



## 交流和合作学习的工具

## SCHOM. A tool for communication and collaborative e-learning

Roberto Berjón\*, M<sup>a</sup> Encarnación Beato, Montserrat Mateos, Ana M<sup>a</sup> Feroso

Universidad Pontificia de Salamanca, C/Compañía n. 5, 37003 Salamanca, Spain

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## ABSTRACT

Emerging technologies cause changes in education. These changes result in new human learning processes that evolve to collaborative e-learning approach, where social and mobile networks take a great relevance.

In this paper we introduce SCHOM (SCHolar Messaging). We have developed this tool for communication and collaborative e-learning in wired and wireless environments. SCHOM, a SaaS (Software as a Service) in the cloud, allows the exchange of information between members of a domain intra and/or inter academic. SCHOM can be used in different communication channels such as e-mail, instant messaging, chats, discussion boards or microblogging. Besides, it supports different devices: smartphones, tablets or computers.

One of the main advantages of this tool is that it ensures the digital anonymous. For instance, one user could send a message to other one knowing his identity. Nevertheless the user will not know the communication channel used to send the message. Each user selects the channels whereby he wants to receive his messages.

Registered users on the system are organized in groups (or organizational units) by forming relationships n:m. Groups in turn can be nested to build hierarchical structures that can simulate real work environments, for example, a faculty with its degrades, courses and subjects, ... A group (each member regardless of the nesting level) can also be receiver of messages.

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## 1. Introduction

Emerging technologies like mobile technologies, its market penetration with smartphones and tablets and young acceptance of them, have opened a huge field in m-learning and collaborative mobile learning. Some studies say (Ryu & Parsons, 2012; Huang, Yang, Huang, & Hsiao, 2010) that factors as social relations and mobile technology affect in human learning process. So the main interest is in the characteristics of these new technologies: portable, customizable and ubiquitous (Ryu & Parsons, 2012; Kim, Lee, & Kim, 2014).

Collaborative learning can be carried out with tools as discussion boards, instant messaging or blogs. With these tools, PC-based or mobile phone-based, students can explain their opinions and they can ask questions more easily than in a traditional classroom (Ting, 2012). Although, some authors think that **when these tools are used in a PC they do not fit to the students necessity of mobility and ubiquity that a mobile phone provides to them and currently**

现代学生需要移动性。泛在性的学习

\* Corresponding author at: Facultad de Informática, Universidad Pontificia de Salamanca, C/Compañía n. 5, 37003 Salamanca, Spain. Tel.: +34 923277100.

E-mail addresses: [rberjonga@upsa.es](mailto:rberjonga@upsa.es) (R. Berjón), [ebeatogu@upsa.es](mailto:ebeatogu@upsa.es) (M.E. Beato), [mmateossa@upsa.es](mailto:mmateossa@upsa.es) (M. Mateos), [afermosoga@upsa.es](mailto:afermosoga@upsa.es) (A.M. Feroso).

**the students need.** (El-Hussein & Cronje, 2010). Other researchers have studied how affect the mobile learning on collaborative learning processes and outcomes (Kim et al., 2014). They suggest that **students should use different kind of tools for different situations.** And for example, for teamwork, mobile instant messaging could be the best option. Other authors (García Peñalvo, Colomo-Palacios, & Lytras, 2012; Millsa, Knezeka, & Khaddageb, 2014; Xi, Hui, Wu, & Ordóñez de Pablos, 2014) think that **internet and mobile technologies have an important influence in the informal learning and it cannot be obviated.** 网络和移动技术对泛在学习的重要性

学生在不同的情境下使用不同的工具

Since mobile learning was born, several tools have been proposed to promote the interaction in higher education (Shishah, Hopkins, FitzGerald, & Higgins, 2013; Zhang, Ordóñez de Pablos, & Zhang, 2012); most of them are based on using SMS and MMS, and some of them use email as way of communication. For example, SHERPA (Schweitzer & Teel, 2011), mobile tool designed and used by teachers and students to facilitate the communication between them. In our University, we have the experience with a communication platform, pioneer in Spain-MoviUPSA (Fraile, Delgado, Sánchez, & Beato, 2007). This platform is based on SMS and email and everyday it is used as a means of communication by faculties, department staff and students in the University. However, SMS

**messaging has significantly reduced its use due to several factors: the cost and the limitation in the content of message.**

Recently **new mobile instant messaging services** have emerged (for example Whatsapp) and these services allow us to exchange messages without having to pay for SMS; another advantage of instant messaging services is that you can send images, video and audio media messages. On the other hand, social networks and microblogging have exploited like communication channels. Social networks, where people with same interests are connected, and mobile social networks, where the communication is using a mobile phone or tablet, are closely related to the learning process. Also both of them, **social networks and mobile social networks, can provide to the users an efficient environment in order to share and to distribute information which is necessary to acquire knowledge in a collaborative way.** Zuhadar, Yang, and Lytras (2013) say that **Social Multimedia System can help to engage students more effective than classical online learning techniques. They talk about the value of accessing recorded videos on smart mobile device and its effect in the learning process.** 社交网络比网络学习更有效

A report of Deloitte. (2014) predicts that in 2014 instant messaging services on mobile phone will carry more than twice the volume of SMS. Other reports point in the same direction. They say that communication services are not increasing except instant messaging. Instant messaging is increasing in 8.9 percentage points, and nowadays, is the most used; it is used by 56% of young (Fundación Telefónica, 2014; 2013). Other metrics are also important such as **frequency of use (83% use it daily) or user satisfaction (7.9 of 10).** So, **instant messaging** is, nowadays, a very important communication media.

Users use different communication channels; **the selected channel is decided by some characteristics, such as, the nature of the communication or/and the entity with which the users want to communicate.** So in personal communications they use phone to talk; if they want to communicate with a group they choose instant messaging (as Whatsapp, MSM Messenger, Yahoo Messenger, ...); if the communication is with a big group they use social network (as Facebook) and if they want to be heard they use microblogging (mainly Twitter) 交流的类型(个人、小组、大组)不一样,选择的工具也不一样

Based on our experience using MoviUPSA (Fraile et al., 2007), which is a SMS communication platform used in our University, we developed a new communication tool based on new emerging communication channels. In this paper this new communication tool is presented, SCHOM (SCHolar Messaging). **SCHOM** will be used in a university environment and SCHOM permits send messages using different communication channels and using a variety of devices for sending and receiving the messages (mobile phones, tablets or computers which can run different operating systems). The different channels will be: **mobile instant messaging, social networks, microblogging and email.** SCHOM ensures digital anonymity, is multichannel and multidirectional.

SCHOM is mainly a tool to improve communication between **all roles in learning.** In this way it is a **tool to facilitate collaborative learning.** It is especially useful for workgroups and for discussion groups, this is due to the use of the last emerging technologies like mobile instant communication or social networks. Mobile technologies allow learners get in touch with their partners and teachers anytime and anywhere so the learning environment improves considerably.

On the other hand, our tool is not a new e-learning system; it is a complement to improve e-learning systems. Its main goal is make easier the communication between teachers and students and between groups of students. We propose that this better communication will be transformed in more motivated students. So our goal is also increase the motivation of the students.

The paper is structured in this way: in this section we make a review of literature related to the context of SCHOM. In the next

section we explain some important concepts to understand the way of working of the tool developed; in Section 3, the own tool SCHOM is presented; after that, we explain the results and some discussions related to our work research, and finally the conclusions of this work are exposed.

## 2. SCHOM. Concepts

Users of SCHOM can send and receive messages and also they can use discussion forums. SCHOM classifies messages according to nature of messages or to usefulness of these.

So, according to **nature of message**, messages are classified in:

- Non-persistent. When the message is delivered to the receiver, the system loses its reference. Only sender and receiver have a copy of it. This kind of message is used in private communication between users, using instant messaging.
- Persistent. This kind of messages is used in discussion board, important notices and topic subscription. They may be reviewed at any time.

According to **usefulness of message**, messages are classified in:

- Notice: It is a message used to post a notice. This kind of message can be send by users with permissions of sending; also the own SCHOM system can send this kind of message to report an error or a warning, in other words, the senders of this type of messages can be users with permissions or the own system. It is a unidirectional message; the sender is not waiting for a response from receiver.
- Private: It is used in n:m communications between users, using instant messaging.
- Discussion: It is used in discussion forums.
- Publishing: It is used in publishing topics.

The user decides what kind of message he wants to receive for each of his channels and then he can configure his account in the system according to his preferences. Furthermore he can block private messages from a particular sender. On the other hand, when a user sends a message, he has available the option to choose all users that he needs to send a message. We will use the term "contact" to refer to the receivers of a message.

A contact can be: individual or group.

- Individual. It is a contact representing a user. We will use contact or user indistinctly.

Every user belongs to an organization or domain. Every individual contact (or every user) must have a profile. A user profile represents the role of the user in the domain that he belongs to. It is possible to have individual contacts without domain associated but in this case, we are talking about special users who are responsible to make configuration and administration tasks. They are called system users.

- Group. Individual contacts must be organized in groups, so a group represents a list of contacts. To describe the group contacts, we will focus on four aspects: composition, security, structure and types.

### 2.1. Composition

Composition describes who members of a group are. Members of a group may be individual contacts or group contacts. So it is possible nested groups. When a group is into other group, we

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can talk about “supergroup” and “subgroup”. On the other hand, “descents” of a group are all subgroups of the group, regardless of its nesting level. And the term “ancestors” represents to all supergroups of a group.

When a group contact is the receiver of a message, the real receivers are every individual contact belongs to the group and its descent. Obviously, a group cannot be in its descent.

Although a group cannot have repeated a same individual contact as a direct member, it is possible that an individual contact is in a group and, at the same time, it is in some other subgroup of it. In order to improve system performance, every group has an “individual set”. The individual set of a group G consists of every individual contact of G and the individual contacts of each group of its descent. This set assures that an individual contact will not appear twice or more times in the same group.

Fig. 1 shows an example of the composition of groups. The individual set of Group-Y will be all its individual contacts and the individual contacts of Group-Z. On the other hand, you can observe that the contact D is only one time in the individual set of Group-X.

## 2.2. Security

By means of this characteristic, we explain how security is managed and what kind of operations is possible to make with groups. It is possible to assign a security policy to a group. This policy defines the operations that a contact is authorized to do in a group. “Authorized contact” is a contact (independently of its kind) that is granted some kind of permissions in a group. An authorized contact may not be member of the group.

Security policy is represented as an access control list (ACL). Each authorized contact has an entry (licence) in the group ACL. The licence consists of an authorized contact and the operations. If an authorized contact is a group we talk about “role”.

When a licence is associated to a role, by default, every individual contact that belongs to the individual set of the role are authorized. But it is possible modify this behavior using a “profile” in the license. In this case, only individual contacts of the individual set of the role with that profile are authorized. If in the license does not specify a profile, the authorization is granted to all individual set of the role.

By default, the fact that a contact is authorized to do some operation in a group, not involve that the contact is authorized in the subgroups of the group descent. Only the contact will be authorized if there is an explicit license in the ACL of these subgroups

authorizing it. In any case, this default behavior can be modified. It is possible to mark that licenses can be inherited.

The kinds of user permissions that can be granted to a user in a contact group are:

- Send notification message: Users are allowed to send messages to contacts in the individual set of the group contact.
- Send private message: Users are allowed to send instants messaging (private message) to contacts in the individual set of the group.
- Send discussion message: Users are allowed to update the discussion board with a new message.
- Publish message: Users with this permission become in publisher of the topic represented by this contact group. This kind of permission is only used in groups of type topic (this kind of groups is explained later).

A user can have zero, one or many permissions granted in a same contact group.

## 2.3. Structure

We are talking about how contact groups are structured, in other words, how contact groups are related to or connected to each other groups in a hierarchy structure.

A group can be part of a hierarchical structure where a parent group can have a lot of child groups and a child group can have only one parent group. Only one root group is possible in the hierarchy structure. The root group is that group without parent group.

On the other hand, a group can be linked with other group if you need related to each other. But if a contact group A is linked with a contact group B does not involve that group A is within group B or vice versa. Therefore, the individual sets of both linked-groups are independent.

## 2.4. Types

Now we are going to describe the types of contact groups that we can define with SCHOM.

- (a) Role: Although, we are defined a role as a any authorized contact group, it is possible to create contact groups whose main purpose is to behave as a role (in any case this type of contact group can receive messages if in their ACL are defined licences that allow to other contact do it).

A contact group of type role can contain both, individual contacts and other group contacts of type role. Contact groups of type role do not present a hierarchical structure.

- (b) Profile: A profile should be interpreted as the user profile that this user plays within his domain or within domain that he belongs to. But it is important to know that a user can play more profiles at the same time.

There are two kinds of contact groups of type profile: system profiles and domain profiles. This classification is made based on whether the contact group is linked or not to a domain. The system profiles are predefined and they manage and set the categories between system users.

A contact group of type profile can contain both, individual contacts and other group contacts of type profile. Domain profiles are not possible within a system profile. However, domain profiles can contain any type of profile but if subprofile is a domain profile, subprofile and superprofile must be

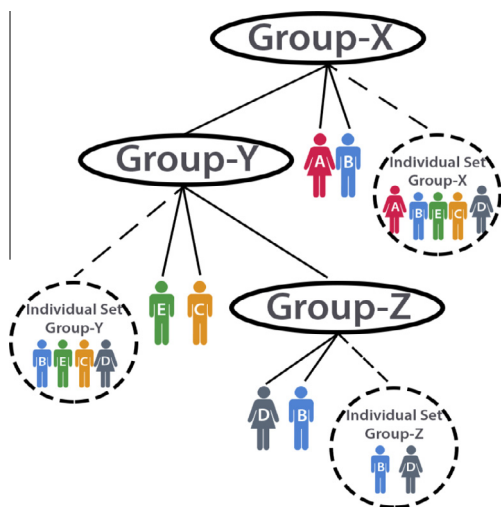


Fig. 1. Contact group composition.

of the same domain. Contact groups of type role do not build hierarchy structure.

- (c) Domain: Represents an organization. A domain can contain other domains and these will be subdomains (for example, if a University were considered a domain, different campus of the University can be defined as subdomains).

On the other hand, domains are disposed in a hierarchy structure: a domain can hold a lot of child domains but it can only have a single parent domain. In the hierarchical of domains, only a single root domain is allowed. Individual contact are always direct members in the root domain, in other words, all individual contacts are always child of first level of the root domain.

A domain can be linked to a lot of group contacts of role type. These groups may become authorized contacts of any subgroup in the domain descent. There is not constraint regarding individual contacts that can be members of the role. Even they could be member of different domains; in this case, for example, it would be possible send messages between contacts of different domains. For example, in a university scenario this could represent inter university workgroups. Profile contact groups only could be linked with the root domain. And every individual contact in a domain must be member of some profile in the domain.

- (d) OU: Represents the different organizational units that an organization is structured. A OU must have a specific class, for example in a University scenario we have faculty, degrees, courses and subjects. These OU may have references or external identifiers to make easier their location. OU are disposed in a hierarchy structure. Different hierarchy of OU can be found in a specific domain, but the root OU must be first level child of the domain.

A root OU can have associated private roles; these roles can be private roles of root OU or also they can proceed from any of its child OU. For the security policy of a hierarchy of OU

can be used its private roles or the global roles of its domain where it is linked to.

In Fig. 2 our University domain is showed. We have defined two OU hierarchies, their root OU are two Faculties. In each hierarchical level is represented, degrees, courses and subjects of each course.

- (e) Topic: Represents a topic which a user can subscribe to. A subscribed user will receive the messages sent to the topic which he is subscribed. When a user is subscribed to a topic, he will be member of the contact group of this topic.

Topics are disposed in a hierarchical structure. For example, a topic named Computer Science could consist of Programming topic, Databases topic and Design Pattern topic. At the same time, Programming topic could consist of Java topic, C topic and Scala topic. If a user is subscribed to Java topic, he will receive only the messages from Java. However if he is subscribed to Programming, he will receive the messages from Programming, Java, C and Scala. In other words, the messages received by a topic-subscribed user can come from the topic or from any topic descendant.

To make this possible in our model, the relationship between super-group and sub-group of topic should be reverse to its hierarchy relationship. Thereby, the parent in hierarchy will be a subgroup of its children, such as the individual set members of a subgroup will be members of each super-group too. Users subscribed to Programming will be indirectly subscribed to Java, C and Scala (see Fig. 3).

In Table 1 different kinds of contacts groups are showed and their characteristics.

### 3. SCHOM tool

General SCHOM Model is showed in Fig. 4. SCHOM tool has two parts: backend (SCHOMcore) and frontend (SCHOMobile).

SCHOMcore is a JEE application deployed in the Cloud (Android Developer., 2014). It provides two facades for the user access (final

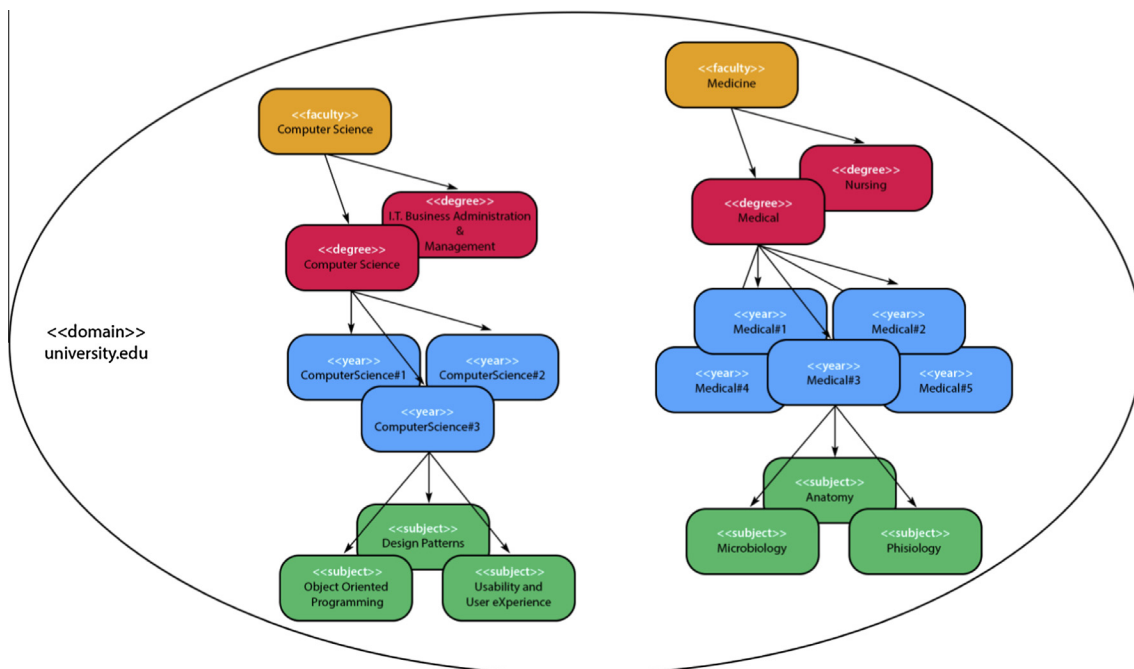


Fig. 2. Organizational units hierarchy.



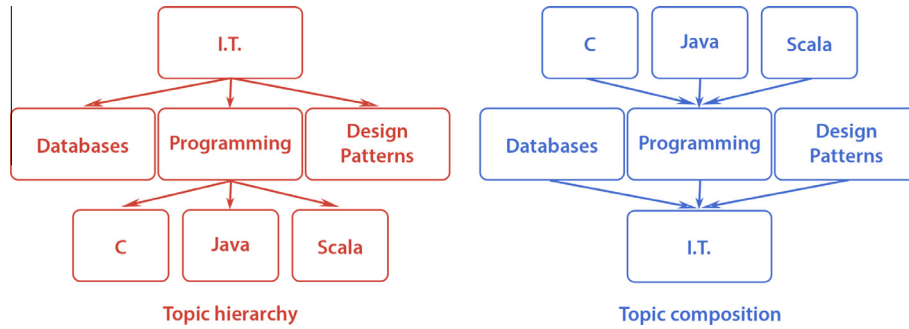


Fig. 3. Topic contact group hierarchy and composition.

Table 1

Contact groups: hierarchy, composition and links.

	hierarchy	sub-groups	referenced by
Domain	<input checked="" type="checkbox"/>	domain, ou	domain, profile rol, ou, topic
Profile	<input type="checkbox"/>	profile	
Rol	<input type="checkbox"/>	rol	
Ou	<input checked="" type="checkbox"/>	ou	rol
Topic	<input checked="" type="checkbox"/>	topic	rol

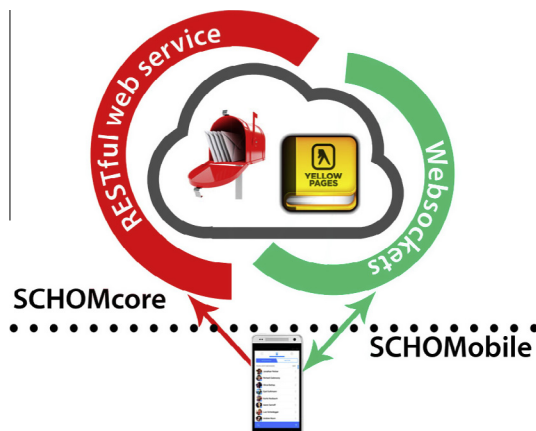


Fig. 4. SCHOM tool model.

or system administrator users). These facades are implemented using RESTful web services and Websockets. On the other hand, SCHOMcore has two parts: YellowPages and MailBox.

YellowPages manages SCHOM contacts, their configuration and queries. These services are used by SCHOM users and by MailBox service. With YellowPages you can set up a new domain, as well as its structure, its contact group composition (domain, OU, profile, topic, role) and register users and specify user channels. For this task RESTful facade provides resources by means of them, this initial configuration is possible to be represented by XML or JSON files.

MailBox service schema is showed in Fig. 5. This service is used to manage sending messages between users. Its architecture is MOM (Message Oriented Middleware) and in this architecture each distributed module is in charge of making a specific task:

- (a) MailBox: It is the entry point to the service. It receives the messages that are sent by users and it starts the messages persistence in the system. At the beginning all messages will be persistent, but private messages will be removed when they are delivered to their recipients.
- (b) Searcher: It is responsible for finding the real recipients of a message. We should take into account that a user can send a message to one or more contacts and else we should remember that any of them could be a contact group. Searcher checks that the sender has permissions to send the message to those recipients and it guarantees that the recipients are unique (in other words, the same message will not be sent to the same user more than one time).
- (c) Customizer: Messages could be customized. For that, it is possible to include in the body of the message variables, which are references to receiver properties. The format of these variables is  $\$(property)$ , where property, is the name of the receiver property. Customizer is in charge of replacing these variables with the value of the receiver property.

On the other hand, customizer includes the sender ID in the case of emails. It should be noted that SCHOM guarantees the digital anonymity and SCHOM sends the messages on behalf of the sender. The sender name must be included in the body message in order to the receiver knows who is the sender.

- (d) Scheduler: this module is in charge of programming the sending messages for each user. The message is sent to every enabled user channels based on the type of message.

When we are using instant messaging, scheduler checks if the receiver has an open session, in this case, it would send the message using instant messages. But in other case, it would send a PUSH notification.

- (e) EmailSender: This module sends the messages via email.
- (f) AndroidPUSHsender: This module sends messages via PUSH notifications, only for Android clients using Google Cloud Messaging services.
- (g) TwitterSender: This module sends messages to a Twitter account. In SCHOM is possible to define users with Twitter credentials assigned. A message sent to these users (or to any contact group where any of these users is) would be published in their Twitter accounts assigned. For example, in a University scenario, a Faculty Twitter account could be created and it could be used like noticeboard. SCHOM allows, not only, to send a message to users (through his defined channel) but also to publish a notice in the noticeboard (via Twitter) at the same time.

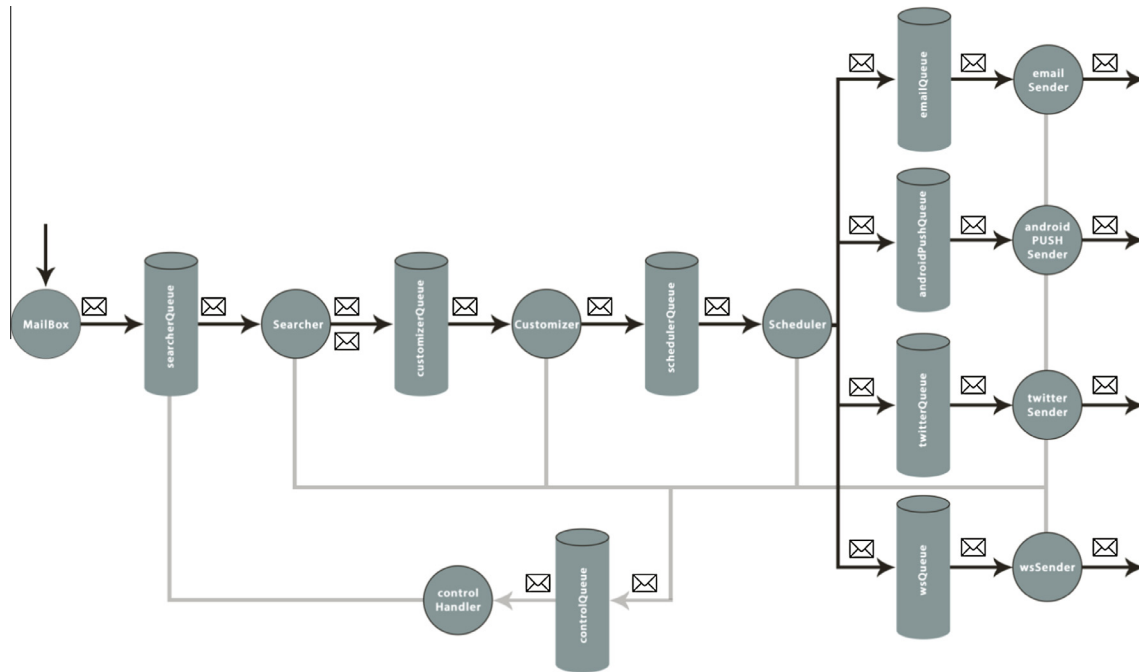


Fig. 5. MailBox module schema.

- (h) WsSender: This module sends messages via WebSockets technology. WebSockets are used to implement instant messaging.
- (i) ControlHandler: This module is in charge of sending control messages, which come from the SCHOMCore. Every module takes contact with it if an error occurs when they are processing the message. Also this module informs the sender that the message has not been delivered.

When SCHOM is used to send instant messaging, this module sends control messages: received message, delivered message.

All messages sent by this module are considered notices so a receiver response is not waited. If an error occurs when a controlHandler is managing a sent message, then the module will try the sending of message again (until three times). If the error keeps going, the messages will be rejected.

SCHOMobile is an app. Users download and install on their Android devices. This app is the wireless client of SCHOM. With this app user receives PUSH notifications, instant messaging and it is used for discussions forum and to consult the information in the topics.

#### 4. Results and discussions

Nowadays, with the smartphone use growth, communication has suffered an important evolution in use terms, so, people use phone not only for communications by voice or email or SMS, but with the phone, we use a lot of communication channels such as email, instant messaging, social networks or microblogging. Until recently, it was impossible to imagine. Users use these channels based on the kind of desired communication, but sometimes they are chosen based on in the preferences of user. These new communication channels, in an educational context, improve significantly the human learning-teaching process. According to some authors if we consider the context (teamwork, individual work, formal or informal learning) we can find that some channels are more useful than others for that context.

In our work explained here, we developed a complete and easy-use communication tool (SCHOM). Our tool combines multiple communication channels above cited to improve the collaborative learning, formal learning and informal learning in a university context.

Users are register in a default way, using the same password as that used in the virtual campus of the university. Also the system provides a default configuration in which there are established several OU by Faculty, by degree, course, and subject. Every user, student or teacher of a subject, is member of the group that represents that subject. In a default way, a user that is member of a group can send private messages to any user that also is member of this same group. In Fig. 6 we can see an example of private messages that are possible send to a particular user o to all users-members of a group.

Every user is assigned at least to one of the following profiles: Teacher, Student, or Administrative. Also, in a default way, there are available the Deanship profile and Delegate-profile (class representative student). All users with student profile can send private message to any other member of the groups that he/she belongs to.

So, a student can send messages to all mates of class and to the teachers teaching in the subjects that this student is registered. Nevertheless the users with teacher profile can send, both, private messages and notices, not only to the members of groups that they belong to, but also they can send them to other teachers (users with teacher profile) and to Administrative (users with Administrative profile). And users with Administrative profile can send notices to teachers, to students and to others Administrative users; also, users with Administrative profile can send private messages to Deanship (users with Deanship profile) and teachers (users with teacher profile).

On the other hand, a teacher that is member of the Deanship of the Faculty is also assigned to the Deanship profile. This profile has an inherited license of the Faculty OU, and therefore, she/he can send both, private messages and notices, to any member of the descendant OU of the Faculty. In Fig. 7, we can see an example of notice that is received as a push notification and also as a message inside the app).

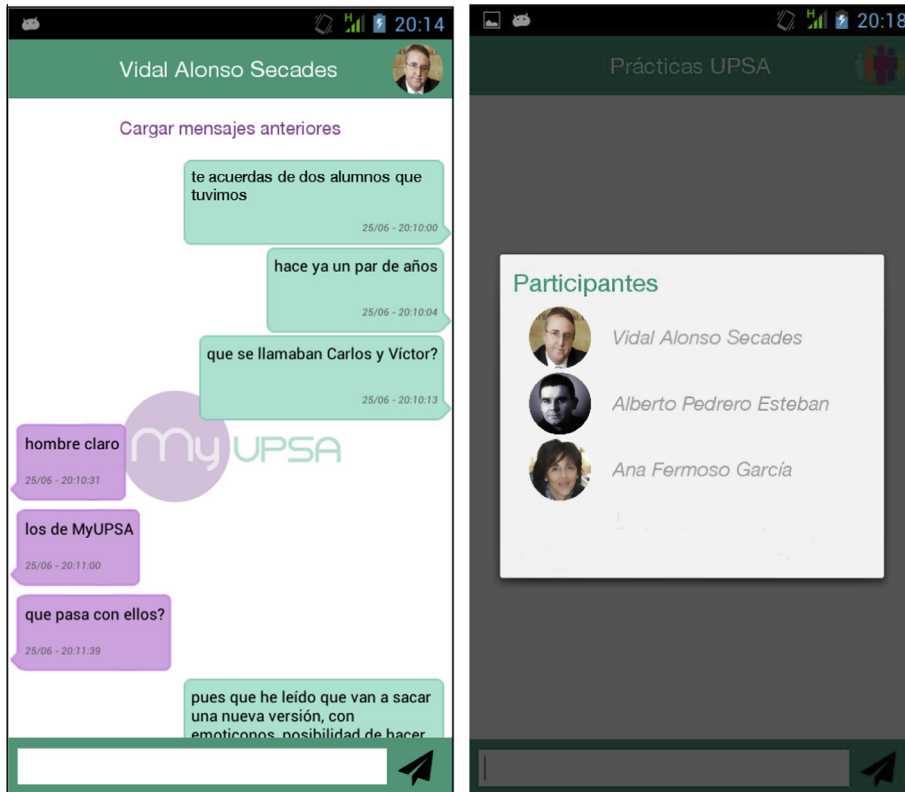


Fig. 6. Individual and group private messages.

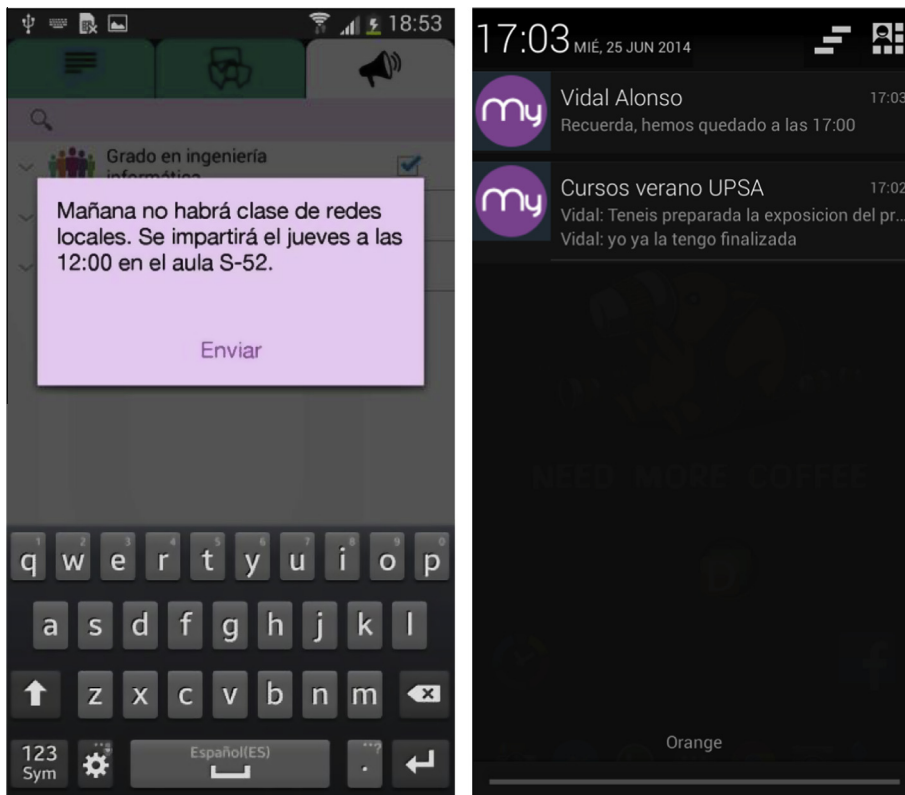


Fig. 7. Notices in SCHOM.



Fig. 8. Threads of discussion in forum of a subject.

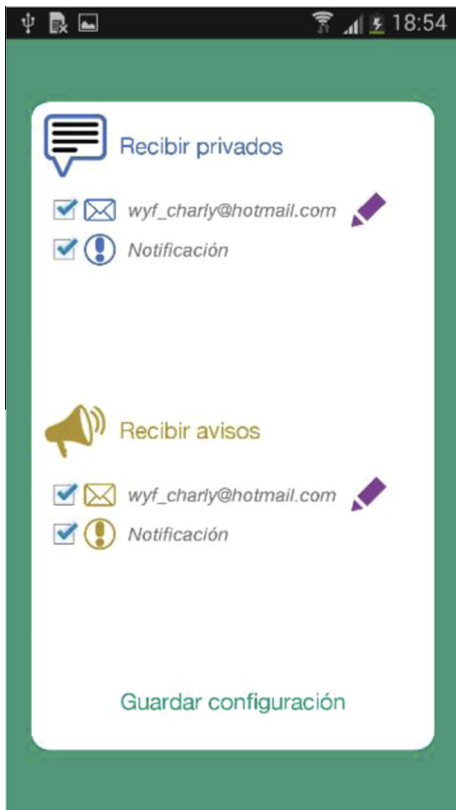


Fig. 9. User channels configuration.

The students that also are class representative are assigned the delegate profile, so they can send both, private messages and

notices, to the members of the groups of the class that they are class representative (in other words, to members of the groups of the subjects of that class); they also send private messages to Deanship.

On other hand, all subjects are discussion forums. Teachers and students can create threads of discussion, and also, they can take part in them. In Fig. 8, we can see an example of a discussion forum of a subject.

On the other hand, one of the main advantages of SCHOM is that ensures the digital anonymous. For example, a student could send a message to a teacher via mobile instant messaging without having to know his phone number. The student only has to know the teacher name, because SCHOM is who sends the message and only SCHOM keeps the association between names of users and digital personal ID (email, phone number, twitter account).

Other important characteristic to note of our tool, is that the user is who chooses the channel by means he/she receives the information (push notifications, instant messaging, one or more email accounts or twitter). This choice is for the reception of private messages and notices, and the user can update this configuration in any moment (see Fig. 9). The discussion forum messages are always received in the own tool.

## 5. Conclusions

In this paper we present a powerful tool for communication and collaborative learning. This tool uses emerging mobile technologies to improve the learning process. Although students have embraced mobile technologies, nowadays there are not dedicated tool that use this so new technology in a learning scenario. In this sense, our tool (SCHOM) is unique and original.

SCHOM takes advantage of the communication possibilities that smartphones provide nowadays, mainly if we consider instant messaging. But it does not force us to use it because the user is who chooses the channels to receive the information (push notification, emails, SCHOMobile app or Twitter). One of the main advantages is that ensures the digital anonymous, regardless of the channel chosen. So a user can send a message to other user, using for example instant messaging, knowing only his name.

Also it is an entirely customizable tool (domains, organizational units, groups, profiles, roles and topics) so it could be used in any educational context or any organization where improving communication is needed.

In the future, we want to test the tool in a completely real scenario with university students in our subjects and to confirm that it improves the learning and increase the student's motivation. We will make an empirical analysis using satisfaction inquiries and we will analyse log data stored by the tool. And maybe SCHOM could be integrated with a LMS like Moodle, this will be our next research work. We think the use of emerging technologies is essential in learning but technology is changing very fast and there is not learning systems in which these technologies are included. It is necessary a bridge between emerging technologies and learning systems, it is for that we think to integrate SCHOM with other learning systems in the future. The modular architecture of SCHOM, and the use of cloud computing will make this fact possible.

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