M-learning tools on distance education

Overview and Case Study

Mauro Faccioni Filho[1,2]

Unisul Virtual

UNISUL – Universidade do Sul de Santa Catarina[1]

Palhoça, Brasil

mauro.faccioni@unisul.br

Lawrence Zordam Klein[#], Moacyr Franco Neto[*]

FAZION Sistemas[2]

Florianopolis, Brasil[*]; Braga, Portugal[#]

lawrence@fazion.com.br

moacyr@fazion.com.br

Abstract—**This paper shows a pioneering project in education with the use of cell phones and other mobile devices. The mobile learning environment was developed by Fazion Sistemas and currently is at the Universidade Fernando Pessoa (Portugal). The paper presents an overview of mobile-learning concepts, its barriers, challenges and trends.**

Keywords- m-learning; distance education; mobile application, mobile learning; e-learning; enginneering education.

I. INTRODUCTION

Today people are used with mobile phones, and pay to communicate with people whom they like or with whom they work, either through direct conversation or by exchanging messages. In fact, the text messages play a very limited role in communication, either by poor information quality or high costs. While the "idea" of the personal computer largely derived from the look of a typewriter and calculator, usually born in the company, the phone came from the merger of the notebook and telephone, being something very personal.

We must learn from this change - home versus business – and what should be done to enhance phone quality when developing applications. Today, more than ever, businesses are stepping forward to bring people together because people like to relate to each other, regardless of business they do. If a mobile network project can be developed in this format, aimed at relationships, then this is the path. [1]

Currently there are three areas where mobility can bring immediate fruits and strategic importance for organizations, which are "mobile-business", "mobile-commerce" and "mobile-learning", or simply "m-learning".

M-learning can be considered an offshoot of e-learning. But, in fact, considering that e-learning enabled the distance learning using the Internet, m-learning goes beyond by allowing the user access to perform anywhere, even on the move, and the device becomes in fact a mobile repository of information. The concept of education with the use of mobile phones covers a wide range of opportunities:

- learn anywhere and in motion, simply carrying a personal mobile device;

- learn by interacting with different people through social networks, forums, etc.;

- archive and order a wide range of information, using memory resources of the device;

- create, with equipment features, image files, video or text, attaching them to the systems of communication and learning;

- consult various information such as grade, messages, calendars, among others.

This paper does an overview about m-learning and shows a pioneering project in education with the use of cell phones and other mobile devices. The project is at Universidade Fernando Pessoa (Portugal) and the basic system refers to academic information such as calendar, information about the subject, grade and environment forum between students and teachers. Universidade Fernando Pessoa uses a very successful e-learning environment based on the *sakai* collaborative platform [2] and sees it as a natural expansion of e-learning environment towards m-learning.

The m-learning project presents several challenges and barriers to transpose, either on technical or cognitive issues. As an example, there is no standardization on the several mobile platforms or devices, screens vary from device to device and the industry is not worried about data traffic or computation basis when compared to voice traffic and its respective earnings. The cognitive aspects of mobile learning is yet more obscure, as the research on this area is just in its very beginning and depends on new experiments and trials.

The project with Universidade Fernando Pessoa is a real case use and is also object of study and research. The paper begins with an overview of mobile learning concepts and describes the context of the project at Universidade Fernando Pessoa.

II. EVOLUTION OF DISTANCE EDUCATION - A BRIEF HISTORY

The evolution of distance education can be divided roughly in three different stages: 1) the distance learning, 2) the electronic learning, and 3) the mobile learning phase.

The distance learning stage, abbreviated as d-Learning, begins with the industrial revolution around centuries 18th and 19th. The industrial revolution brings several new possibilities for communication, and one of the most important is the printing facility of large volumes of books, newspapers and

other documents. The post service evolved those days, and the expansion of railways, with trains arriving or passing through distant places, got the advantage to take people together or more connected then ever before. The first distance education courses were based on books and correspondence, and people away from large centers could receive materials, study alone and conduct tests and relationships through correspondence. In the United Kingdom the University of London opens its education program in 1840. The concept of distance education evolved until the last century when, during the 1970 decade, the first "Open Universities" opened in Europe (UK, Spain and Germany).

The electronic learning, or e-Learning, comes with the electronic revolution and the internet. The arrival of electronic communications has enabled a new level of access and communication for education, first with the radio live broadcasts of courses, and after the television era came. Then in the nineties arrived the internet network that allows a wide range of new possibilities for communication, especially interactive, which was not possible with radio and television. Learning systems using the internet can provide content, promote discussion forums and chat in real time, show videos and create other possibilities as an entirely new way to educate through the use of web tools. The intensive use of internet was possible due to several facts:

- deregulation of communications, followed by telecom privatization around the world;

- development of personal computers and its popularization in the '80s; computers became easier to use and price came down year by year;

- communication networks have switched from analog to digital; this digitalization allowed the development of new transmission technologies and protocols and conditions to compact more information in a single "packet";

- Internet has become public in the '90s; earlier used by academic or military reasons, then became public and spread out.

After the internet revolution came the wireless revolution that brought the new stage of mobile learning, or m-learning. A personal communications revolution began at the turn of the century when the number of mobile phones surpassed the number of landlines of the traditional telephony. There were 500 million handsets in 1999/2000, and in 2008 there were more than 3 billion mobile lines in the world. Features were added every year, such as photography, music and video in all devices. In these handsets the computing power is already higher than the desktop from a few years ago, with increased memory and sophisticated web browser. Currently there are three times more mobile phones than PCs with Internet access, and we are in an era of global mobility, where 50% of workers spend up to half their time outside the office. The cell phones are personal items, and define a personal style. But the experiences with the use of mobile devices for education are just beginning, and most of them focuses on implementing, literally, the versions of the web to the phone while using the browser, or merely implementing very simple learning objects

or small games [3] [4]. An overview about m-learning can be found in [5].

III. CONCEPTS OF M-LEARNING

As a first view, the m-learning can be considered as an offshoot of e-learning, allowing a wide range of opportunities in education. Just like e-learning that has become an entirely new way to teach and transfer knowledge, m-learning is now showing a horizon of new challenges and possibilities. Some of these challenges and possibilities can be described as:

- learn anywhere, everywhere, and in motion - just simply carry a personal mobile device wherever you go;

- learn by interacting with different people, whether in the social community or through social networks, forums, etc;

- archive and sort a wide range of information, using memory resources of the device (the information will be always at hand);

- create, using the equipment features, image, video or text files, and then attach to the systems of communication and learning; this way all participants of the learning network can be knowledge collaborators;

- continuous extended library - information such as grade, messages, calendars, among others, can be always updated and seen.

Devices for this kind of learning are in continuous evolution and going for a technological convergence. Today one can see equipments for training and education varying from common mobile phone to new advances like smartphones, palmtops, pocketPC and several kinds of personal digital assistants.

IV. CHALLENGES OF MOBILE EDUCATION

The main overall challenge is to develop new paradigms to support education on mobile platforms. Paradigms which are different from the ones that emerged from the previous internet era. New wireless paradigms such as:

- collaborative learning – people are now connected all the time and can collaborate in real time, asking, answering, discussing and participating in a very democratic way;

- corporate education – as the workers are more and more on the go and out of office, the corporate education must pass through mobiles;

- collective generation of knowledge – as the device has powerful tools (camera, recorder, text, etc) and is always connected, it should be used to generate knowledge from the field;

- the growing experience of young people with social networks can be turned on an advantage for the mobile-learning.

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Another complex challenge is the mobile content authoring. How to develop a new authoring platform for content development, how to solve the markup text for different devices and formats, and how to use the small interface to show text and images are fundamental questions [6].

Existing content in e-learning must be adapted for the new devices, and this should be done by automatic processes. This can generate new business models, like new platforms for m-LMS (learning management systems), and new businesses to interact with existing ones.

The challenge of the mobile features: every year (or month!) new features are built on the mobile devices and this is very exciting. How to fully exploit these new features, such as geo-location, motion sensors, photo and video, to make the educational experience as interactive as possible – that's the defiance to deal with.

V. BARRIERS TO M-LEARNING

Despite the evidence of the wireless revolution and all the possibilities it brings for several areas, there are yet important barriers for de m-learning adoption. Some of these barriers can be described as follows:

- the cost of packet transmission (WAP, GPRS, 3G and other) is yet impeditive in several countries, mainly in poor regions and even in developed countries, maybe due to the business models of telecom operators which are yet focused on voice billing and short message services;

- the size of devices is a problem because the screen is considered small, the keyboard is not practical to text, and there is no uniformity of devices in the industry; some of these problems were surpassed by the touch screen interfaces, but dimension is an usability question to solve [6];

- multiple platforms, multiple operators – each manufacturer constantly launches always new devices with different dimensions and features, and telecom operators have not a standard of data quality transmission or business models, what puts difficulties for developers in general;

- there are only just few experiences in mobile-learning, which are yet incipient and often discontinued [1];

- reactivity and the conservatism of educators – most of them see these kind of technologies as a new problem to deal with, and sometimes prefer old ways which they are used with;

- new technology adoption is a barrier because depends on early adopters;

- the need to produce new content and learning objects could be a strong barrier because teachers and researchers do not have this know how [7];

- despite the huge mobile phone installed base, development of applications for mobiles is still something very embryonic [8];

- owing to the students misuse of mobile phone at schools (for instance counterproductive conversation at classes, ringtones and so on), there is yet a negative image of mobile within the educational environment.

VI. M-LEARNING PLATFORM TYPICAL TOOLS

When we think of mobile-learning tools we can classify them into two major groups: 1) access to academic information (schedules, marks, information about educators on the educational institution, etc.) and 2) access to educational content. The second group should consider the use of assessment tools of learning, like the creation of multiple choice questionnaires, and how to associate this kind of testing with confidentiality and safety measures, as well as the correct user ID system at the completion of the assessment.

Considering these two groups we can enumerate the following functions that are typical of mobile platforms:

- alerts and alarms: set indicated to alert on events on determined schedules or agendas;

- direct communication tools: peer to peer possibility of communication between educators and students;

- multiple choice systems: development of evaluation questionnaires;

- educational games: how to make content more attractive to the audience, development of learning objects considering the game designing style;

- records, schedules, evaluation scores: basic tools for access to scholarly information;

- searching tools: words, glossary, dictionary, tools supporting the dissemination of content;

- links to mobisites: how to make content more dynamic and how to find more references;

- instructional videos and audios: use of multimedia resources to enrich the contents and overcome the monotony of long texts;

- tools to capture information: capture in the field and then send to referral groups, encouraging the use of mobile platforms in times of extreme mobility;

- forums and social networks: the approach is fundamental because participation in forums and social networks in the m-learning universe is a way to boost the mobile employment for education. This trend is in line with recent research showing that mobile phone users have the largest networks of contacts [9].

VII. MAJOR ISSUES FOR THE M-LEARNING FUTURE

The future of m-learning, its success and time to adoption depends on a series of questions, like portability, capability of interaction with existing educational methodologies and technologies, the device dimension and related features, data transmission quality, social interactivity and user centered applications. Let's exploit these points further.

The portability of applications: mobile-learning systems must search for applications that can be used in a wide variety of devices, in order to democratize access to mobile-learning and be as less as possible dependent on new hardware launchings.

Hybrid educational opportunities: use of mobile-learning systems operates as a complement to formal face-to-face and e-learning education and could be used as an additional teaching method outside of the classroom, as an online bridge between students and educators, allowing quick exchange of information between these actors.

Small size of devices (screen and keyboard): the easiness that younger generations adapt to mobile devices can predict that actual difficulties will be overcome in the same proportion as the devices become more sophisticated and prices go down. Just observing the ease with which young people create text messages on their cell phones and we can glimpse that the small keyboard will not be an obstacle in a short time.

Quality of transmission networks: the enhancement of the quality of transmission network in many countries, the quality of its coverage and even the possibility of ever-increasing use of free Wi-Fi will bring more and more ease of access to information.

Interactivity: one of the biggest attractions of mobile networks is the possibility of being connected to the network all the time and interacting with other people through it. The design of platforms that make use of principles of social networks to disseminate knowledge and not just entertainment is the path to education in the near future.

User centered applications: tools for mobile-learning should be created in the user viewpoint, i.e. the student. The conservatism of educators must be overcome with other strategies, through training and development of tools for "back office" that encourage the use of mobile-learning. The fact is that the applications to be installed on mobile phones should be visually attractive, user-friendly and stimulating for students, and certainly soon a specialty area of design will be established, geared specifically to create visually exciting interfaces for mobile phone screens.

VIII. CASE STUDY: UFP M-LEARNING PROJECT - UNIVERSIDADE FERNANDO PESSOA

The project developed in partnership with the Universidade Fernando Pessoa aims to provide students, faculty and staff an innovative way of access to information, as well as a versatile tool for exchanging messages and a real time mode to the promotion of discussions on relevant topics and disciplines.

The mobile-learning application is designed to live alongside with other ways of access to information already available at the Universidade Fernando Pessoa. Among the technology platforms of education available in the institution we can cite the environment of e-learning developed with the *sakai* [2] collaborative learning tool, and the access to virtual office via the Web.

The e-learning environment provides access to documents relating to each discipline. In principle, each student has access

to courses that are enrolled in a given period. Within each virtual class is offered the content, the teacher information, the possibility of a conversation environment among students and teacher, which can send messages to students about facts that occur during the school year. Also available is a forum environment, where students can discuss topics of interest related to the discipline on focus.

In the virtual secretary office environment, which is also accessed via Web browser, it is possible for the student to access academic information such as calendar, evaluation scores, financial situation as well as information about the services available in the university.

The mobile-learning application developed by Fazion to University Fernando Pessoa took account of these environments and attempts to build a single application to gather information more meaningful to the daily lives of students, faculty and staff. They can have in their hands palm, even when moving, the information deemed essential to their routine. For this step of the mobile-learning application development Fazion conducted a survey of the most relevant needs and how they should arise in the interface of mobile phones.

The goal of this mobile-learning tool is to allow access and storage of essential information to the user. In the case of the student, the real sense that is possible through the application be directly related to the school year in which he/she is. When updating the information on the agenda, the app shows the information of the subjects the students are to attend at the current school year. Such information, after updated on the device, will remain stored there. When the student does an update on another school year, the previous period subjects will be replaced by new subjects, leaving only the history of the marks obtained before. A major advantage of this application is just the fact of allowing the student to have in one place all information related to his/her grades. The information is available personally in the particular device, without having to login every time one wants to see it.

Another important feature is the ability to send alerts from teacher to students. By accessing the Web Portal tool related to the m-learning app, the teacher sees the list of their students sorted by discipline. This feature is useful for sending last minute alerts, when students are already on the move, for example if a change of venue or time made just before the start of a lesson. In this case sending an e-mail can not work and SMS can be tricky, considering the list of students. With this tool the teacher can ensure the communication with the students in situations of extreme mobility and with just one click.

Also included is the possibility for the student to consult information from the faculty during the school year, and then have in the palm of the hand the information needed to contact them at any time (their agenda at university, phone and e-mail). Information about the core services of the University, like library and department hours as well as phone and email contacts are also included.

To create a social networking environment among student's users of the tool, m-learning app has inserted a forum, which

allows the creation of discussions about the subjects taken at the school year, with the teacher's intermediation. The goal of this tool is to encourage the exchange of information among students, especially when they are out of the classroom, providing the questions anywhere and even encouraging reflection on specific topics. This is very interesting to occupy lost times, such as when one is commuting public transport. This forum is also an environment for content exchanging between students (text, music, videos and other docs).

Finally there is a user profile area. The first login to the m-learning app shows the form to fill together with the login and password to access the system. After this initial insertion there is no need to re-fill the login, which ensures quick access to information. This is a slight and important difference to the traditional virtual environment office, where you must reenter your login and password every time access is done.

IX. TECHNICAL ASPECTS OF THE UFP M-LEARNING APP

Java programming language was used to develop the tool with its ME (Micro Edition) architecture, which consists of a collection of specifications and technology created by Sun Microsystems and the JCP (Java Community Process) to develop applications that will run in environments with limited resources, like small devices with low-capacity memory, small display and limited power capacity. The main factor that influenced the choice of language was driven by portability across platforms, enabling the tool to be used for a wider range of users, no matter the mobile device manufacturer or service operator.

As shown in Fig. 1 the architecture of the application is divided into three concepts.

- Service Platform – Platform responsible for communicating and processing of content that could to be provided in a format that a low power processing device could receive and manipulate information easily. The concept of "Web Service" was used for implementation of the platform service provider. The concept of service adds to the m-learning platform flexibility for contents to interact with systems developed on different platforms, exchanging information in XML (eXtensible Markup Language). This characteristic makes it an interoperable platform.

- Web Platform: Tool responsible for managing the content and audit system access. The web tool communicates with the institution software legacy to provide writing and reading content availability on the institution portal. This flexibility provides real-time evaluation scores, class schedule as well as other content and interactions with students.

- Mobile Platform: it is able to communicate with the service platform and do the exchange of information and do the presentation of content and learning objects. As already mentioned, the mobile architecture is based on Java ME, making it independent of operational systems (OS). Through the mobile platform, the user can monitor contents, score and schedule and has the opportunity to ask questions to the teachers and receive

public or private notices. The major difference of this approach is that students have access to information, consulting or even interacting using mobile handset, regardless of physical location. Another important factor is that with this approach, the channel or medium of communication between the mobile platform and service platform becomes flexible. User can use any available technology, being able to access the service platform via GPRS, EDGE, Wi-Fi, 3G or other technologies available.
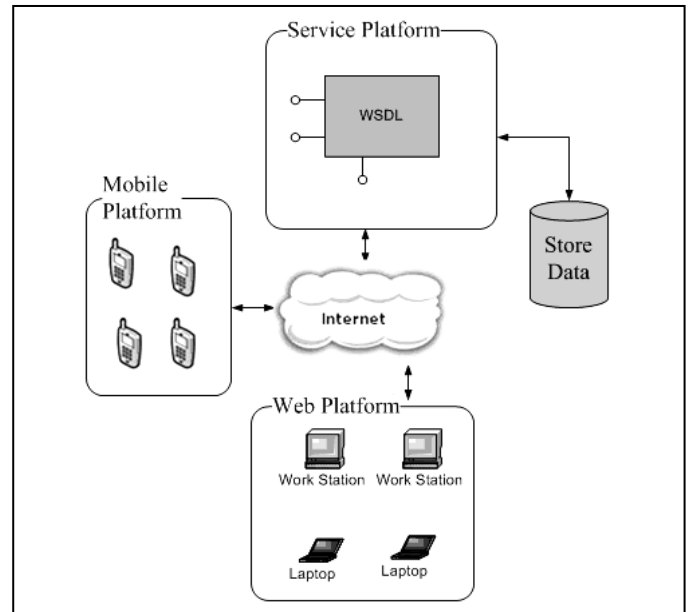

Figure 1. M-learning application architecture.

A. Tools and diagram

The main diagram of the mobile application framework is shown in Fig. 2. It is only illustrative and presents a diagram of the interfaces and flow of screens used in the mobile tool implementation. With this kind of diagram is possible to preview interactions between the User and the device, allowing efforts to design more user-friendly applications.

B. Mobile tool app

The "Beta" mobile version of the UFP m-learning platform allows the students to access information like evaluation scores and agenda of the disciplines to which they belong, as well as relevant information from their teachers and services provided by the university.

Using the mobile handset it is also possible to participate in forums linked to the disciplines, and receive warnings from teachers and sectors of the institution. Fig. 3.a illustrates the main screen of the mobile tool.

Fig. 3.b illustrates the layout used to provide evaluation scores. For future reference the student can obtain the current grade of a particular discipline and store it in the phone.

Through the module "message" the student can receive in the cell phone not only reports but images and texts in various
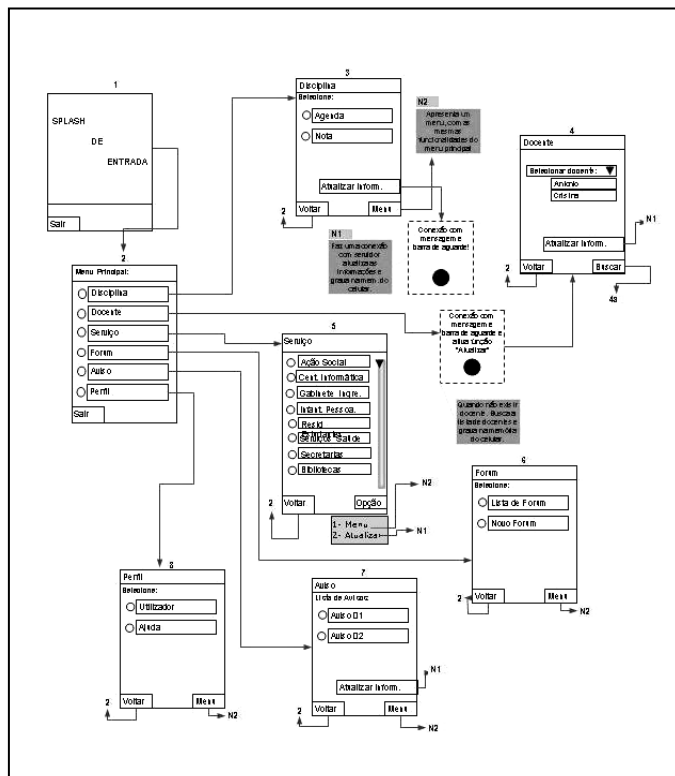
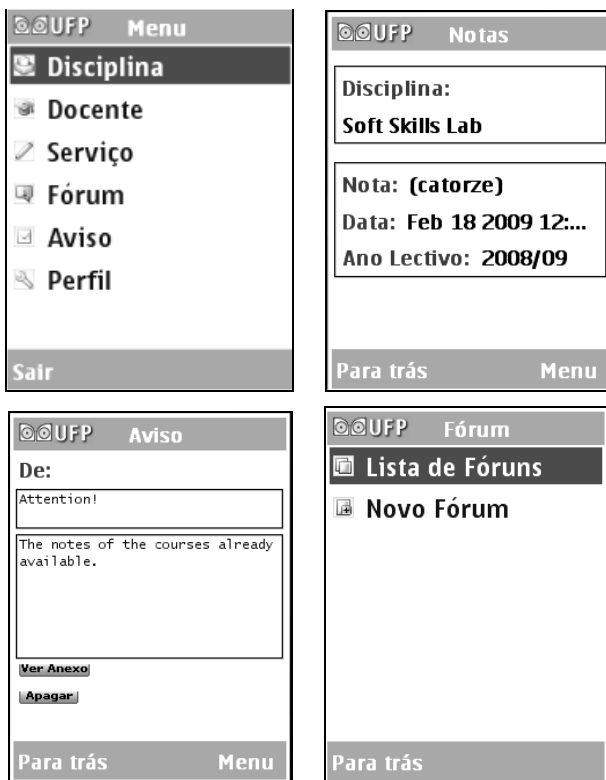formats (as exemplified in Fig. 3.c).

Figure 2. Interface flowchart.

Figure 3. Mobile learning interfaces.

A major differential of the mobile tool is the flexibility given to the user, which permits him to have access to content anywhere and be able to interact with teachers, within the university campus or in any other location. Fig. 3.d illustrates the forum entrance functionality.

C. Web tool app

The mobile learning system application has a web portal that operates as an original authoring tool, responsible for monitoring the content of education as well as handling and sending grades and reminders to students. Through this portal the teacher can interact by sending content or answering questions through the forum features, and sending alerts. Fig.4 illustrates some of the interfaces of the web portal.

At the "forum" module the teacher may add questions or even answer questions from students remotely via the mobile platform. In this module the teacher can create new discussions withim disciplines, encouraging and urging the students to search for knowledge.

At "alert" module the teacher can monitor and send public messages to all students enrolled in his/her courses, or can also send private messages directed to a single student. Through this module teachers can provide content of their disciplines and also notify students of the existence of new content.

The web tool also enables to audit the use of the system, recording date and time of use of both the web tool and the mobile tool. Fig. 4.d illustrates an example of the logs of requests occurring in a given period. Note that through this module it is possible to identify the resources more accessed by a particular class of users, building a customized social network to analyze. The possibilities of monitoring and auditing the connections, and the interaction between the mobile application and the web service are fundamental functions of the system.

X. CONCLUSIONS

Seek for new ways and tools in education is a challenge increasingly compelling. University Fernando Pessoa, from the city of Porto in Portugal, has chosen to look for new technologies to make the art of teaching more interesting and motivating. Since its beginning the organization has chosen to develop tools and methodologies of teaching aligned with the state-of-art of technology. This was the thinking that led to the partnership for the development of the m-learning tool, which represents a differential respect to other higher education institutions globally. Thinking about the student and giving him different forms of interaction with the University is the way to make learning more interesting.

In this sense, the whole process of developing this m-learning tool used as fully as possible the information already available in the university database for conventional forms of web access, and created new options for communication between students and teachers through messages and forums.

The continuous use of the m-learning tool in the university and the feedback from users will allow new questions and new enhancements, important for the maturation process of mobile-learning as a whole. For instance, engineering courses that require laboratories and other face-to-face classes may be, in parallel, facilitated by new learning objects and relationships that may be available on mobile phones. This new way of educating opens potential applications, especially in the area of interpersonal relationships in online interaction, and provides the experience of knowledge even when outside the traditional educational environment.

REFERENCES

[1] M. Faccioni, "M-Learning: mobile devices and trends in education", in *ICBL 2008 International Conference on Interactive Computer aided Learning*, Florianopolis, SC, 2008.

[2] L. B. Gouveia and P. Reis, "The sakai collaborative learning environment," *Revista da Faculdade de Ciências Humanas e Sociais*, no. 5, Porto, 2008. Available: http://hdl.handle.net/10284/904.

[3] G. Kress and N. Pachler, "Thinking about de 'm' in m-learning", in *Mobile learning – towards a research agenda*, N. Parchler, Ed. London, UK: WLE Centre, 2007, pp. 7-32.

[4] A. Mitchell, "Get real! – reviewing the design of a mobile learning game", in *Mobile learning – towards a research agenda*, N. Parchler, Ed. London, UK: WLE Centre, 2007, pp. 75-103.

[5] A. Kukulska-Hulme and J. Traxler, *Mobile learning: a handbook for educators and trainers*. Oxon, UK: Routledge, 2005.

[6] L. Gorlenko and R. Merrick, "No wires attached: usability challenges in the connected mobile world", *IBM Systems Journal*, vol. 42, no. 4, pp. 639-651, 2003.

[7] J. Cook *et al.*, "Generating learning contexts with mobile devices", in *Mobile learning – towards a research agenda*, N. Parchler, Ed. London, UK: WLE Centre, 2007, pp. 55-74.

[8] A. S. Andreou *et al.* (2002). *Mobile Commerce Applications and Services: A Design and Development Approach* [Online]. Available : http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.71.8094

[9] K. Hampton *et al.*, "Social Isolation and New Technology - How the internet and mobile phones impact Americans' social networks", Pew Internet & American Life Project. Nov. 2009.

Figure 4.   Web portal learning interfaces.