REFERENCE ARCHITECTURE**

The implementation of the Software Architecture was the development of a native application for the iOS platform. The application was published in the Apple Store with the name of WOLF (Work Linear Flow). Next we describe the functionalities of the mobile application that follows the technological patterns of the Software Architecture.

### 3.1. Log-In

In the figure 2 the Log-in allows the user to access the application with his user name and password, another option is to use Facebook, The technological solution known as Single Sign On was implemented in order to access the user profile in Facebook and in that way authenticate and identify the user inside the WOLF application.



**Figure 2.** Log-In in the WOLF application.

### 3.2. Work List Handler

In Figure 3 the Work List Handler Tool and the Task List is displayed, From the Work List Handler is where the user can have access to all the main functionalities of the WOLF application, from here the user can have access to all the lists with the work items. The Task List shows the information of each one of the work items that belongs to the user, from here the user can select an item in order to start the functionality that shows all the information related to the Workflow and also develop the task that was assigned to the user inside the Workflow.



Figure 3. Work List Handler and Task List.

### 3.3. Workflow Task Management Tool

In Figure 4 the Task Management Tool is displayed. In the WOLF application, the users can create projects and associate Workflows to them, a Twitter hashtag is created for each project so in that way the users can post tweets about the learning activities that are related to the Workflows, the project and communicate with other users for collaboration. The users can open Twitter inside WOLF in order to see the list of tweets related to the hashtags of the projects.

The instantiation of a Workflow contains all the information the user needs to know about it, like the project it belongs to, the starting and the finishing date, the owner of the Workflow, the documents that are shared, the number of steps (activities), and the comments the users make. The steps are executed in a sequential flow, all the steps related to the Workflow are displayed in an item list in the order they should be executed, each one of the steps can be evaluated, in that way the user can reject the activity (deny button) that was executed in the previous step, if this is the case, the flow goes back one step and the user in charge of the rejected activity is notified with a push notification. When the user has finished the activity that was in charge of, the user has to forward (validate button) the Workflow to the next step, then the user in charge of the next step is notified with a push notification.

### 3.4. Content Management Tool

In Figure 5 the Cloud Storage and Content Management Tool is displayed, with this tool is possible to manage content stored in the cloud in order to associate the content with the activities and tasks inside the Workflows, the cloud services that are integrated with the application are Dropbox, Google Drive and Evernote. The documents associated with the Workflows keep all the functionalities of each one of the cloud collaboration tools for example the documents from Google Drive are still managed by Google Drive in order to allow who has the rights to open and modify the documents in that way the workflow application extends its functionalities for content management.

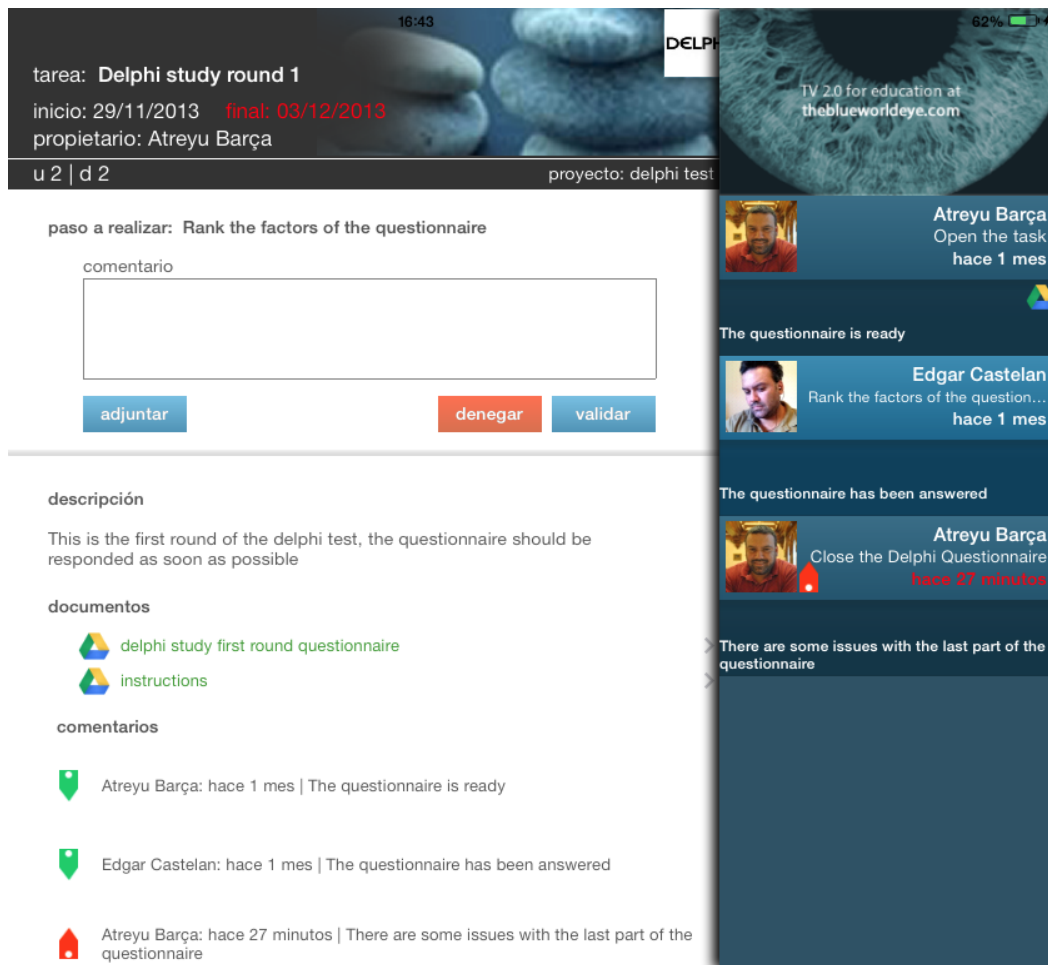


Figure 4: WOLF - WfMS mobile application for iOS platform.

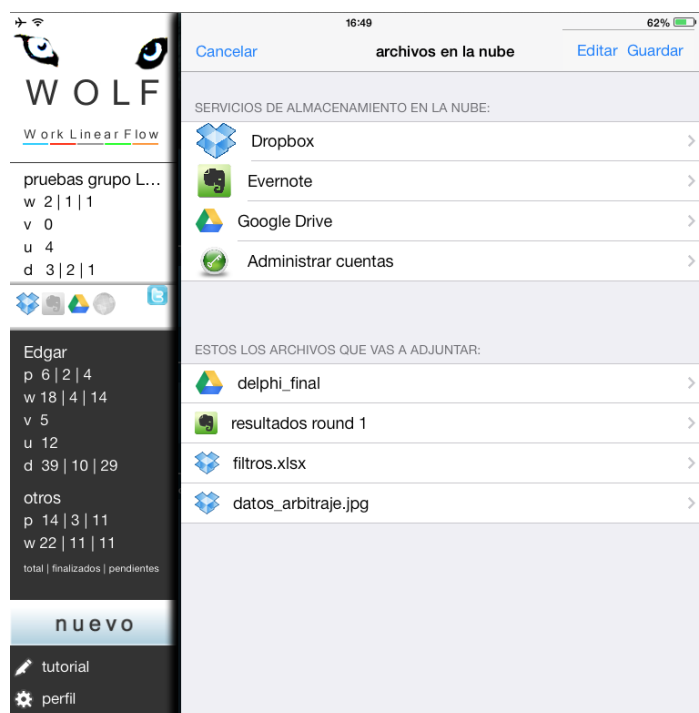


Figure 5: Content Management Tool.

### 3.5. Process Definition Tool

In the figure 6 the Process Definition Tool is displayed, with this tool is possible to create Process Definitions (Workflows) with the steps and activities that are going to be part of the Workflows and associate the required information that is going to be relevant to the process definition. This tool allows to create the logic order of execution of the activities and tasks that belongs to the Workflow.

Also in the Process Definition Tool is where the user can assign human resources to each one of the activities that are part of the Workflow, there is a dedicated tool that provides a list with all the users that are part of the collaboration group where the user is part of. The mobile application makes use of the mobile social services provided by Facebook in order to have access to more human resources options.

The Workflow must be associated with a project so there can be an unlimited number of Workflows belonging to one project from the Process Definition Tool the user can access to the list of projects in order to associate the Workflow to one of them, and also has the chance to create new projects, when the user creates a new project a Twitter Hashtag is associated with the project, in that way the users working and collaborating in the Workflows of that project can tweet information and keep updated the users about the latest outcomes.

16:09

Crear WOLF [Guardar](#)

Título

Inicia el: 24/01/2014 Finaliza el: 26/01/2014 [Proyecto >](#)

Descripción

Workflow con usuarios de pruebas para realizar un estudio Delphi piloto con expertos de Latinoamérica y España

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Edgar Castelan
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Atreyu Barça [>](#)
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Edgar Castelan [>](#)

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Figure 6: Process Definition Tool.

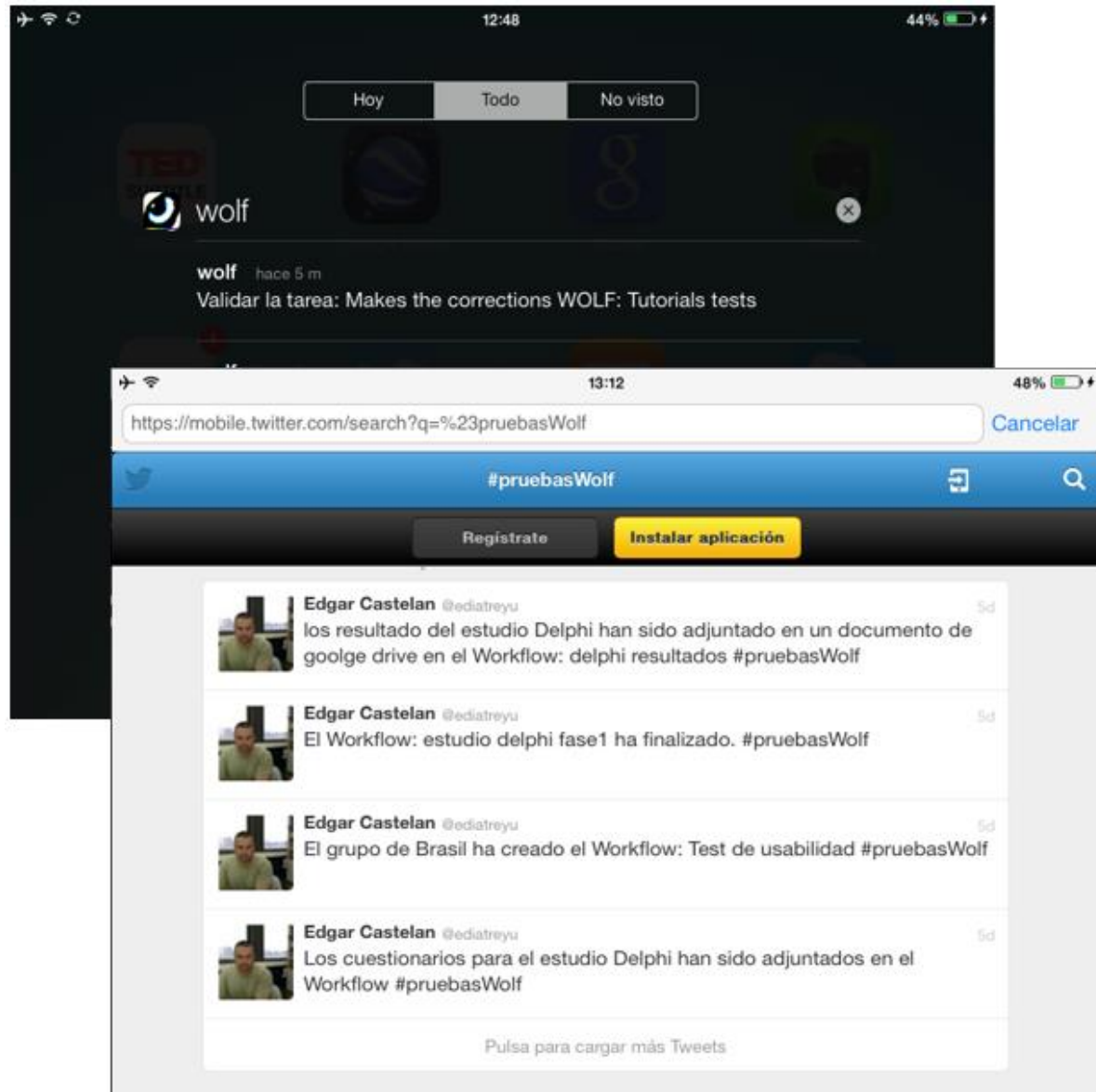
### 3.6 Notification Tool

The Notification Tool keeps the users updated about the state of the Workflows and the latest outcomes of the activities and tasks inside the Workflows, like for example; if a new Workflow was created, who is the user executing the next task, or if a new document was added.

The users can receive notifications with the push notification system that is part of the iOS platform (see Fig. 7), in that way the user is always updated it doesn't matter if the WOLF application is running or not, as long as the device is connected to the internet the user can be notified with the latest updates.



The Social Media is also used as a notification tool (see Fig. 7), the users can post tweets and also have access to the list of tweets that are related to the hashtag that was associated to the Workflow, in that way the users can read all the notifications the users are Tweeting about the Workflow, activities and tasks.



**Figure 7:** Push and Twitter Notifications.

#### 4. CONCLUSIONS AND FUTURE WORK

As a result of this research two artifacts were designed: a Software Reference Architecture for the design and development of WfLMS and a mobile application as a result of the implementation of the software architecture. This research was based on rigorous methods for the construction and design phase of the software architecture and makes the use of architectural pattern solutions that are well established and recognized in their own fields of research.

The Reference Architecture has been adapted in order to provide the best WfLMS solution, taking advantage of the cloud, mobile and collaborative functionalities for the learning environment. Future



evaluation for the WfLMS iOS application has to be done in order to evaluate the functionalities of the mobile application.

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