Characteristics of M-Learning Applications Designed for Collaborative Virtual Organizations

CRISTIAN CIUREA, PAUL POCATILU
Department of Informatics and Economic Cybernetics
Academy of Economic Studies
Piata Romana 6, Bucharest
ROMANIA
cristian.ciurea@ie.ase.ro, ppaul@ase.ro

Abstract: - This paper reveal specific quality characteristics of mobile learning applications developed for assisting the collaborative learning process inside virtual organizations. The features of virtual organizations are analyzed and their collaborative character is presented, in order to identify their advantages compared with the classical organizations. M-learning applications are described and mobile learning processes are analyzed inside a virtual campus. An m-learning application is used in the virtual campus of Bucharest Academy of Economic Studies, in order to calculate specific indicators necessary to evaluate the performance of mobile learning processes in collaborative virtual organizations.

Key-Words: - Mobile Learning, Virtual Organization, Collaborative, Application, Virtual Campus.

1 Introduction
The virtual organization represents a collaborative system where components have more capabilities and more power than individually. The working context of virtual organization is built on four elements, namely connectivity, purpose, technology and separation.

The virtual organizations are collaborative systems used in economy, in which people share resources and develop complementary activities in different locations, in order to achieve a common goal.

It is considered that the virtual organization has also the interdependence characteristic in addition to flexibility, in the sense of cooperation between departments and authorized individuals within one single organization.

The characteristic of virtual organizations is that they have many virtual offices in different locations from the world. Their employees must relocate from an office to another, in order to fulfill the organization needs. In order to access resources from different locations, they are using mobile applications.

The mobile technologies and applications offer a lot of new opportunities for virtual organizations, they also presenting development and implementation challenges [1].

The market of mobile application is searching for solutions to empower mobile devices with web services integration while minimizing the existing performance issues [2].

The paper is structured as follows:
Collaborative Virtual Organization section presents the characteristics of virtual organizations that run in a collaborative way.

In M-Learning Applications section are presented the main characteristics of mobile learning applications and theirs role in virtual organizations.

The development and implementation of m-learning applications are analyzed in Development of Mobile Learning Applications for the Virtual Campus.

The section Using M-Learning Applications in the University Virtual Campus presents an m-learning solution adapted for a university.

The last section, Metrics for Evaluation of Mobile Learning Processes in Collaborative Virtual Organizations, analyze several metrics built in order to measure the performance of m-learning processes.

The paper ends with conclusions and future work.

2 Collaborative Virtual Organizations
The virtual organization features that distinguish it from the classical organization are:

- semi-permanent structural units, geographically dispersed;
• performance level based on a common understanding of the business;
• continuous adjustment of organizational forms;
• intensive use of information technologies;
• information flows and allocation of resources in real time.

Figure 1 shows the position of virtual and classical organizations in space-time coordinates [3].

Fig. 1. The classical and virtual organization in space-time coordinates

In a classical organization, the activities are conducted in real time and from the same physical locations. In the case of virtual organizations, cooperation takes place in real time, but in different locations, which allow analyzing virtual organizations systems in terms of collaborative systems.

The anytime, anywhere and anyone characteristics are placed at the intersection between classical and virtual organization, on the space axis. These characteristics are valid both for virtual and classical organizations, but it is very difficult to be placed in the middle of space and time axis to achieve them.

In the case of a virtual enterprise for software development, the virtual organization requires a very good coordination between its members, being oriented towards teamwork. The work from different locations and the lack of physical interaction between employees are compensated by the appropriate tasks sharing by managers, so that each employee knows exactly what to do.

The virtual enterprise for software development enables better risk management and effective cost control, compared to the traditional enterprise. The software products supplied are checked in terms of the insertion of open source code.

If the virtual organization is represented by an enterprise for goods production, unlike the traditional enterprise the virtual enterprise enables lower production costs, reduces production cycles and requires very large databases containing different types of resources and raw materials.

The objective of virtual enterprise for goods production is to maximize the profit obtained by automating production processes and reducing costs with personnel and locations.

If the organization is represented by a university, then the comparison between classical education and online education reveal that the assimilation of knowledge is made more efficient in the case of online education, due to the process of collaborative learning within the teams.

3 M-Learning Applications

In the last years, all classical learning techniques were revised and new other techniques were introduced. The e-learning and m-learning applications were the revolutionary new ways through which the students got the necessary needed knowledge and skills [4].

The development of m-learning applications is different by the one of a normal application, because m-learning applications are designed starting from the mobile devices on which are used.

M-learning applications are designed to be used on mobile devices in order to provide anytime and anywhere access to educational content. This is done in a virtual environment when is difficult to train the employees or the students face to face in a classical systems.

M-learning applications are integrated in a mobile learning system to assure an efficient functionality. A mobile learning system consists at least of the three components:
• Mobile devices;
• Mobile learning software;
• Mobile learning content.

Figure 2 depicts the interactions among these components.

Mobile devices could be mobile phones, PDAs, tablets. Their size, input capabilities, display capabilities vary, and that is a major issue in developing m-learning applications. Also, there are several mobile operating systems and platforms upon the m-learning software can be developed.

The software required for mobile learning process could be a simple mobile Web browser or a dedicated application, that can be standalone or a client application in a distributed environment.

The mobile learning content is accessed from mobile device storage or from a server, depending on the architecture of the m-learning system.
either way, the mobile learning content has to be compatible with the mobile device capabilities, keeping in mind its limitations.

A complex m-learning application includes the following modules:
- Courses
- Tests and quizzes
- Homework and Projects
- Marks
- Personal profile administration
- Payments
- History
- Communication and feedback

Every implementation depends on the organization needs.

An important process during the development of mobile learning applications is the quality assurance. Beside this, the analysis of existing m-learning applications has to take place, as is stated in [5].

In any virtual organization that uses m-learning systems, there are four types of users: learners, trainers, content providers and administrators. The roles can overlap (the trainer could be also the content provider and/or administrator etc.). The users interact in this collaborative environment using the mobile learning system infrastructure, figure 3.

The learners interact very often with the trainers (feedback, answers, questions etc.), rarely with administrator and could provide some feedback to content providers.

Content providers interact often with the administrator for educational content. These interactions take place in a collaborative manner in this virtual environment due to the m-learning system capabilities.

Collaborative virtual environments have the great potential to enable innovative and effective distance learning techniques, involving for example debate, simulation, discussion groups, and project-based group work. The emphasis can be placed on the human-human interactions as common understandings are negotiated and developed across differences of knowledge, skills and attitudes [6].

4 Development of Mobile Learning Applications for the Virtual Campus

The virtual campus is the virtual organization designed for the development of online educational processes at all training levels.

The evolution of knowledge-based society involves the development of virtual campus through a collaborative learning environment. Collaboration is an important dimension when it comes to sharing and integrating the experiences and training courses of different groups of learners. Supervisors, teachers, and learners from the virtual campus play different roles in the learning process. They need to work in the same environment, collaboratively instead of individually, to perform an adaptive learning strategy [7].

The applications from the virtual campus of a university are divided into modules, subsystems and applications covering the full range of university teaching and non teaching activities.

Developing m-learning applications is the situation where software developers and teachers come in contact. Solid mobile development is required in order to obtain high quality software in this specific environment [8].
The development of mobile learning applications is different by the development of the normal e-learning applications, because mobile applications are designed starting from the mobile devices on which they are used.

In [9] is considered that the development of mobile learning applications can be simplified by appealing to the open-source market, where one can find some solutions for sustaining on-demand collaboration anytime and anywhere.

The first page of the MLE Moodle platform, seen from the Opera Mini browser, is available in figure 4.

Even if specialists consider that Moodle platform is still under construction and never had a real course to demonstrate its feasibility, many universities use it in different bachelor and master programs, because it is free and open-source and offer the advantage to be customized.

In the case of e-learning platforms which are adapted for mobile access, special views must be created in order to be supported by a mobile internet browser.

The applications used in the virtual campus are very different and aims to extend online secretarial services, with the possibility of filling in forms and request directly from the personal page, but also to set up online payment opportunity of university fees.

In a virtual campus, the use of mobile learning can develop higher level thinking skills, social interaction skills, and responsibility for each other and even promote higher achievement [10].

Interaction between learners is very important for mobile learning, and learners need to do real work together in which they promote each other's success by sharing resources, discussing, helping, and congratulating each other's efforts to achieve [11].

5 Using M-Learning Applications in the University Virtual Campus

The virtual campus of Bucharest Academy of Economic Studies contains three departments:

- the Public Relations and Online Education Service;
- the Internet Service and Digital Library;
- the TV Studio Service.

Each service is managed by a chief of service, which is subordinated to the department manager. The virtual campus department ensures the development of virtual education services and research.

The structure of an m-learning testing application from the virtual campus, used for the evaluation of students’ knowledge, is shown in the Figure 5.

Every test contains many questions. For any question in the test, there are many possible answers, like a), b), c), d) or e). If the tests are right formulated, the results of the students evaluation have a normal distribution: 15% results are between 9 points and 10 points, 15% are between 3 and 4, and 70% results are between 5 and 9.

In this case, for a question in the test, the situations are possible:

- all the students have submitted the answer a) and the correct answer was b); the conclusion is that the question was very difficult;
all the students have submitted the answer b) and the correct answer is b); in this situation, the question was very simple. The databases of tests are different for each lesson or course, the total number of tests available in the virtual campus being integrated in a virtual database. In Figure 6, the virtual database of tests is presented.

When estimating the volume of the virtual database of tests, it is necessary to consider as more elements so that whatever changes will occur to the virtual database, its structure remains stable. An m-learning testing application has a database that stores information about user behavior: when they enter in the application, the options that they access, when they exit. The application contains a number of counters for the information analysis on user behavior. The values are 0 for all counters when a user enters into the application. As the user accesses certain features of the application, the counters associated with these options are activated and takes the value 1. Introduction of these counters is to develop an automatic restructuring of the application, according to the most frequently options accessed by users [12].

6 Metrics for Evaluation of Mobile Learning Processes in Collaborative Virtual Organizations

In order to measure the performance level of mobile learning processes in a virtual campus, it is considered a students collectivity that participate to a test in an m-learning testing application. For the questions from the test taken into consideration, the performance level of one student, $PL$, is calculated as follows:

$$PL = \frac{\sum_{i=1}^{n} p_i}{n},$$

where:
- $p_i$ – the points received by the student if he give the correct answer to the $i$ question ($p_i = 10$ if the student responded correctly and $p_i = 0$ if the student has given an incorrect answer);
- $n$ – the number of questions from the test.

Another indicator is the degree of successful responses that is computed using the following metric:

$$DR = \frac{N_S}{N_T} = 1 - \frac{N_U}{N_T}$$

where:
- $N_S$ – number of successful responses
- $N_U$ – number of unsuccessful responses
- $N_T$ – total number of responses.

Depending on the students' training, the number of successful responses can vary.

In the case of a virtual enterprise, the degree of satisfaction of the employer can be computed as:

$$DS = \frac{\sum_{i=1}^{T} DSR_i}{R_T}$$

where:
- $DSR_i$ – the degree of satisfaction for the employee $i$
- $R_T$ – total number of trained employees using mobile learning

The degree of satisfaction for an employer in a virtual organization is a value from 0 (no satisfaction) to 1 (fully satisfied).

Work productivity of trained employee based on inputs is given by:

$$W = \frac{\sum_{i=1}^{n} O_i}{\sum_{j=1}^{m} I_j}$$

where:
- $O_i$ – the output $i$ (deliverables, results)
- $I_j$ – the input $j$ (manpower, resources per time unit)
- $n$ – the number of outputs
- $m$ – the number of inputs

The performance of mobile learning processes can be also evaluated by applying other formulas and indicators, depending by the process or person that is evaluated.
7 Conclusions and Future Work

The collaborative virtual organizations refer to an effective collaborative system in which people and applications cooperate in order to achieve certain objectives. The situations of Human-Human Interaction and Human-Computer Interaction are much encountered in this case.

Mobile applications fit very well in a collaborative environment specific to virtual organizations.

The mobile learning applications provide the great advantage that can be accessed from anywhere and anytime to achieve educational activities.

In the case of m-learning application designed for collaborative virtual organizations, new educational standards are needed to evaluate and increase the performance of the educational process.

Future work includes the development of a mobile learning application in the virtual campus of Bucharest Academy of Economic Studies in order to diversify the learning techniques and facilitate the achievement of educational process performance.

We consider that even this research paper is a very rough idea, not very practical, it can be a very good direction for future references.

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