M-LEARNING (MOBILE LEARNING) IN PRACTICE: A TRAINING EXPERIENCE WITH IT PROFESSIONALS

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ABSTRACT

This paper presents the results of a study that addresses the following question: what are the real possibilities of m-learning (mobile learning) for the development of individual competences and also for collaboration in the organizational setting? The paper analyzes a real experience in m-learning for training IT professionals. For this purpose a mobile virtual learning environment called COMTEXT was developed and implemented, which was designed to support competence development for workers using PocketPCs. The participants of the training activity (13 professionals) evaluated the m-learning experience via a structured questionnaire; all the content and interactions within COMTEXT were analyzed via content analysis. The results generated important insights into the ergonomic, technological and pedagogical possibilities and limitations of mobile and wireless technologies for corporate training and also on methodologies and learning tools that can be applied to m-learning. As an exploratory study, it also indicates issues for further research on m-learning in the organizational context.

Keywords: M-learning, Mobile Learning, Mobile and Wireless Technologies, Competences development

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1 INTRODUCTION

The growing development and diffusion of Mobile and Wireless Information Technologies (MWIT)[1] create possibilities of enhancement and redesign in organizational and educational context processes. Among them, MWITs can contribute to teaching and learning processes not being limited to environments traditionally dedicated to this purpose and enable learning to occur in any setting or at any moment, according to organizational and individual needs.

A recent idea is called Mobile Learning or m-learning. This concept refers to teaching and learning processes that occur with the support of MWITs, involving mobility of human subjects who can be physically/ geographically far from each other and far from formal educational physical spaces, such as classrooms, training/ graduation/ qualification rooms or workplaces.

This idea is especially valid if we consider that, through the growing development of activities related to services - that occur in different settings, not only in fixed places, such as factories - mobility now represents a constant in the lives of many workers in the most diverse fields of work (Kristoffersen and Ljungberg, 2000). Thus, it has become important that learning can be accomplished in various settings and with flexible hours, allowing mobile professionals to stay where they need to be: in the field, handling customers, providing services, doing business, developing projects.

This presents a meaningful change in the logic of teaching and learning processes. Needs are emerging, subject to the context where learners are found, that makes it increasingly necessary to be updated and learn on a continuous basis to meet all the demands of a dynamic, competitive and quite unpredictable market.

In this scenario, formative processes should not be restricted to absorption of information. One should, however, understand the context related to the development of competences, which is the capacity that individuals have to integrate and mobilize not only their knowledge, but also their skills and attitudes in work activities, especially in relation to unpredicted and emerging situations (Perrenoud, 1997). Competences are developed, by definition, in situated actions.

Through this context, this article reports the results of research that addresses the following question: what are the real possibilities of M-learning (Mobile Learning) for the development of individual competences and also for the cooperation in the organizational context? This project aims to contribute to answering this question, by analyzing a real m-learning experience in enabling professionals.

A virtual learning environment was developed and applied, called COMTEXT (an acronym that stands for COMpetence in conTEXT), which was created as a tool to test concepts related to learning, the development of competences and m-learning, aiming to contribute to the understanding of the possibilities that MWITs may create for these processes. COMTEXT was used as a platform to do a workshop with a team of IT professionals from one of the largest private universities in the country.

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[1] They include Information Technology tools that allow access to data and to personal communication remotely via wireless network access. Examples: cellular telephone (2.5 G or 3 G), Palmtops, Smart Phones, PDAs or laptops that are equiped to connect to different kinds of wireless networks (Wi-Fi, Wi-Max, Bluetooth, cellular telephone systems, satellite-based transmissions and GPS, for instance), RFID applications (*Radio Frequency Identification*), as well as software used in these tools (Saccol, 2005).

In this article, the m-learning experience is analyzed from the standpoint of the acceptance and usability of the applied m-learning solution, considering user perception, as well as the possibilities and limitations of this kind of tool in corporate training activities.

The article is structured as follows: first, the COMTEXT environment is presented with the theoretical references considered to design it. The adopted research methodology and the collected data analysis are then in the sequence. In the last section, the investigation results and the lessons learned are discussed, raising questions for further research.

2 THE COMTEXT ENVIRONMENT AND THEORETICAL REFERENCES

Throughout the development of the mobile virtual learning environment, COMTEXT, the competence management approach was considered as a basis (Prahalad and Hamel, 1990; Ruas, 2005; Boterf, 2003, Mills *et al.*, 2003; Lindgren *et al.*, 2004). Although competence management is rather diffused in companies worldwide, so far it has been observed that there are few virtual environments for e-learning and even less for m-learning, which are specifically designed to meet the needs of this approach (Lindgren *et al.*, 2004). The COMTEXT environment was designed to contribute to the understanding and meeting of such needs.

The competence approach, from the organizational point of view, can be regarded as a development strategy through which an organization identifies the necessary competences to achieve its goals and from that moment on it chooses, develops, monitors and evaluates people according to the targeted competences (Lindgren *et al.*, 2004). COMTEXT has a logic that is compatible with these processes.

This logic considers a cycle of development with four support modules, beginning with the "PROFILE" module, which allows the identification of competences and their development level, as well as the gaps that need to be overcome. Next, it allows for planning graduation/qualification activities ("PLANNING" module). Then, within this environment, the "LEARNING" module is found, which offers a series of tools to support teaching and learning activities. Finally, the environment offers the "EVALUATION" module, which allows monitoring and verification that the targeted competences have actually been developed, giving feedback to the initial "PROFILE" module.

In order to develop competences, an interactionist/constructivist/systemic approach was taken, which was strongly based on Piaget's theory as a reference (Piaget, 1995). The individual is seen as an agent in the learning process, as a subject who has previous knowledge and a thinker that intervenes with reality, interacting, establishing relationships and expressing learning (Schlemmer, 2002).

Aligned with this paradigm, which places the learner at the center of the learning process, the different types of mobility involved in m-learning should be considered. Mobility does not imply only moving physically; such mobility concepts as temporal, conceptual, social and interactional should also be considered, as well as technology mobility (Smørdal and Gregory, 2003; Ogata and Yano, 2003); Lyytinen and Yoo, 2002; Kakihara and Sorensen, 2002; Sherry and Salvador, 2002; Sharples *et al.* 2007;

Sorensen *et al.* 2008; Sharples *et al.*, 2008). They can be understood as follows:

- *Learners' physical mobility:* people are constantly moving and they can find spare time to learn. The physical context can be a determinant in the learning process or it can represent only a background for it (Sharples *et al.*, 2008).
- *Technology mobility:* many mobile devices can be carried around as the learner is moving around, and they can be interchangeable, depending on the context and needs (Sharples *et al.*, 2008).
- *Mobility in conceptual space:* learning topics and themes compete for each learner. We experience countless daily situations that may create learning and our attention is shared among them according to our interests, curiosity or individual commitment (Sharples *et al.*, 2008).
- *Social/interactional mobility:* people learn at different levels and in different social groups, including family and workplace or formal education groups (Sharples *et al.*, 2008). Kakihara and Sorensen (2004) also indicate the concept of *interactional mobility*, related to multiple and fluid interactions that an individual establishes when moving around, based on the use of wireless technologies.
- *Temporal mobility:* a learning process develops over time as it involves (re)-significations and connections between a wide variety of learning experiences, both temporal and informal. Kakihara and Sorensen (2002) highlighted the temporal mobility question, stating that MWITs increase polychronicity and multitasking, which is to say that an individual performs many parallel tasks, making the separation between work time and personal time more subtle.

By understanding these different types of mobility, a combination of tools that favor m-learning should be sought. Considering the use of technology for education, some tools are more adequate to support information exchange, others are more suited to support the sharing of knowledge, ideas and experiences, while others are used for collaborative and cooperative work.

The tools available in the COMTEXT environment interactively support the development of competences in order to facilitate the development of individuals and collective competences that are the basis for organizational competences. Thus, the environment allows the creation of a community of practice (Wenger, 1998; 2008). In this way, one can have an advisor, a professor or a coach as a facilitator of the interaction processes among learners, according to the characteristics and needs of the corporate training to be developed by using the environment. The tools available for such learning processes were:

- *Learning diary:* It allows individuals to record their observations, comments, learnings, questions, difficulties and feelings. It is a space for individual guidance, which can also be monitored by an advisor, coach, leader or another facilitator in the learning process.

- *Discussion forum* – It allows synchronous interaction in the community, encouraging the discussion of the most different kinds of subjects.

- *E-mail* – It allows users to quickly access their respective email providers through the web.

- *You Tube® Mobile* – One of the greatest limitations of mobile devices is the difficulty in manipulating text due to downsized screens and keyboards. That is why it is important to have access to image resources, such as YouTube Mobile®, a tool that is largely diffused as a repository of videos, which can be specifically created for a certain corporate activity (for instance, presenting products or institutional and promotional videos) or for using videos for corporate training.

- *Skype®* - Instant communicator, widely used and free of charge.

- *Conceptual maps* – They allows the creation of conceptual maps through which individuals or teams can express their understanding of a certain concept and relations between them or their understanding of a certain reality.

- *Learning objects* – They allow insertion and access to different kinds of objects (documents, figures, photographs, audio material, video material, etc,). Each member of the community can insert and access resources into this tool.

All these tools and the teaching-learning approach and development of competences that substantiate the COMTEXT environment were applied to a study based on intervention, according to the explanation in the methodology section below.

3 METHODOLOGY

The research is exploratory and based on intervention, following previous studies about m-learning and ubiquitous learning, such as Smørdal and Gregory (2003) and Ogata and Yano (2003), who developed and applied software for learning that are accessed by means of mobile devices. Based on state-of-the-art literature on m-learning, the COMTEXT environment has been developed since 2006 by an inter-disciplinary and inter-institutional research group composed of professionals and scholars from such fields as Management/Information systems, Education and Computer Science. The experience reported here consisted of the first application of the COMTEXT environment in an actual organizational environment.

The pilot study occurred in one of the universities in which the research had been developed and which is one of the largest private universities in Brazil with approximately 30,000 students. It began its competence management practices in 2004. The IT area was identified as a potential partner for the pilot to take place, due to the fact that its employees usually show interest in testing new technologies. The research team proposed a learning activity that was interesting to these professionals, as well as a methodology aligned with the development of targeted competences in the IT area.

In order to accomplish this, a two-week workshop on *"Mobility and Ubiquity"* with volunteer participation and a total of 13 professionals attending took place in July of 2008. During this workshop, COMTEXT was used by means of HP Ipaq® Pocket PCs which were provided to all the participants (Figures 1 and 2).
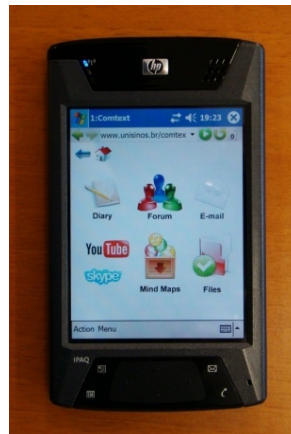
Figure 1: COMTEXT – interface and main modules

Figure 2: COMTEXT Learning Tools

In order to evaluate the m-learning experience, different types of data from different sources were collected and analyzed. As a source of qualitative data, the workshop facilitators, who were also members of the research team, not only monitored the experience, but also participated in the activity. They were able to observe, ask, and monitor the interactions between participants, as well as their reactions and perceptions with regard to the new technology. Reactions and perceptions were recorded in both the opening face-to-face session (in which participants were asked about their expectations) and in the closing face-to-face session. At that time, expected results that were not met could be evaluated, as well as what could be improved in the COMTEXT environment and in the m-learning process. Also, all the content that was introduced in the forums and chats, as well as the COMTEXT usage logs were saved and then analyzed.

In addition to the qualitative data, a workshop evaluation questionnaire was used and filled out by 10 out of 13 participants. It consisted of 25 questions about the experience of using the COMTEXT environment and the mobile device and also requested an evaluation of how much e-learning helped in the development of the targeted competences. These questions were composed based on scales that had already been developed and that are commonly used in the IT/IS area in order to assess individual acceptance of technology as per the revision by Jeyaraj *et al*. (2006) and Venkatesh *et al*. (2003). They include the following elements: perceived usefulness, ease-of-use and user support and anxiety towards the new technology. The questionnaire was used as an additional source for triangulation of the qualitative data collected. These results are briefly presented below.

4 DATA ANALYSIS

First, the learning activity characteristics and the participants are described. Next, qualitative data is analyzed regarding the m-learning process. And finally,

quantitative data is presented according to the questionnaire.

4.1 General characteristics of the Workshop

Most of the workshop participants have a degree in Computer Science. Two of them have a degree in Communication and one of them in Engineering. They are young professionals with an average age of 30 and ranging from 23 to 39 years old. Nine of them work in user technical support and 4 of the participants work in internal systems development and maintenance at the University.

The workshop purpose was to *"Promote understanding and discussion about the new Ubiquitous Computing paradigm and its possible applications for the University"*. It also targeted the development of teamwork, systemic vision, communication, creativity and project management competences. They are all organizational competences at the individual level according to University competence management.

The workshop lasted 15 hours over a period of 2 weeks and was composed of two face-to-face sessions of 1 and a half hours (an opening and a closing session) and the other sessions through virtual interaction in the COMTEXT environment, which were accessed through Ipaqs®, with a set of support learning materials; including slides (with large fonts and many images) and videos. In addition, a case study and the creation of a conceptual map were used. With the exception of three sessions, there were chats at the end of each day. Forums were also created in order to discuss the subjects of the day and to resolve any doubts from the chats.

Since the workshop was about practices related to the use of MWITs, some activities were also proposed to encourage the use of the available technology. The following was proposed during the planning of specific meetings: *"Try using bluetooth to exchange data"; "Use PocketPC to navigate the web and identify successful cases in mobile business"*. Also, as a practical activity for the development of the targeted course competences, the preparation of a (hypothetical) project was proposed, considering possibilities for the application of MWITs in University business processes.

Thus, workshop activities varied in order to test the use of all the virtual environment tools and to verify which of them were the most effective.

4.2 The M-learning process

The qualitative dada analyzed in this section refers to three different time periods (showing different reactions from participants regarding the m-learning experience): the beginning, development and closing of the workshop).

The beginning of the workshop: great expectations – The first face-to-face/ physical session, which lasted 1 and a half hours, introduced the workshop's goals for its participants and presented its methodology, as well as mobile equipment and an overview of the COMTEXT environment. Each participant received a Pocket PC to access the environment and explore it.

At first, the participants showed dissatisfaction in not being able to use the Pocket PC in other places and times outside the workplace. It was then made clear that

the reason for this was asset control due to the inherent risk in the use of mobile devices, which are frequently a target for theft in Brazil. Use was prohibited from public places and means of transportation for example.

Despite this restriction, participants showed general interest and excitement for the idea of using new technology and attending the workshop. Jokingly, they revealed their curiosity towards the originality of the experience: *"Will we get in touch with our inner child?"; "What happens if all of us connect the bluetooh at the same time?"*. These were some of the comments that made it possible to see that the use of the device made them playful (at least for some of the participants), similar to getting a "new toy".

In the learning diary, written after the first face-to-face/physical session, the participants wrote about the process of being familiar with the new technology and their respective expectations related to the use of the new technology itself. They also wrote of the possibility of use *"in everyday life"*, *"in development courses"* and in *"mobile technology implementations for students by means of the offer of services"*.

In spite of the user's deep IT knowledge, questions about its effectiveness as a solution to learning appeared in the initial participant entrees in their "Learning Diary" tool. For example: *"First workshop day. I am still getting used to the virtual keyboard. The first doubt is about the feasibility of this platform used for learning, if it depends on writing"*.

Another participant wrote the following: *"I am in building X [university dean's office building] and I am easily connected to the wireless network. I'm going toward the lake right now"*. One of the participants added *"using Skype far from my computer"* to his personal identification, using the Skype® tool with his Pocket PC.

Therefore, these initial possibilities of mobile technology generated a certain level of participant excitement and positive expectations in relation to the workshop; in the initial moments prior to the chats, in forums and instructive/pedagogical activities.

During the workshop – navigating "the open sea" - From the beginning of the workshop on, dynamic interaction and heated discussions about mobility and ubiquity were established when the participants were actually in direct contact with mobile technology.

During activity development, especially using chats that require synchronous interaction, limitations and m-learning challenges became clearer. One of the main technical limitations was the lack of wireless network coverage or connection instability on campus. Thus, on the first day the ergonomic limitation imposed by mobile devices was noticeable: data input and reading were hindered due to the device small scale and its virtual keyboard. Interactions developed in this first chat show this limitation (see table 1).

Table 1: Initial comments – first chat in the COMTEXT environment

- [Chat using the mobile device] "way too slow";

- "It is really annoying that you have to scroll all the way down whenever you write something!"

- "when you finish writing, the subject of the conversation has already changed"

- "I think that a forum is more suitable in this kind of technology"

- "next time, we should use keyboards"

- "the chat was good, but the dialog was very fast and the device writing limitations made me miss part of the conversation since I was paying attention to writing"

- "[...], please, is it possible to increase the screen zoom, because even though I was wearing glasses and with the light adjusted, I found it difficult to read the forum. […]".

Source: Research data

At the beginning of the first and second chats, two participants revealed that they did not have time to read the assigned material and three others mentioned to have read it *"very quickly"*. One participant talked about the need of organizing his time to read it, since the chat would clearly have been more productive if he had read the material. Indirectly, in other chats, it was possible to notice that the material reading frequency was not as high as expected. In the m-learning experience, similar problems related to remote activities were noticed, such as the aggravating fact that reading on the mobile device is unappealing to reading.

Other possible tools were discussed with the participants in order to make interaction through mobile devices easier, including voice chats that aim to overcome the Pocket PC virtual keyboard ergonomic limitation. However, this possibility was questioned with regards to privacy and also due to the fact that people feel self-conscious when talking to machines. It was also discussed that this use of voice would impose restrictions to interaction in some situations. How would it be possible to participate in a chat, for instance, in your workplace or in any other settings where it would not be appropriate or comfortable to talk out loud? One of the participants said: *"I have already participated in a voice chat...it is really complicated"!*

Another possibility considered was the use of games, which was regarded by the participants as easy and pleasant to use, though questions were raised about how interaction with the professor would take place while being used as a learning tool. It is important to notice that, when asked about the relevance of the professor's role, learners still consider it important, if not fundamental in the learning process facilitation. In the second chat, one of them said *More than ever, the professor has a fundamental importance in organizing the muvuca*"* [muvuca is Brazilian slang meaning "messy and crowded place"; this word was used when referring to the multi-directional and intense dialog that took place in a chat].

The word "comfort" was repeated by some of the participants when discussing MWITs. One of them said that certain processes (enrolling at the university for

instance) are sometimes difficult by PC, let alone through devices lacking *"comfort"*, such as mobile devices. As for the use of alternative media such as digital TV, another participant said: "I find it uncomfortable to watch TV on a 2.5-inch screen".

As for the chats, it was noticed that they make room for rich discussions and interactions, though they are noted for being fast and for short texts, meaning that it was more difficult to express a line of thinking or a more detailed explanation about a point of view through a chat. Given the mobile device ergonomic limitations, it was noticed that the use of chats took place more often through desktops than through Pocket PCs (access to the COMTEXT environment through desktops or through other devices had not been banned by the research team). This fact can be seen in the environment access logs. In the first chat, 70% of the logons were done through Pocket PCs, while the third chat was only 20%. There was a total of 130 chat participant logons throughout the workshop. Out of the total, 49 logons were done through Pocket PCs, 81 through desktops and 1 through iphone®.

Interestingly, the participants who continued to access through Pocket PCs were at a disadvantage, because they could not insert or read the content of the discussions at the same pace as those who accessed the COMTEXT environment through desktops.

In the forum, a meaningful level of cooperation among the participants occurred, including the exchange of links and references about mobile technologies they found interesting. The forum was seen as a more suitable tool by many participants due to the freedom it gave though its flexible schedule, which had no fixed participation time.

The level of critical vision and participant reflexivity towards MWITs were outstanding throughout the workshop. They established relations between the types of use and the implications of these technologies in their everyday life. Some of the comments were *"There are people who are very dependent on this technology; if they do not have their cellular telephone, they freak out"; "We end up being more and more isolated"*. Other questions addressed by the participants referred to consumerism and the use of technology as a status symbol. The question to be considered is whether to adopt the technology for reasons of necessity or for personal desire, or even by outside pressure. The information overload that we are subjected to with these new technologies was commented on by one of the participants as follows: *"a lot of information can be as useless as no information at all"*.

The participants extensively discussed the actual application possibilities of MWITs for both personal and professional use. It was possible to notice that the experience interested the participants since the subject being discussed concerned the experience they were personally undergoing with technology. Feelings of frustration towards some types of technological limitations were expressed (see Table 2).

Table 2: Frustration with technological difficulties (MWITs)

- "Feelings of frustration, because I forgot my charger, then my battery started to show it was getting low: (I had to leave the chat at 6 PM to recharge the "tamagotchi". Maybe this is still one of the barriers: power supply".   - "Today, I unsuccessfully tried to log on from snack bar "X", but it wouldn't log on. I went to [one of the learning centers at the University] and it was trying to find a connection, once again unsuccessfully. I spent one hour of my class break on these attempts, because I will be working today at the time of the chat. I gave up and I will try to log on through a PC."

Source: Research data

A slow-motion practical activity on the way to closing the Workshop – The first workshop week focused more on the proposed content, including the reading of instructional material and chat/forum discussions of a more conceptual nature, while constantly searching for examples and practical applications. In the second week, the creation and discussion of fictional MWITs projects for use in processes at the university were scheduled to take place, attempting to get the participants to apply the acquired knowledge and, at the same time, to develop their design and project management competences.

The development of this activity was slower than the interaction pace found in chats and forums, which was expected and can be understood through the following aspects. First, the development complexity of the project methodology is superior in comparison with other methodologies due to the fact that it involves: definition of the problem that generated the project, the forming of groups (according to individual interests), strategy definitions and planning to develop them, research, socialization of the information collected, reflection and articulation between different points of view, mutual respect, negotiation, establishing of relations through previous knowledge, and systematization originating from this process, among others. With all this to consider, cooperation is put into practice in order to achieve satisfactory results.

It was noticed that the participants were initially slow to establish work groups and ideas to be developed in projects, since everything was done remotely through chat or e-mail. Although the proposed ideas were very creative, the development of the projects progressed slowly.

Five work groups were formed (in twos or threes), but only one of them actually managed to make a clear project that was developed and delivered on schedule. Two other groups delivered the project after the end of the workshop and the remaining groups did not deliver it at all. Only two groups were really able to interact with the facilitators in order to clear up questions and improve their projects. 8 out of 13 participants completed the assignments planned, being that even with a small group it is possible to say that 38% of the participants were not able to complete the activities planned, although there were no participant withdrawals (course abandonment).

One of the participants said: *"it is difficult to gather the group for discussion"*, due to the lack of time and involvement with the work itself. Then, up to two weeks after the end of the workshop, the participants were encouraged to complete the project's practical activity.

4.3 M-learning Participant Assessment

As a complement to the qualitative analysis, data from the workshop evaluation questionnaire is presented and given at the last face-to-face session with a total of 10 respondents (see Table 3). It was also requested, whenever possible, to give detailed answers to each question.

Table 3: Results from the first block of assessment questions

#	Questions on a scale from 1 (I completely disagree) to 5 (I completely agree)	Mode	Average
	I believe the COMTEXT environment is useful for corporate training	5	4
	Using the COMTEXT environment helped the training activity to be more effective.	4	4
	I would use the COMTEXT environment again in other corporate trainings.	5	4
3	The manner in which the training was developed through the COMTEXT environment contributed to a more significant learning process.	4	4
	The COMTEXT environment tools are easy to use.	4	4
	It was easy to learn how to use the COMTEXT environment.	5	5
	I enjoyed using the COMTEXT environment	5	5
	In some way, the COMTEXT environment intimidated me.	1	1
0	I had all the necessary support to learn how to use the COMTEXT environment.	5	4
1	I felt apprehensive when using the COMTEXT environment.	1	2
2	I can say that I mastered the use of the COMTEXT environment.	5	4
	I believe that the COMTEXT environment, which is accessed through mobile devices, is more efficient for training than the traditional way (through face-to-face meetings).	2	3
	I believe the COMTEXT environment, which is accessed through mobile devices, is more efficient for training than DL (Distance Learning) using desktops.	2	3
4	I believe that other more efficient methodologies/dynamics (pedagogical practices) could be developed through the use of the COMTEXT environment from the learning process point of view, considering mobility possibilities.	5	5

Source: Research data

In order to evaluate the COMTEXT environment in corporate training processes (the system usefulness dimension), questions 1, 2, 4 and 13 were analyzed (in yellow, Table 3). The results show that respondent perception indicates the environment contributed to this kind of training. However, questions 6, 9 and 14 (in pink, Table 3) evaluate the effectiveness and possibilities of the environment in comparison with other training methods. The results express the group's perception that the environment, when accessed though mobile devices, is not more efficient than "traditional" training methods, whether physical/face-to-face or "fixed" DL method through desktop PCs. Questions 6 and 9 were the ones that generated the most detailed comments.

In these comments (Table 4), it was noticed that the advantage the environment offers (associated with mobility) is in part canceled out by the ergonomic limitations of the mobile devices and by the difficulty accessing wireless networks.

Answers to question 14 complemented the comments described in Table 4, since all the respondents agreed that other more efficient methodologies or pedagogical practices from the learning process point of view could be developed for the COMTEXT environment, considering mobility possibilities.

Table 4: adequacy (usefulness) of the m-learning solution

- "As a mobile device, the COMTEXT environment is not very efficient due to the difficulty in using its own device (typing, Internet access, etc)."

- "It depends on the course content and on the target public"

- "I think it depends on its final purpose"

- "In fact, the question is the COMTEXT environment approach; there is a lack of resources which are not available within the mobile devices scope."

- "What makes the COMTEXT mobile device easy to use is just that, mobility. Taking that away and COMTEXT is better suited for desktop PCs.

- "The COMTEXT environment resembles [...] WebCT, very user friendly".

- "I think the principle is the same [as E-learning through desktop PCs] with mobility added, which will not always be available."

- "A monitor is missing (a wider screen), and a keyboard as well"

Source: Research data

In questions 3, 5, 7, 8, 10, 11 and 12 (in green, Table 3), related to ease-of-use of the m-learning solution use, most agreed that the system is easy and that they enjoyed using it. However, one participant highlighted that this is especially applied to intensive technology users.

When the respondents were asked to classify the COMTEXT environment tools in respect to their effectiveness in learning, it was noticed that the classification was influenced by the workshop methodology. The most intensely used tools were chats and forums, being assessed as having the highest level of importance (see Table 5).

Table 5 – Importance of the COMTEXT environment tools in learning.

TOOL	ORDER OF IMPORTANCE	
	Mode	**Average**
Forum	1st	2nd
Chat	2nd	2nd
Diary	3rd	4th
Files	4th	3rd
E-mail	4th	4th
You Tube Mobile	6th	7th
Conceptual Maps	6th	7th
Skype®	7th	6th

Source: Research data

The two following questions in the questionnaire attempted to evaluate which functions were used in the mobile device in addition to the COMTEXT environment and which of them were regarded as interesting. Most respondents mentioned having accessed e-mail, surfed the Internet, using tools such as Messenger® and Skype®, as well as using other Pocket PC tools (Pocket Office®, notepad, file manager, etc). The comments made indicate that the thing that pleased the participants the most was the possibility of staying connected and having access to information in different settings.

The two questions presented next attempted to verify which tools, according to user perception, should be kept or removed from the COMTEXT environment. Except for one respondent's recommendation to remove the chat, the other respondents did not suggest the exclusion of any tools. They suggested a longer time gap between sessions and improvement of the chat, as well as the possibility to carry the mobile device anywhere.

The last group of questions assessed the development of competences allowed by experiences according to participant perception (subjective) (Table 6). The answers showed that the participants perceived the experience as a contributor to the competence development goals of the workshop.

Table 6 – The M-learning contribution to competence development

Contribution of the experience to competence development (1 to 5)	Mode	Average
Team work	5	4
Systemic vision	4	5
Communication	5	4
Creativity	4	4
Project design and management	5	5
Knowledge of MWITs and business applications	5	5

Source: Research data

5 LESSONS LEARNED AND SUGGESTIONS FOR FURTHER RESEARCH

Since this is a study in progress, in this section we seek to highlight the lessons learned so far, as well as to list questions for further research, aiming to contribute to the creation of an m-learning theory in the organizational context.

Initially, we considered the different types of mobility applied to the m-learning process: not only learner's physical mobility, but also technological mobility itself (Lyytinen and Yoo, 2002; Kakihara and Sorensen, 2002; Sherry and Salvador, 2002; Sharples *et al*. 2007; Sorensen *et al*. 2008) and the possible relations between learning, mobility and competence building. The study reveals the close inter-relationship between these different types of mobility as a condition to facilitate mobile learning in the organizational context.

As for physical mobility, learners showed interest and excitement for the innovation characteristic of m-learning, especially due to the fact they can get connected and use learning resources in different settings. This is substantiated by previous research (Jones *et al*. 2007, for instance). However, excitement turns into frustration when mobile and wireless technological limitations are faced, as well as the mobile device ergonomic limitations. These limitations have already been noted by several studies, both in the mobility field and in the m-learning field in different contexts, such as Sorensen and Gibson (2002) and Waycott and Hulme (2003). Also, as for spatial mobility versus technology mobility, it is necessary to ensure security to learners when it comes to MWIT use in different settings, avoiding theft risks related to the use of these technologies in public places, for instance.

It is noted that portability is not the only condition for technology mobility.

Maturity in mobile and wireless technologies is necessary so that user motivation can be managed through actual mobility in order to support learning. If not,

there is a risk of course abandonment as technology may keep learners from connecting (and collaborating) or being able, for instance, of properly reading texts and other materials designed for learning. When it comes to corporate m-learning, this is a particular concern, because it must foster cooperation and the development of projects or practical learning activities found in the work context, which are essential to build individual and collective competences (Boterf, 2003).

Therefore, further research is suggested to seek to develop methodologies and specific resources, which take real m-learning possibilities into account. For instance, in order to offset ergonomic mobile technology limitations, more natural interaction ideas should be studied/applied (voice, sounds, and videos). However, as the data suggests, care should be taken as to what is suitable in certain environments where the mobile worker is interacting - an important aspect in social mobility, which recognizes, among other aspects, the conventions and rules of living in different social circles (Sherry and Salvador, 2002).

As for conceptual mobility, which considers that different concepts and topics compete for a person's attention (Sharples *et. al*, 2007), the real m-learning contribution should be investigated for the development of competences in the organizational context due to the fact that mobile technology is intended for short and fast interactions, with "small pieces" of information. Trifonova (2003) shows that learning modules that are 5 to 10 minute long are more suitable for m-learning. However, competence building demands more sophisticated learning processes, which entail methodologies that stimulate learner action and reflection and not only the access to momentary concepts or fast interactions. Time and conditions for reflection are essential for "double circuit" learning, not only for superficial or immediate behavior change, but also for changes in underlying logic, which serves as a basis for certain actions – the essence of significant learning, which is crucial in building competences (Boterf, 2003; Argyris, 1992).

In this experience for example, the project methodology, due to the level of complexity it demands, aligned with the use of mobile devices in the remote learning model, involved the development of many lessons learned simultaneously. This required more time for students to get used to the processes. Aligned with these processes, we can still notice that there is a certain resistance to the methodologies that require more autonomy, creativity and cooperation, mainly in the corporate training context, which normally adopts a "passive" nature, that is strongly based on the "stimulus-response" type of the contents or methodologies, which can not manage the complexity of the competence development process (Hardless *et al*. 2001). Further research is suggested that explores other methodologies that stimulate action-reflection in learners in an organizational context, such as mobile games. However, it is necessary that the learners be able to, whenever required, interact and cooperate in games with their peers, with experts in the competence to be developed or with professors/facilitators in the learning process.

Establishing a connection between conceptual mobility and temporal mobility, one should pay attention to the overload question, since learners have to manage their work demands and their learning demands. The polychronicity/multitasking issues, which are stressed by the use of mobile technologies (Kakihara and Sorensen, 2002) could be unfavorable to effective learning.

The temporal mobility question becomes even more important with regard to time and necessary conditions for interaction within a group. Activities that demand text-based synchronous interaction proved to be limited in the m-learning experience. Those who use the mobile device in these situations are at a disadvantage in relation to other participants who use fixed computers. Likewise, interactions are based on short messages, through which it is more difficult to express a line of thinking or a more detailed explanation of a point of view.

One must investigate to what extent limitations will reduce the possibility for a needed richer cooperation, for instance, to solve work-related problems. This can be done by means of voice (fixed telephone systems or IP mobile telephone systems), but where will these interactions be recorded in order to share them in a community of practice? How can this voice content be managed, inputting the foundations of cases, solutions and ideas? Despite ergonomic limitations, asynchronous tools, such as forums, enable learners to reading and contribute at their own pace, whenever they are available or whenever they wish to participate in the interaction.

It is also interesting to notice that in one of the discussions, the role of the professor/facilitator is regarded as important, not to mention essential, to organize activities done remotely and within a mobility context. Special attention is necessary regarding the combinations, planning and instructions of practical activities. Facilitation (whether by a professor, facilitator or coach, or by specific system mechanisms or methodologies) in the corporate m-learning process deserves further research. This is particularly valid in relation to learner temporal mobility facilitation, so that individual paces are respected with collective results being achievable, in addition to meeting training deadlines, which always involve investments on the part of the organization and is a fact that can not be neglected.

Also, according to the participants it is clear that m-learning was not regarded as preferable to face-to-face training or even for e-learning in which "fixed" resources are available. Hardless *et al*. (2001) also emphasized the fact that in corporate training activities many people see it as an opportunity to take a break from their daily work routine, which can be seen as a benefit to individual quality of life and for learning itself. This results in the need of further research that will analyze how different training methods (face-to-face - physical, or through e-learning or m-learning) can accomplish synergy, leading to comfort, efficiency, stimulus and effective development for the employees of an organization.

It was noticed that the workshop participants showed a heightened critical view of MWITs, associating them with the experiences undergone and questioning their importance and impact, mainly in relation to the interaction versus isolation issue. Users were not passive in the presence the new technology. It is essential that their perceptions be considered, targeted at the quality of the development process through m-learning. Sorensen *et al*. (2008) say that mobile technologies can both promote individualization and break barriers of time and space, encouraging cooperation at work. This can also occur in relation to learning processes.

Despite the difficulties encountered, participants regarded the m-learning adopted solution (COMTEXT accessed through Pocket PCs) as suitable for corporate training and easy to use. However, it was perceived as a mobile version of a solution to e-learning. In further research, it is essential that virtual environments for mobile

learning in corporate environments have more sophisticated resources according to the nature of this new technology. This is essential in order to take advantage of worker mobility and offering location-based resources, for instance (see Ogata and Yano, 2003; Sharples *et al*. (2007).

Finally, participants considered that the m-learning experience contributed to the development of the targeted competences, although this has not been evaluated in a more objective way due to the short time of the competency activity. Methodologies to evaluate the development of competences when learners are far away and mobile also pose a challenge for further research.

This article has attempted to investigate and discuss m-learning in the organizational context through a concrete experience. Despite the limitations of the technical solution used, we consider that the application of the COMTEXT environment has helped in understanding the m-learning dynamics, the tools that work and do not work in this modality, the possible methodologies and the appropriate time needed for learning, in addition to all the other factors discussed before.

The study made results in a series of insights that can be useful to other contexts where m-learning is being planned or developed. This is an emerging and fertile field for the designing and testing of innovative solutions that explore the frontiers of possible MWITs use for organizational processes, including those related to learning.

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