

How to Design a Mobile Learning Environment

Recommendations Based on Student Perceptions

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Abstract: The rise in sales of smartphones, the importance of anywhere connectivity, the general adoption of mobile apps, and the opportunities brought by mobile devices in educational settings underline the delay with which universities have moved to adapt their virtual learning environments for mobile devices. Providing students with a means to access the learning environment from a mobile device is therefore a pressing need. In this paper we present a series of recommendations designed to guide universities in the development of mobile learning environments, based on a case study of the Universitat Oberta de Catalunya (Open University of Catalonia, UOC), an online university. A focus group was organized to gather students' views on the three mobile developments for the UOC's Virtual Campus: a native app, an adapted version for mobile browsers, and an e-mail client app.

1 INTRODUCTION

Smartphones and tablets are increasingly used by the general population and Spain, in particular, is one of the countries of the European Union with the highest levels of smartphone sales (Europapress, 2013). The expansion of the apps market appears unstoppable (Ticbeat, 2013), and uses are being found for mobile devices and apps in an increasing number of areas, including leisure, city management, public administration, education, etc.

The spread of mobile devices and apps has given rise to various debates, which centre around the technology itself, how this technology should be used (Maceiras et al., 2011; Piguillem et al., 2012; Rathí et al., 2012), how to guarantee a satisfactory user experience (Ballard, 2007, Nakhimovsky et al, 2009), and the relative merits of native, web and hybrid apps (Budiú, 2103; Charland, 2011).

In education – particularly the higher education sector – debate over mobile apps must also incorporate consideration of the use of mobile devices and apps for teaching and learning, or *m-learning*, (see, for example, Barnes, 2013).

As such, if a university wants to adapt its virtual learning environment for mobile devices it will need to take decisions regarding educational content, technological structures, and the desired form of human-computer interaction (HCI).

While there is already a body of literature on m-learning (Barnes, 2013; Gikas, 2013), the relationship between m-learning and UX (Dirin, 2013), and the types of technology and platforms that can be used to in adapting a virtual learning environment for mobile devices (Xhafa et al., 2010), there is an obvious lack of studies addressing the views of students, not with regard to the learning process itself but in respect of their capacity as users of both mobile devices and mobile learning environments. In other words, the literature contains little consideration of the extent to which virtual campuses are adapted to the real needs of their *users*.

Questions that must be asked include the following: If a university offers a wide range of services, which are the most relevant to students when they connect from a mobile device? Would students prefer to use a virtual campus specifically adapted for mobile browsers, a native app, or the choice of both? If the university intends to develop an app, would students prefer a single app that combines only the most relevant services or individual apps for each of the services offered?

In this paper we aim to shed light on the options open to a university when developing a mobile learning environment, based on the perspective of the student-user. Specifically, we present a series of recommendations based on a case study (Eisenhardt,

1989) of the Universitat Oberta de Catalunya (Open University of Catalonia, UOC), an online university. A focus group was held with UOC students to gather their views on the mobile developments currently offered at the UOC and the direction work on these developments should take in the future.

The mobile developments discussed in the focus group were: an adaptation of the UOC Virtual Campus for mobile browsers; a native app of the Virtual Campus; and a native e-mail client app.

In the following sections we describe the three mobile developments and explain the objectives and composition of the focus group and the results obtained from the discussion. Finally, we present a series of conclusions and the recommendations for other universities.

2 MOBILE DEVELOPMENTS AT THE UOC

As stated above, the focus group was used to discuss the adapted version of the Virtual Campus for mobile browsers, the Virtual Campus native app, and the e-mail client app.

The UOC Virtual Campus works as a portal where students have access to all the different services necessary to carry out their studies, such as e-mail, the agenda, classrooms, news, library, secretariat, and so on.

Optimized access to this learning environment from mobile devices was both a necessary step and an inevitable development. The growing use of smartphones across society as a whole, and the general profile of UOC students, who want to make the most of any chance to carry out activities related to their studies, have made it increasingly important to provide an effective means of connecting to the Virtual Campus from mobile devices (Gil-Rodríguez, 2010).

Following a user-centered design methodology (ISO; 2010), in an initial phase a series of focus groups (Rebaque-Rivas, 2010), context studies (Gil-Rodríguez, 2010) and usability tests (internal document) were organized with UOC students to find out about their requirements and to assess the different design proposals deriving from their comments. The results were used to define the functions and services that students consider essential in a mobile learning environment.

Having completed the initial research in 2011 the UOC launched the adapted version of its Virtual Campus for mobile browsers (Office of Learning

Technologies - Open University of Catalonia, 2011). The new version has three main tabs: *My UOC*, which gives students access to the principal range of academic services (e-mail, virtual classrooms, calendar, etc.), adapted for mobile devices; *Menu*, which lists the other services available in the standard Virtual Campus, which are not adapted for mobile devices but are considered useful enough for links to be provided; and *Alerts*, which provides direct access to the main information and notification spaces of the Campus (e-mail, virtual classrooms, work groups, teacher board, etc.).

The simultaneous availability of conventional and mobile services was one of the main points considered during the focus groups.

Development of the native app began in 2011 through a joint initiative with Orange Spain to design a Virtual Campus for exclusive use on iPads (Gil-Rodríguez, 2011). The app was refined and enhanced before being made available in late 2012 as a download from Google Play and the Apple Store for the UOC community.

Unlike the adapted Virtual Campus for mobile browsers, the native app only contains those services that students identified as essential: e-mail, virtual classrooms, alerts, news, agenda, and learning resources.

The e-mail client, launched for Android at the beginning of 2012, was the first UOC app to be released. It is essentially a "light" version of the standard web client, providing a smaller number of key functions (inbox, folders, and compose messages).

3 FOCUS GROUP

In this section, we describe the objectives, methodology and composition of the focus group and the principal results obtained.

3.1 Objectives, Methodology and Composition

The Virtual Campus native app was launched in September 2012, alongside the mobile browser version and the native e-mail client. The simultaneous availability of multiple mobile developments was considered to be a potential source of confusion among students, who would have to consider the relative usefulness of three different tools, the type of use they would be likely to make of each one, and their preference for a

native app or an adapted learning environment for mobile browsers.

A focus group was organized with UOC students to find out the extent to which they are aware of the mobile tools developed by the UOC, the use they make of each one, and their satisfaction with the functions provided. The students were also asked to give their opinion of the combination of sections adapted to mobile browsers and sections for traditional browsers within the mobile version of the Virtual Campus.

Specifically, we hoped to obtain information on students' patterns of use and connection habits beyond strictly quantitative data (4% of total connections to the UOC's Virtual Campus are made from smartphones, of which 50% are iOS handsets, 38% are Android, 8% are BlackBerry and 4% are other platforms (internal document). This data differs from the Spanish market shares of the major smartphone operating systems: Android, 92%; iOS, 4,2%;, Windows 8, 1,9%; Symbian 0,9%; BlackBerry 01% (Europapress, 2013). We also aimed to determine the degree to which students are aware of the different mobile developments offered by the UOC, the use they make of each one, and their views on the simultaneous availability of different tools, as the basis for consideration of possible improvements and potential developments in the future.

For the focus groups, smartphones and tablets were used to access the different mobile developments, with demonstrations projected in real-time to facilitate in-depth discussion and evaluation of the students' views. Students were also given the chance to access and browse the tools themselves (although they used their owned devices for these tasks).

The sample taking part in the focus groups contained representative proportions of male and female students, 50% of whom had been UOC students for more than one year and 50% less than one year. The students were aged between 25 and 45 and were enrolled in different degree courses (Business Administration and Management, Communication, Public Relations, Systems Engineering, and Criminology). Students were selected on the basis of being regular users of a smartphone and tablet (some had actually bought their smartphone or tablet with their UOC studies in mind, together with other factors). In addition, almost all of the students divided their time between study and work.

3.2 Principal Results

In this section, we present the principal results for the main aspects discussed in the focus groups: 1) patterns of use, connection habits and choice of devices for connecting to the Virtual Campus; 2) evaluation of the adaptation of the Virtual Campus for mobile browsers; 3) evaluation of the Virtual Campus native app; 4) evaluation of the e-mail client app; and 5) future of the developments.

3.2.1 Virtual Campus: Patterns of Use, Connection Habits and Choice of Devices

For most UOC students, one of the main factors in choosing to study at an online university is the need to combine their studies with other activities, in particularly their jobs.

As such, the patterns of use identified in the focus groups were not completely uniform, varying according to the students' non-academic commitments. Nevertheless, a few general observations were made:

- Students connect almost every day to check for messages and notices, including updates to forums, email or messages from lecturers, work groups, debates, etc.
- Students generally browse the Virtual Campus or connect to study at night or after lunch time.
- The students' view on the importance of the flexibility that the UOC provides depends to an extent on the number of subjects in which they are enrolled (which, in turn, depends on the time available for study and each student's budget).
- The periods during which students connect are determined in part by the academic calendar, with more frequent connections registered when assessment tests are due for submission or when marks are posted.

Two distinct uses of the Virtual Campus were detected: 1) to obtain information, for example by checking for alerts and notices, viewing documents, obtaining marks and consulting documentation on continuous assessment tests; and 2) to work, for example by downloading, completing and submitting continuous assessment tests, and sharing information with other students, lecturers or tutors.

With regard to the choice of devices for connecting to the Virtual Campus, the primary options are laptops or desktop computers, complemented by less frequent use of smartphones and/or tablets.

Laptops and desktop computers are used for both

of the principal activities referred to above (obtaining information and working) as the students find them easier to work with. This is due in part to the screen size, but also reflects the availability of material and the ease of carrying out continuous assessment tests on the larger devices. Students also suggested that they feel more secure about carrying out their work on laptops and desktops.

In the case of smartphones, during the initial research we found that most students were not aware of the developments we aimed to test in the focus groups and that comments on connection habits actually related to an unofficial mobile version of the Virtual Campus developed by a UOC student as a final degree project, or to the standard Virtual Campus accessed from a mobile browser. As such, the data on connection habits via mobile devices could not be considered conclusive.

Students use smartphones devices mainly to check for daily updates and notices in the communication areas of the Virtual Campus. One student explained: *“Whenever I have a break from work I check my mobile to see if anything new has come up”*. The students value the mobility and immediacy of a smartphone for obtaining information, although they acknowledge that it is not very practical for consulting documentation; indeed, a common complaint was the incompatibility of smartphones with Office tools.

Finally, the students use tablets primarily for viewing documents. They define tablets as comfortable and practical devices that enable them to read in situations where it is easier and more user-friendly to use a handheld device than a computer. As one student described: *“... While you’re away, at the weekend, on the train, on the sofa ...”*.

3.2.2 Virtual Campus for Mobile Browsers

Following a demonstration of the mobile version of the Virtual Campus and having been given to chance to access the adapted version from their own devices, students were asked to give their opinions of the development (see Figure 1).

We found that there was generally little awareness of the mobile version of the Virtual Campus. Most students were more accustomed to checking the standard Virtual Campus from their smartphone or tablet, either because the standard version opened automatically or because they had not found the link to the mobile version.

Having watched the demonstration and used some of the functions of the mobile version from their own devices, students commented that they

particularly valued the practicality of the adapted Virtual Campus, in the sense that it contains all of the most relevant information for connections from a mobile device.

The most negative comments reflected the students’ dissatisfaction with the fact that some sections, such as *Secretary’s Office* and *Tutor*, had still not been adapted for mobile browsers, while there were links to other sections that students were unlike to use from a mobile device, including *Library* and *News*.



Figure 1: Virtual Campus adapted for mobile browsers.

Students were not critical of the combination of sections adapted for mobile browsers with other sections designed for traditional browsers, as they understood that the mobile version was still in the development stage. However, students did stress that it would only be necessary to adapt those sections they were most likely to connect to from a mobile device, such as the academic record, alerts and notifications, the teacher board, forums, subject work areas and agenda.

3.2.3 Virtual Campus Native App

Students were shown an on-screen presentation of the native app and were given the chance to use it on their own devices (see Figure 2).

We again found that only a small number of students were familiar with the app. In fact, the students who had used it were generally those who had enrolled at the UOC most recently. In some

cases, as observed above, students confused the native app with the unofficial tool that is also available.



Figure 2: Virtual Campus native app.

The most positive comments reflected the students' satisfaction with the fact that the app meets their preferences and corrects the problems encountered with the mobile version of the Virtual Campus; in other words, it only contains the information students consider relevant for connections from a mobile device. As one student remarked: *"It's like a pared-down version of the mobile version, it has everything you need"*. They also remarked that the app is modern, innovative and functional, which transmits a good image of the University as a whole.

The most negative comments received from students – in line with their appraisal of the adapted version of the Virtual Campus for mobile browsers – referred to the absence of the *Tutor* and *Secretary's Office* sections (particularly as this prevents them from consulting their academic records – they are less concerned about being able to manage tasks) and the lack of a general option to personalize the app.

Students also suggested that the sub-folder structure should be improved for communication in forums, virtual classrooms and via UOC e-mail, as the current structure creates a feeling of uncertainty and generates concern that if students are unable to connect to the full Virtual Campus they may be missing out on information. It should be noted,

however, that at the time the focus group was arranged, the native app was affected by a technical issue and could only display the principal folders in the forums, classrooms and e-mail.

3.2.4 e-Mail Client App

Finally, the e-mail client app was presented, following the method adopted for the previous two developments (see Figure 3).



Figure 3: UOC e-mail client app.

Students most highly valued that the app is a quick solution for accessing their UOC e-mail. They were less positive about the fact that the client app is basically a substitute for the native Virtual Campus app, making it both too specific and not sufficiently comprehensive. As such, it does not meet the students' information requirements, as they will also need to view other types of messages and alerts. As one student explained: *"When I want to check something at the UOC it's not just my in-box, it's to see whether there are messages on the notice board, the forum..."*.

In other words, the students considered that all of this information should be gathered together in a single app and that the e-mail client serves no useful purpose, given that they can already check their e-mail via the Virtual Campus native app. They explained that having a number of different tools creates a degree of uncertainty. As one student pointed out: *"If you have to check various apps, you get the feeling that you might be missing out on information"*.

3.2.5 Future of the Developments

Once the three developments had been presented, students were asked to give their views on how they should be developed in the future and what use they are likely to make of each one.

The students indicated that they would connect most frequently to the native app, as they see it as the most direct form of accessing the Virtual Campus and consider that it includes enough of the necessary services (lacking only the *Secretary's Office* and *Tutor* sections, as they mentioned), unlike the adapted version for mobile browsers.

The students also suggested functions that they would like to see integrated into the native app. These include a file storage and sharing system, such as an internal server or a tool along the same lines as Dropbox, compatible with all mobile ecosystems, in order to access their records (documents, continuous assessment tests, messages), and an instant messaging tool similar to WhatsApp, to facilitate interaction in specific tasks such as group projects.

With regard to the potential use of different types of hardware (conventional computers and mobile devices), the students consider that they will continue to use a combination of the two, and that mobile devices are unlikely to replace computers altogether.

As tablets becomes more widely adopted, and once assessment tasks can be carried out from these devices, students believe that use will probably increase, and that tablets could even become the principal tool for certain tasks. The consensus is that tablets could become an active part of their studies and could even be the main device for connecting to the Virtual Campus, as it was also pointed out in the NMC Horizon Report 2013 (Johnson et al 2013) in which tablets were identified as one of the key trends in education and are regarded as having immense impact on learning and teaching in the next up to five years.

With regard to smartphones, students indicate that they will continue to be an important means of connecting to the Virtual Campus, as a complement to computers and tablets.

As such, students believe that the ideal solution in the future will be an offer of services that are fully functional via mobile devices, although they acknowledge that total adoption would be difficult to achieve. Indeed, as one student commented: *"It's a physical thing – It seems strange to think that I could actually write or work on a tablet, let alone a smartphone"*.

Finally, in relation to the availability of the three

developments and the general lack of awareness among students, and taking into account the unofficial app that many students were aware of, it can be concluded that students would like improvements to be made in the way launches of new developments and tools are communicated. As one student pointed out for the specific case of the mobile app: *"We could have been sent an e-mail: 'Download the app'."*

4 CONCLUSIONS

The focus group with students yielded a series of conclusions from which recommendations can be drawn to guide other universities in planning the adaptation of a virtual learning environment for mobile devices. In this section we describe in detail the conclusions of the focus group. The resulting recommendations are presented in the following section.

As a general conclusion, the students were satisfied with the mobile browser adaptation and the native app and considered that they provide a comprehensive answer to their current connection needs, as well as portraying the UOC as a modern, innovative university. However, students also suggested that they would only use the native app, as it integrates and links to the most relevant services, and ruled out using an e-mail client app or the mobile version of the Virtual Campus.

For the native app to be fully satisfactory, three principal improvements must be made: 1) direct access from the app to a full range of services demanded by students, who indicated that they would like to see a section for consulting marks and a link to the *Tutor* section; 2) an integrated instant messaging system to allow fluid and fast communication with fellow students; 3) a system for storing, sending and sharing files.

On the other hand, the students' regular use of smartphones and tablets to connect to the UOC Virtual Campus, their opinion about considering tablets as the potential main device for these connections in the near future, and as well as their positive appraisal of the native app underline the fact that the mobile learning environment is already an integral part of students' day-to-day activities. It is therefore necessary to provide them with an optimized means of accessing the Virtual Campus from smartphones. The rise in sales of smartphones, the importance of anywhere connectivity, the general adoption of mobile apps, and the opportunities brought by mobile devices in

educational settings (UNESCO, 2012, Johnson et al, 2012, Johnson et al., 2013) underline the delay with which universities have moved to adapt their virtual learning environments for mobile devices.

Finally, it should be noted that most students were either unaware of the mobile developments described in this paper, even though they have been available for some time, or were familiar with unofficial apps before they learned about the official versions. It is clear, then, that efforts to communicate the availability of these developments failed, hence greater efforts should be made to provide students with more direct information about new tools and enhancements, rather than expecting students to “discover” them unaided.

5 RECOMMENDATIONS

In the following table (see Table 1) we present a series of recommendations drawn from the UOC case study which may be of assistance to other universities interested in developing mobile learning technologies.

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Table 1: Recommendations to guide universities in the development of mobile learning environments.

A single native app	Developments should be unified in a single app that brings together the most relevant services for students. This is preferable to offering multiple apps, each dedicated to a different service, which may be perceived as overly specific or lacking functions, or an adapted version for mobile browsers, which would provide access to a series of services that students are unlikely to use from mobile devices.
What the student-user requests	Students periodically use a smartphone or tablet as an alternative to a computer. But the services they are expecting to find and use in the mobile learning environment may be different from the services found in the computer learning environment. Therefore it is crucial to know what these students’ requirements are in order to design and develop a mobile learning environment according to their needs, and as a consequence to assure a satisfactory user experience. As referred to in the previous recommendation, offering other services that cannot easily be used via a mobile device could distract and hinder the students’ goals when using the mobile learning environment and, as well as generating unnecessary development costs. Employing a user-centered design perspective is an optimal way to achieve these objectives.
Devices and contexts	Regular use of smartphones and tablets by students makes it necessary to design and develop mobile learning environments taking into account both devices and their respective contexts of use.
Document management function	Although it is difficult to create or edit documents from a smartphone, an option within the mobile learning environment to save, manage and share documents gives students greater <i>in situ</i> control over their work and records, without having to wait until they can use a computer.
Instant messaging function	The emergence and mass adoption of instant messaging apps typified by WhatsApp have created a need among students for rapid and efficient communication within the mobile learning environment, particularly for group work.
A good impression	The availability of a Virtual Campus app gives a good impression and portrays the university as a modern, innovative institution.
Effective communication of new developments	New developments, tools and enhancements must be communicated effectively. Options include providing information on how to access a new development, for example in the form of an e-mail with a link to the tool, or clearly marking links to the enhanced version of an existing tool from the previous version. The strategy should focus especially on students who have been enrolled at the university for some time, who are more likely to have developed a routine and may be less receptive to new tools or less active in the search for new options.

REFERENCES

- Ballard, B., 2007. *Designing the Mobile User Experience*, John Wiley & Sons.
- Barnes, J., Herring, D., 2013. Using Mobile Devices in Higher Education. In R. McBride & M. Searson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2013* (pp. 206-211). Chesapeake, VA: AACE. Retrieved September 19, 2013 from <http://www.editlib.org/p/48093>.
- Budiu, R., 2013. Mobile: Native Apps, Web Apps, and Hybrid Apps, in *Nielsen Norman Group*. Consulted September 16, 2013. <http://www.nngroup.com/articles/mobile-native-apps/#>
- Charland, A., Leroux, B., 2011. Mobile application development: web vs. native, *Communications of the ACM*, v.54 n.5, May 2011 (doi>10.1145/1941487.1941504).
- Dirin, A., Nieminen, M., 2013. State-of-the-art of m-learning usability and user experience. In *The Fourth International Conference on e-Learning (ICEL2013)* - Czech Republic, pp 130-139.
- Eisenhardt, K. M., 1989. Building Theories from Case Study Research. *Academy of Management Review*, 14 (4): 532-550.
- Europapress, 2013. España lidera en Europa en uso de 'smartphones' con un 66% de penetración. *Consulted September 19, 2013*. <http://www.europapress.es/portaltic/sector/noticia-espana-lidera-europa-uso-smartphones-66-penetracion-20130820134026.html>.
- Gikas, J., Grant, M., 2013. Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, Volume 19, October 2013, Pages 18–26.
- Gil-Rodríguez, E. P., Aracil, X., Manresa, I., Loste, E., 2011. iUOC: Enhanced Mobile Learning at UOC. *Proceedings of EUNIS International Congress*, Dublin, June 15-17.
- Gil-Rodríguez, E. P.; Rebaque-Rivas, P., 2010. Mobile Learning and Commuting: Contextual Interview and Design of Mobile Scenarios. In *Leitner, G.; Hitz, M.; Holzinger, A. (Eds.), HCI in Work and Learning, Life and Leisure. Lecture Notes in Computer Science* (Volume 6389, pp 266-277). Springer Berlin Heidelberg. doi: 10.1007/978-3-642-16607-5_17.
- ISO, 2010. ISO 9241-210:2010 - Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems. http://www.iso.org/iso/catalogue_detail.htm?csnumber=52075<http://url/>.
- Johnson, L., Adams, S. & Cummins, M., 2012. NMC Horizon Report: 2012 Higher Education Edition. Consulted September 27, 2013. <http://www.editlib.org/p/48964>.
- Johnson, L., Adams, S., Cummins, M., Estrada, V., Freeman, A., Ludgate, H., 2013. The NMC Horizon Report: 2013 Higher Education Edition. Consulted September 27, 2013. <http://www.editlib.org/p/46484>.
- Maceiras, R., Cancela, A., Sánchez, A., Casar, A., Urrejola, S., 2011. Adaptation of a Virtual Campus for Mobile Learning Devices. *In Global Engineering Education Conference (EDUCON)*, 2011 IEEE, pp.165-167.
- Nakhimovsky, Y., Eckles, D. Riegelsberger, J., 2009. Mobile user experience research: challenges, methods & tools. *Proceedings of the 27th international conference extended abstracts on Human factors in computing systems*, April 04-09, 2009, Boston, MA, USA (doi>10.1145/1520340.1520743).
- Office of Learning Technologies - Open University of Catalonia, 2011. Campus móvil: el campus de la UOC en tu móvil. <http://www.slideshare.net/olt/presentacion-campus-mvil-uoc>.
- Piguillem, J., Alier, M., Casany, M. J., Mayol, E., Galanis, N., García-Peñalvo, F. J., Conde, M. A., 2012. Moodbile: a Moodle web services extension for mobile applications. In *Proceedings of the First Moodle Research Conference* (in press).
- Rathi, K. V., Kosale, S. S., Mayank Kumar, Thote, S. R., 2012. Implementation of a mobile campus using open source software. *World Research Journal of Human Computer Interaction* ISSN: 2278-8476 & E-ISSN: 2278-8484, Volume 1, Issue 1, 2012, pp.-09-12. Available online at <http://www.bioinfo.in/contents.php?id=219>.
- Rebaque-Rivas, P., Gil-Rodríguez, E. P., Manresa-Mallol, I., 2010. Mobile Learning Scenarios from a UCD Perspective. MobileHCI '10. In *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services*. Pages 389-390 ACM New York, NY, USA.
- Ticbeat, 2013. El número de aplicaciones descargadas en el mundo se duplicará en 2017. Consulted September 19, 2013. <http://devs.ticbeat.com/numero-aplicaciones-descargadas-mundo-duplicar-2017/>
- UNESCO, 2012. UNESCO leads discussion on mobile learning at WSIS Forum . Consulted September 19 , 2013. http://www.unesco.org/new/en/education/resources/online-materials/single-view/news/unesco_leads_discussion_on_mobile_learning_at_wsif_forum/#.UIV-FnjPni.
- Xhafa, F., Caballé, S., Rustarazo, I. & Barolli, L., 2010. Implementing a mobile campus using MLE Moodle. *IEEE Proceedings of International Conference on P2P, Parallel, Grid, Cloud and Internet Computing* (pp. 207–214). Fukuoka, Japan.