Learning with Mobile Technologies, Handheld Devices, and Smart Phones:
Innovative Methods

Zhongyu (Joan) Lu
University of Huddersfield, UK
Chapter 2

A Mobile Learning Content-independent Versatile Ubiquitous System (CiVUS)

Joel J.P.C. Rodrigues
Institute for Telecommunications, University of Beira Interior, Portugal

Diogo Videira Sousa
Institute for Telecommunications, University of Beira Interior, Portugal

Isabel de la Torre
University of Valladolid, Spain

ABSTRACT

Mobile learning (m-learning) introduces the idea of learning from virtually anywhere, regardless of the in-motion learner. This paper presents the development and impact of m-learning system capable to deliver personalized contents to the learner, called Content-independent Versatile Ubiquitous System (CiVUS). This solution promotes communication between learners and their teachers by encouraging learners to share self-made multimedia contents. Enabling interactivity makes mobile devices suitable for the development of collaborative activities amongst engineering students. CiVUS intends to offer support for engineering subjects study. It can be used inside or outside classrooms by learners and teachers, due to the mobility of these devices, at the time they find more suitable. The system has been validated and evaluated through a real usage. The study group collected answers from 10 teachers and 87 engineering students of the University of Beira Interior, Portugal and the University of Valladolid, Spain. The results demonstrate that the majority of the inquired people totally agree (all items over 72% for professors and 74% for students).

DOI: 10.4018/978-1-4666-0936-5.ch002
1. INTRODUCTION

Advancements in Information and Communication Technologies (ICT) have introduced several areas to e-learning environments such as ubiquitous learning (u-learning), mobile learning (m-learning), and television learning (t-learning). These technologies enable learners to access learning contents through a variety of devices with more flexibility and consistency (Chang et al., 2007; Kahigi et al., 2008).

E-learning and m-learning have the potential to reduce the transactional distance between learner and instructor and enable learning experiences that are more collaborative, more richly contextualized and continuously accessible (Hui et al., 2005; Barreto, 2003; Serrano-Fernández, 2009).

For people who have left University early, for those who have jobs and cannot afford to stop working or even those that need to attend to the company’s latest training program, it would be important to have a tool that would enable them to learn at any time of the day they find suitable, regardless of their location. For those people and many others in similar situations, the system introduced in this paper intends to find a solution for this challenge.

M-learning is an ideal solution for those who do not have permanent access to a desktop computer, who are usually in transit and have a need or a desire to learn. There are many mobile applications that target a particular area. If there is an application with visual contents to teach mathematics and there is another with audio contents to teach someone a new language, why not try to reunite them and make one versatile mobile application with capabilities to show both types of contents? The research work behind this paper focused on finding such a solution for this problem.

This paper presents the Content-independent Ubiquitous Versatile Learning System (CiVUS). The platform can be linked to other e-learning platforms such as Personal Learning Environment Box (PLEBOX) (Simões et al., 2011), Moodle, etc. It intends to offer support for subjects study such as data transmission, software engineering, etc. A device can be used both in and out of the classroom promoting interaction among learners, and also between learners and teachers. It is a m-learning system that can help not only at University but it is also ideal to people that just have the desire to learn and wish to do so anywhere, when they find more suitable.

The main asset presented by this system compared to others is its versatility and its ubiquity, which makes it ideal to download contents from a fixed platform and increase the learning experience. Since mobile devices are small and can be carried all the time, allowing anywhere-anytime learning.

This application is capable of delivering multimedia contents to the users regardless of their location. The multimedia learning contents are encapsulated into a learning module, which makes the system content-independent and thus suitable for any type of engineering learning subject.

The remainder of this paper is organized as follows. Section 2 elaborates on the background about the topic while gathers contributions to this work. Section 3 describes the methodology to develop the proposed platform. Section 4 focuses on the results achieved (CiVUS platform, validation, and system evaluation). Finally, Section 5 presents a discussion, conclusions, and future work.

2. BACKGROUND

2.1. Mobile Learning (m-learning)

Mobile communication technologies are changing the way people educate themselves. Today’s learners, those born after 1982, are ‘digital natives’. They are usually digitally literate, ‘always on’ and are used to perform multiple tasks simultaneously, like playing computer games while watching TV. Learning outside the classroom targets an increasingly mobile population interacting with
A Mobile Learning Content-independent Versatile Ubiquitous System (CiVUS)

an also mobile society. It is about making use of the multimedia capabilities offered by mobile phones in increasingly sophisticated ways. In this context, collaborative learning is a set of learning activities that enables the group members to enjoy the learning scenario and reach common goals through affective and cognitive comprehension, cooperative work-sharing and social interaction. To promote social interaction in a classroom context the teacher should first try to motivate students to inquire and participate.

The use of ubiquitous devices to enhance students’ learning in museums has been developed with great success (Pace et al., 2008; Beg & Ibrahim, 2009). In field trips or museum visits, one can get information about the place while going there and during the visit to enhance the experience (to capture or record what is happening, like a tour guide explanation). From then on, why not send it or post it into a message board, a Website, or a blog? By doing so, the recorded pictures or videos would be associated with that specific learning module for as long as it remained active. Also, this would suppress the need to store those taken pictures or recorded videos in the device, freeing up valuable disk space. With this method a much more enriching experience is provided because the learner has access to the knowledge beforehand, during the visit and afterwards.

Learning outside the classroom may be more effective and a learner only needs a mobile device. One user will be more used to it (save the experience period) and when school or work finishes the learner keeps the device and it can then be used at home and on weekends. Then, learners can study subjects that interest them using their own time. Independent exploration to complete school based tasks or homework is a very effective way of really understanding a material.

Another great value of m-Learning is that it fosters communication between learners. Social interaction plays an essential role on the learning process. To promote social interaction in a classroom context the teacher should motivate students to inquire and participate – which will enhance the need of collaboration by assessment and feedback; try to focus students’ attention; and try to make students externalize their internal thinking (Zurita et al., 2008).

There are a significant number of mobile applications that target a particular area, meaning that it is easy to find applications that provide access to specific learning contents, but there are only few that try to be flexible so they can incorporate distinct contents. Furthermore, many mobile device applications with mathematical learning activities have been developed (Romero et al., 2009; Stefanovic et al., 2010; Daher, 2010; Abdellaoui, 2010).

Another interesting example for mathematics learning using mobile devices is Skills Arena. Skills Arena is a mathematics video game created in 2004 for the Nintendo Game Boy Advance. It tried to supplement traditional curricula and teaching methods. Second grade students were encouraged to compete in matches against computer-generated opponents, ranked by difficulty. The game consisted in addition and subtraction exercises with variable difficulty levels. An initial pilot study was carried out over 19 days with 39 students that completed an average of 1296 problems each, three times what would be expected with traditional worksheets. The program goal, which is to provide increased motivation, seems to have been achieved not only for the students but also for the teachers who found the activity easy to administrate and control. It was also reported that students’ active engagement was extended beyond the classroom (Wu et al., 2010; Lu, 2008). Some applications improve the learning of English language vocabulary (Lee et al., 2004; Cavus & Ibrahim, 2009; Thornton, 2005), others focus on the students’ English listening and speaking skills (Saran & Seferoglu, 2010) and even classical Chinese poetry has its own application (Liu, 2009). But if there is an application with visual contents to teach mathematics and there is another with audio contents to teach someone...
A Mobile Learning Content-independent Versatile Ubiquitous System (CiVUS)

A new language, why not try to gather them and make one versatile application with capabilities to show any contents? The research work behind this paper is focused on finding such a solution.

There are limitations when it comes to build mobile learning applications: small screen sized cell phones may not display all the information or it may not be comfortable scrolling from left to right; the limited processor capability may increase the response time; and limited memory capacity, storage space or battery issues (such as constant need of charge, which may lead to information loss in case the device runs out of battery) are all drawbacks to consider.

With all the new available technology one can be overwhelmed and design a solution that, although it could be very interesting and forward-thinking, it may propose to solve problems that do not exist. One may think that is designing a revolutionary application but in reality an author is not using the appropriate technologies to solve the problem. For example, it may be chosen the use of a mobile phone screen when the appropriate would be a computer monitor. In some cases, the usefulness of the screen may be proportional to the screen size (Cao et al., 2009; Han & Li, 2009).

When there is a final version of an application, the company that produces it will want to make several versions to target all available platforms so that it can sell it to all mobile devices’ users. This is not an easy thing to do because screen sizes vary from device to device and there are several operating systems, each one with its particularities. Also, due to the rapidly growing mobile phone market, a device can be outdated in a few months. Nevertheless, e-learning and m-Learning have the potential to reduce the transactional distance between student and instructor and enable learning experiences that are more collaborative, more richly contextualized and continuously accessible (Attewell et al., 2009).

There are a vast number of mobile technologies that can support m-Learning, such as the following: mobile phones, portable digital assistants (PDAs), MP3 and MP4 players, smartphones, handheld gaming devices – like Sony PSP or Nintendo DS -, Ultramobile PCs (UMPCs), mini notebooks and netbooks, like the Asus EEE. Mobile learning is accessible from virtually anywhere using one of these devices.

Learners can therefore engage in a more enriching experience that is also captivating and fun, without being bounded to location or time issues. Mobile learning also involves connectiv-
ity for downloading, uploading and for online working via wireless networks, mobile phone networks or both. This connectivity is provided by several communication technologies, such as GPRS, GSM, IEEE 802.11, Bluetooth and IrDA. The communication between students and their teachers can be synchronous - because the student has the ability to communicate in real time with his teachers -, asynchronous (leaving the communication mainly to e-mails and SMSs), or both (Georgieva et al., 2005).

2.2. Ubiquitous Learning (u-learning)

Ubiquitous learning (u-learning) is similar to some simple form of mobile learning because learning environments can be accessed in several contexts and situations. An ubiquitous learning environment would be the one in which students could become totally immersed in the learning process.

Ubiquitous computing attempts to engage many computational devices and systems simultaneously while trying that end-user does not realize what is happening (Klopfer et al., 2002; Cooney, 2010). The idea is to discreetly integrate.

For over a decade, wireless and mobile technologies help to improve learning (Sharples et al., 2002). Thanks to mobile devices, ubiquitous computing attempts to discreetly integrate computers into the physical world making their presence increasingly natural and eventually blending them into our everyday lives. An ubiquitous learning environment would be the one in which students could become totally immersed in the learning process. Just by being there they would learn and may not even be aware that they were doing so because the information would be presented in the embedded objects to them (Liu et al., 2003; Jones & Jo, 2004).

With the exponential advances on mobile technologies that are able to see nowadays, mobile devices are becoming more embedded, ubiquitous, and interconnected, with enhanced capabilities for rich social interactions, context awareness, and Internet connectivity. Computer supported cooperative work was still in its infancy a few years ago. This evolution in mobile technologies and devices makes them an adequate support for cooperation between students (Yin et al., 2009). The above-mentioned technologies can have an important impact on traditional means of learning. This evolution is believed to happen in terms of moving further and further away from the classroom to students’ personal environment. The goal is to have a more situated, collaborative, and lifelong learning. The big challenge to researchers of this topic will be the discovery of how to use mobile technologies to turn learning into a seamless part of daily life to a point where it is not recognized as learning anymore, as referred by Schrott and Gluckler (2004).

The popularity of mobile devices comes from their ease of use, portability, small weight, and size (Naismith et al., 2005). This makes them prime candidates for having applications that satisfy students’ needs at their spare times. In many countries, the number of mobile phone users is far above the number of people that access the Internet with other mobile devices. Accessing information through mobile Web will greatly broaden the scope of education. It is reasonable to believe that mobile learning will become the most popular and convenient way of learning after Internet-based learning (Fetaji & Fetaji, 2009).

3. METHODS

The system was developed to facilitate the collaborative creation of content, organization, control, and to manage the publication of documents in a centralized environment. As we have said in Introduction section, CiVUS can be linked to different e-learning platforms such as PLEBOX and others.

This section presents the system architecture, its design, used technologies, and system overview.
3.1. Required Techniques

Mobile devices connect to the LCMS (Learning Content Management Systems) fixed platform for contents download and upload over an available wireless network connection. The LCMS systems combine the management and administrative functionalities of LMS and CMS to author, approve, publish, and manage learning content. Figure 1 shows the system architecture. As may be seen, the system can be deployed in many mobile devices and they can connect to the server wirelessly.

CiVUS system allows access to modules with specific learning contents. Each module should support images, audios, videos, texts, PDF, and PowerPoint presentations, all relative to a specific learning content. After watching all these learning contents, the learner should be able to test the new knowledge that was just acquired in an assessment module with questions related to those learning contents. These assessments can be used later for evaluation purposes or just to obtain statistics of the learning effectiveness. Furthermore, the system should provide the ability for the learners to write feedback regarding the contents. A learner should have the possibility to interact with other learners and with his/her teachers through the sharing of captured self-made contents. Making use of the devices features, the learner can capture images, audio, and videos of his/her surroundings or write a text file regarding the subject of the learning content.

Figure 1. System architecture in LCMS working environment
One of the main concerns when building a platform for a mobile device should be about the correct display of information on the screen. An effort should be made to assure that user could have all the important information available without needing to scroll down (Georgieva et al., 2005; Brown et al., 2009). This concern was detected in the development of a cross-platform ubiquitous language learning service (Brown et al., 2005). The proposed system was designed considering that all the available options are presented to the user in the main screen, without complicated menus or scroll bars. When the information was too much to fit in one screen it is divided in two, as may be seen in Figure 2.

To improve the use of the application and make it accessible to any kind of person, there should be a concern regarding the design of the interface, which should try to be as attractive and friendly as possible. Also, the navigation throughout the system should be easy and without great effort.

### 3.2. System Design

For the development of the CiVUS mobile application, the following technologies were employed. CiVUS application was developed for Windows Mobile 6 operating system. Later, the same system can be developed for different platforms. The project was developed in Microsoft Visual Studio 2008 Professional. Microsoft Visual Studio is an Integrated Development Environment (IDE) that can be used to develop console and graphical user interface applications along with Windows Forms applications, web sites, web applications, and web services in native or managed code. A managed application is an application written in C# or Visual Basic .NET; a native application is written in C or C++. .NET Compact Framework.

This point describes how CiVUS system works. After the learner is authenticated, the device shows the learning modules associated to that user. Then, a learner proceeds to choose a module, which can contain images, videos, audio, texts, PDFs, or PowerPoint files.

Statistical analysis of study results confirm that students believe that the download of these learning contents results in a more effective learning than with their textbooks or their own notes. They also indicate that are more receptive to this approach than to traditional methods (Fallahkhair et al., 2007). Once the learner is connected and authenticated, the device will download learning contents as they are selected by the user. If the system is configured for immediate download of all contents after authentication, the used bandwidth would be inappropriate and could overload the network. The users will only pay for the total downloaded bytes. The teacher can send warnings through the system (SMS or MMS) to the students via the mobile devices to remind them of examination dates and work assignments. Once the learning contents are all viewed, the learner can evaluate his knowledge in a quiz that is downloaded from the LCMS. After solving the quiz, the student will upload it to the system for a later review by the teacher. Finally, the teacher can send another system SMS or MMS to the student and save the score at the main system (on LCMS server).

### 4. RESULTS

Along this section, it is described the CiVUS platform, its corresponding validation and system evaluation.

#### 4.1. CiVUS User Interaction

Figure 3 shows a screenshot of the CiVUS application’ initial splash screen. This application was conceived to fully work without needing the fixed keyboard, inspired by the success that the iPhone (that works in a similar mode) has had over the past few years. There is a blue icon with an ‘i’ that appears in almost every form of the
A Mobile Learning Content-independent Versatile Ubiquitous System (CiVUS)

application (such as in Figures 3, and 4 through 6). ‘Form’ refers to Windows forms; in the application every visible screen is a form. The blue icon (with ‘i’) that appears in the middle bottom of every form is the help button. It contains tips adjusted to the correct form to help the user. The first form that allows interaction with user is the authentication form. Upon selecting one of the input fields, a virtual keyboard appears so the user information can be filled with the help of the stylus pen. After the learner is authenticated, the system shows the learning modules associated to that user. The design of the interface was based in two main ideas, simplicity and easy-to-use. The goal was for that experienced user could use the application as well as a beginner. The interface is very intuitive and does not have complicated or hidden options. There are no menus and the possible options of each form are all immediately visible. Again, this approach was inspired by the iPhone’s simple interaction. Figure 4 shows the learning modules associated to a user. In this case, the learner has six learning modules associated to his user account. The learner can now chose one of these learning modules and access the respective learning contents, logout and return to the authentication screen or exit the application. As above-mentioned, the blue icon in the bottom middle is a help system that displays messages explaining the available options just mentioned. Since the learner is connected and authenticated, the device will download learning contents as they are selected by the user.

If the system had been configured for immediate download of all contents upon authentication, the used bandwidth would be inappropriate and could overload the network.

If the learner selects Images, the system will produce a screen like the one presented in Figures 5a and 5b. The green arrows allow the scroll...
for all available images. If the user double taps the current image, it is displayed in full screen. Another double tap and it returns to the normal screen. Figure 5a portrays the situation of the user watching an image in an emulator screenshot and Figure 5b shows that same image in full screen in a PDA.

Figure 6a appears after the user selecting Audio. Again, the green arrows allow the user to scroll through all available audio files. This form presents regular playback controls, besides the sound up (+) and sound down (-) controls. In Figure 6b, the user has already selected a specific text file. Before this screen, there is another in which the file to be displayed can be selected. If the text file is too big, the available scroll bars will make sure that the user can access the entirety of the text.

The teacher can send warnings (by SMS) to the learners to remind them of examination dates, work assignments, or available new learning modules. Once the learning contents are viewed, the learner can evaluate his knowledge in a quiz downloaded from the LCMS.

The evaluation functionality is accessible in the upload contents area by pressing the Assessment icon. After solving the quiz, the learner will upload it to the system for a later review by the teacher.

An interesting functionality implemented that is worth highlighting is Take a Photo. Instead of immediately starting the camera, the system displays thumbnails of all available photos in a grid. By doing this, the user can select and upload a picture previously taken.
4.2. System Validation

To validate the proposed system, the application was installed in several PDAs and submitted to performance tests. Figure 7 shows the CiVUS system running in three distinct mobile devices, namely (from left to right) in a HTC Herm 200, an Asus P527, and a HTC Touch Diamond. In all tested devices, the application behaved as expected and all functionalities worked properly. The first device, a HTC Herm 200, displays the Take a Photo functionality. The student is selecting a picture to upload from the photos gallery. The second device, an Asus P527, shows the upload contents area. The last one, a HTC Touch Diamond displays a functionality that had not yet been shown, the Record Sound, part of the upload contents area. This functionality has all the regular recording controls, namely, record, stop, play, an OK button to save the file and a Cancel (the ‘X’) to leave the recorder without saving the file.

With the implemented functionalities the software meets the pre-established requirements for this system. Besides being robust and reliable, there was a great concern to make it efficient - and spend as little resources as possible. “Do not do anything unless it is absolutely necessary” is a recurrent advice from experienced mobile developers like Maarten Struys (Microsoft’s Device Application Development Most Valuable Professional). It reminds novice developers that a mobile device has few resources and they should not be wasted.

4.3. Users Evaluation

The method used to collect data was a personal survey. The survey was developed at the university context. Although the universe of the surveyed people was about 12 teachers and 95 engineering students of the University of Beira Interior, Portugal and the University of Valladolid, Spain. The study group collected answers from 10 teachers (between 27 and 49 years old) and 87 engineering students (between 18 and 25 years old) of distinct subjects who participated and answered the survey accurately.

Figure 5. Show images, in one of the user’s learning modules
The age of the surveyed people was taken into account, given that some professors are not familiarized and are reluctant to the use of new technologies. Before the survey, the system features and its advantages were explained to the participants and they were afterwards encouraged to test it without restrictions for approximately 2 hours, both in and out of the campus.

The survey shown in Table 1 includes six questions. The first question intends to measure the device’s easy-to-use capability, the effortless navigation, and the friendliness of the user interface.

The second question intends to assess if the icons used in the application are adequate to the device, in terms of shape, style and color. The third question focuses in analyzing if the downloaded contents are visualized correctly and if they are downloaded in a reasonable time. The fourth question intends to determine if the device allows an easy collaborative interaction with other learners. The fifth question inquires if the

Table 1. Items of students’ and teachers’ perception

<table>
<thead>
<tr>
<th>Q</th>
<th>Items</th>
<th>SD</th>
<th>DA</th>
<th>U</th>
<th>A</th>
<th>TA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>The tested device is easy to use, with effortless navigation and friendly environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Q2</td>
<td>The application icons are adequate to the device, in terms of shape, style and colour.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Q3</td>
<td>The learning contents were downloaded in a reasonable time and are visualized correctly.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Q4</td>
<td>The device allows an easy collaborative interaction with other learners.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Q5</td>
<td>The connection and authentication to the server/LCMS ran without incidents.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Q6</td>
<td>I would be interested to follow the presented learning method with a mobile device, like the one tested.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Strongly Disagree (SD); Disagree (D); Undecided (U); Agree (A); Totally Agree (TA); Question (Q)
user’s connection and authentication to the server ran without incidents. The final question allows understanding if the learners would be interested to continue using the presented learning method via a mobile devices, like the performed tested.

To measure the answers a Likert scale with dimension five was used, in which (1) means ‘strongly disagree’, (2) means ‘disagree’, (3) means ‘undecided’, (4) means ‘agree’, and (5) means ‘totally agree’ with the presented statement. This survey allowed the collection of the users’ opinion that has been used the system in the mobile device and their satisfaction level. Figures 8 and 9 show the survey results for professors and students, respectively. As may be seen, the results demonstrate that the majority of the inquired people totally agree (all items over 72% for professors and 74% for students). A small percentage of users agree and, surprisingly, nobody strongly disagrees with the use of mobile devices. The interactivity, ubiquity and offered possibility of downloading any type of contents were the most highlighted application characteristics. With these results, it is assumed that CiVUS system and mobile devices offer quality of service and good user experience for the use of m-Learning contents.

5. CONCLUSION AND FUTURE WORK

Mobile learning is about being able to learn wherever and whenever you have a need or curiosity and to integrate that knowledge with other learning experiences. For being accessible from virtually anywhere, learners can engage in a more enriching, captivating, and fun experience than traditional tuition. It does not occur only with cellular phones or smartphones, but also with other devices such as MP3 and MP4 players, handheld gaming devices, PDAs, ultra mobile PCs, mini notebooks, and tablets. Due to mobile devices’ small screen size and limited battery life, sceptics doubt that learning through a mobile device will ever become effective learning. Nevertheless, allowing students to learn and to access college or school resources using one of these devices seems to be the inevitable future of education.
The system presented in this paper, CiVUS, intends to offer support for different subjects/courses study. The main asset presented by the application CiVUS compared to others is its versatility and its ubiquity, which makes it ideal to download contents from a fixed platform and increase the learning experience.

It can be used inside or outside classroom by learners and teachers, due to the mobility of these devices, at the time they find more suitable. CiVUS intends to offer support for different engineering
A Mobile Learning Content-independent Versatile Ubiquitous System (CiVUS)

subjects study and offering a mobility experience. The interaction provided by this system goes beyond the classroom and can help not only those who go at University but also those that just have a need or curiosity. With this application they can find a solution, regardless of location and at anytime they wish.

A personal survey was elaborated to analyse the user experience and the effectiveness of the application. 10 university teachers and 87 engineering students of different subjects were involved. The survey results show that the majority of the inquired professors and students totally agree with the usage of the device, both in terms of the intrinsic characteristics of the developed application and in terms of interaction with other users and the contents download.

Regarding future work perspectives, the approach may be extended making the application available to other platforms, make it a multiplatform system (such as Android or iPhone). Another possibility is to adapt or migrates the system to the Windows Mobile 7 platform once it is released as a full functioning platform. Finally, one last suggestion for a future task would be the creation of a functionality to automatically notify learners by SMS when a new learning module is available.

ACKNOWLEDGMENT

Part of this work has been supported by the Instituto de Telecomunicações, Next Generation Networks and Applications Group (NetGNA), Portugal, and by Project e-Learning 3.0 from PT-QREN I&DT/5635/2009. Authors would like to thank the company iZone Knowledge Systems for the cooperation on this project and to those people that tested it and whose answers allowed authors to evaluate their user experience and understand their satisfaction degree.

REFERENCES


A Mobile Learning Content-independent Versatile Ubiquitous System (CiVUS)


