MADAR Learning:
An interoperable environment for E&M learning

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Abstract- The rapid development we have been witnessing for some decades has placed digital information and computer networks at the core of most components of professional and individual life. Learning is one of the crucial fields of activity that have benefited from such technological development. During the last decade, integration of ICT gave birth to what is now called E-learning. The trend towards mobile technologies led to M-learning at the beginning of the current decade. The happening of these two learning environments has raised several research interrogations that revolve around the need to tap the progress by each one of these two environments for the benefit of the other. Our research group deals with this issue too. Coexistence between E and M learning has brought about the need for interoperability, which involves maximum use of technological breakthroughs in both environments and makes it, therefore, possible to build up an educational heritage, regardless of the technological learning tools used. We try to present our approach to create an E&M learning continuum.

Key words: E-learning, M-learning, pedagogy, mobile technologies, MADAR learning, interoperability, standard, IMS LD, adapting standards, modular architecture.

I. INTRODUCTION

Learning has always been a fertile ground for research aiming to facilitate access to information and content sharing, so as to provide knowledge, know-how and self management skills. To this end, researchers involved in learning have striven to tap technological innovation for the benefit of learning.

The rapid development we have been witnessing for some decades has placed digital information and computer networks at the core of most components of professional and individual life. Learning is one of the crucial fields of activity that have benefited from such technological development. During the last decade, integration of ICT gave birth to E-learning. The trend towards mobile technologies led to M-learning at the beginning of the current decade.

The coexistence of these two learning environments, that though they use different technologies, they share the same subject of knowledge and pedagogical approaches, induces a fundamental question concerning how to build E and M learning continuum.

Our research revolves mainly around this question. We are dedicating this article to present our vision of creating the E & M learning continuum. To target this goal, several questions arise: what are the common points between these two environments? What are the different needs behind the exchange and the communication between them? How these needs can be satisfied?

To begin with, we will present the reasons behind creating an M & E learning continuum from a pedagogic and a technologic point of view. We are going to identify, at second place, the different needs' levels of exchanges and communication between these environments. Finally, we will suggest a comprehensive and a general vision of the above mentioned continuum that we name MADAR Learning.

II. WHY AN M & E LEARNING CONTINUUM ?

A. *Pedagogic common points*

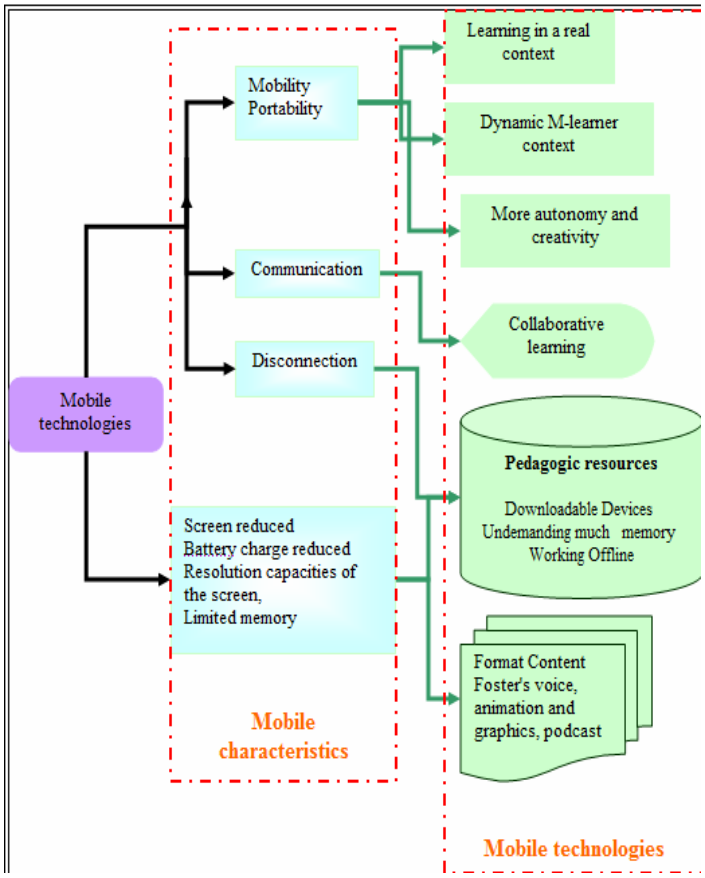
M-learning and E-learning are both distance learning environments and have, evidently, common features stemming from their context which the aim is their raison of existence . It is thus obvious that these two learning environments share the objects of knowledge that are primarily pedagogic content and support services. In fact, independently of the technological environment, the main actors in a learning situation are: The learner, the teacher, the tutor and the administrator. The process of E-learning will remain the same because it does not depend on the technology used. Consequently, the learning content, the profiles of learners and

the E-learning services such as personalization, adaptation, tutoring and administrative management of training sessions are part of the M-learning.

As for the transmission mode, it can be in real time or deferred in both the E-learning and the M-learning. The existence of a virtual environment as a platform for the learning services' provision is essential to allow each actor to perform his/her functions: trainings' monitoring, interactions between different actors and the training administration management. Spaces of discussions on the Web (blogs, wikis, discussion forums, chat and email) are also the same. Thanks to the traceability provided by these tools, they currently represent a learning platform par excellence.

The adoption of pedagogic approaches, appropriate to learning pedagogic contexts' objectives, constitutes also a common component of the two learning environments. Currently, several studies have proved the positive impact of classic technology and mobile technology on the learning process. Indeed, in these technologies, a collaborative learning centered on the learner is favored, and that is based primarily on the constructivist pedagogic approach and its successors (socio-constructivist and situational or contextual learning).

Figure N : 1 effects of mobile technologies on M-learning



We can conclude that the components forming a system for managing learning are the foundation of any learning regardless of the technologies used.

B. Technological differences

If the E & M learning share all pedagogic aspects of learning, they use, however, different technologies that influence the learning environment. Indeed, the use of mobile technologies has expanded, in our point view, learning opportunities and imposed new constraints [3] as illustrated in figure N°. 1.

To sum up, we can say that the M-learning can be considered as a new brick that can be added to the strengths of E-learning. Both environments, therefore, need to collaborate so as to guarantee coexistence.

However, we should take into account the specificities of M-learning. That is to say, to consider the parameters of mobile technologies in the adaptation of learning services and E-learning standards and platforms to be able to meet the specificities of M-learning in terms of: mobility, dynamic context of the learner, technical constraints of mobile devices and periods of disconnection.

The collaboration between the E and M learning can be fragmented into several levels (where each level includes the previous level), namely [1]:

- The communication: simple exchange of data;
- The cooperation: Seeking to target a common goal which is the raison d'être of the learning environment that includes the M & E learning;
- The integration: transparent belonging to a same entity. At this level of collaboration, the exchange of data, the sharing of tasks and the going after a common goal, are inherent since environments are integrated within the same learning environment (virtual or real).

To ensure this integration, we are faced by interoperability needs between E & M learning. What is interoperability between E & M Learning? What are the different levels involved? The following paragraphs are an attempt to answer such questions.

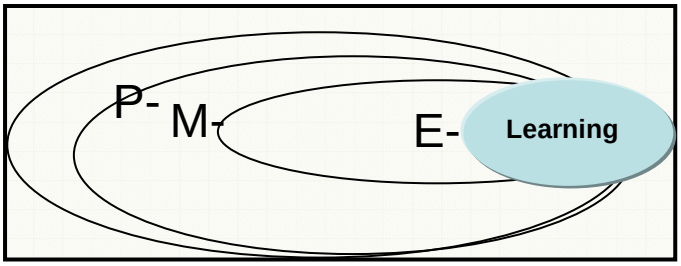
III. INTEROPERABILITY AT THREE LEVELS FOR A REAL M & E LEARNING CONTINUUM.

According to IEEE standard computer glossaries (1990), interoperability is the ability of two (or more) systems or components to exchange information and to use the information exchanged.

In projecting that definition in the field of distance learning through conventional and mobile technologies, interoperability involves securing communication and sharing of data, services and learning activities regardless of the development environments and instruments involved.

We have identified [7] three levels of interoperability, namely: lexical, organizational and technological.

Figure N ° 2 : MADAR learning: an overview



A. *Semantic Interoperability*

The content exchanged in such an environment is extremely important meaning wise, as it is designed to meet specific pedagogical objectives. Semantic Interoperability meets such a requirement. It consists in exchanging and reusing not only contents, but their meaning too.

B. *Organizational interoperability*

Interoperability between E & M learning is also of an organizational nature. This level corresponds to the need to capitalize on knowledge and past experience in E-learning and use them in M-Learning, in particular, as well as in future learning environments resulting from constant technological progress.

C. *Technological interoperability*

E & M learning environments require technological interoperability. Indeed, an independent technological environment is needed to support the technologies used by learners, so as to ensure reuse, exchange and communication of learning data, services, activities or processes.

The strategies envisaged to meet interoperability requirements include: the use of standards or families of communicating standards, the external mediator approach acting as an interpreter among components; and the use of a common communication language between modules.

The issue of interoperability between E & M learning is no exception to these rules. Solving it involves mainly: the use of standardization, along with an external mediator and common communication protocols; availing deployment environments that enable portability and mobility functions; suggesting a learning architecture that recognizes M-Learning specificities and takes advantage of E-Learning developments; and, finally, modeling distance learning scenarios in the E&M Learning environment.

In the next section we present our MADAR learning approach that seeks to respond to different levels of interoperability.

IV. MADAR LEARNING APPROACH FOR AN INTEROPERABLE E & M LEARNING ENVIRONMENT

A. *MADAR learning: an overview*

MADAR learning is an acronym for 'Mobile ADaptable ARchitecture learning. This is a learning architecture adaptable to mobile technological environments [08 ICL architecture]. It may form the nucleus of an extensible architecture for future technological environments. MADAR means in Arabic trajectory. In the solar system, the course of stars tracks "MADAR" whose perimeter evolve from one year to another. Similarly, MADAR learning tracks, within our team, a continuous evolution stemming from a consecutive integration of advanced technological devices in the field of learning as illustrated in the following figure.

The aim of our approach is to create a core of services, activities and pedagogic content that will serve to create an exploitable educational heritage via various existing and future technologies.

Besides, MADAR learning suggests a management of interactions between the various existing services and the ones specific to the M-learning. However it remains extensible and open to new learning environments, namely the P-learning. That is to say, our approach targets the capitalization of the know and the know-how in the area of learning to meet the needs of three levels of interoperability between M & E learning, at first place, and foreseen learning environments that will emerge in the future (P-learning and others).

B. *Pedagogy : the core of MADAR learning*

Since the sixties, researches in the field of pedagogic learning approaches have witnessed an extraordinary evolution, ranging from a transmissive learning to a learner-centered pedagogy.

The constructivist approach constitutes the foundation on the basis of which many other approaches, favoring collaborative and contextual work, have emerged.

All the approaches that have emerged tend to provide an appropriate learning to the learner context, while taking into account his/her physical environment and his/her own knowledge. However, in a class environment, it is difficult or even impossible to provide individualized training (depending on the needs of each individual).

Furthermore, it is difficult to create working groups and manage collaboration within the same classroom. Moreover, it is not always possible to implement the theoretical knowledge in a real context for different reasons, namely:

The remoteness of the areas of practice from the learning institutions, the difficulty of making simulations in artificial laboratories, time constraints (practice is time consuming) etc…

Moreover, it is difficult to manage learners' autonomy in the classroom in the sense that the pace of some learners might create psychological weakness problems for the others. In addition, it is impossible for a teacher to follow different rhythms and get adapted to them during a session in the classroom environment. Because of these constraints and being aware of the benefits of ICT and mobile technologies, we suggest in our approach, MADAR learning, a collaborative learning based on the socio-constructivist approach and a contextualized learning based on situational learning [5]

C. Adaptation of E-learning standard for M-learning

The communication and the reuse of content (data, services and activities), in their original senses, are crucial to ensure the success of pedagogic objectives.

The interest in this aspect of interoperability in distance learning is thus legitimate, it emanates from its raison d'être which is the transmission of the know, the know-how and savoir être. To achieve this level of interoperability, metadata are commonly used and more precisely domain' standards or ontology that link the standards of both environments. However, in the absence of specific standards for M-learning, the use of standardization is the only resort in our opinion. We have proposed adaptations of LOM and IMS LD standards in order to use them in M-learning context [2].

D. MADAR learning architecture: The layered model

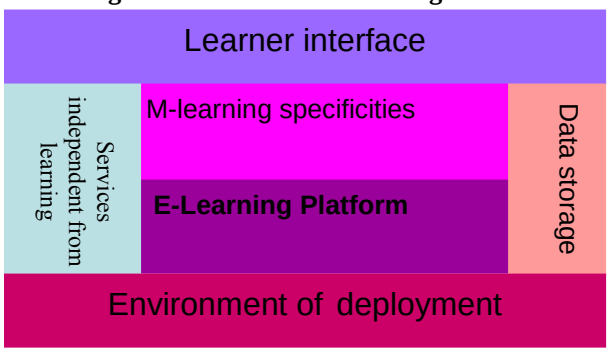
1. Characteristics of MADAR learning architecture

MADAR learning architecture must respond to three objectives, whose the achievement of one can be done only by the achievement of the other, namely: accessibility, adaptability and interoperability [4] . To target these objectives, MADAR learning must be: General, Generic, Open, Modular and independent from access equipment used by the actors.

- General : in the sense that architecture must be able to provide access to all E & M learning activities.
- Generic as far as it must provide a core of basic services common to evolving technological environments.
- Opened : in the sense that it must enable communication, exchange and exploitation of learning content, regardless of their environments of development. To achieve that, learning content should abide by the standards of the domain.
- Modular: as we mentioned earlier, our architecture must respond to evolving needs. To facilitate its extensibility of integrating new technologies, the partitioning into modules seems to be the fitting solution.
- Independent from the technology used by the actors: MADAR learning must provide independent services of access equipments be it used by learners, teachers and tutors or by the administrator.

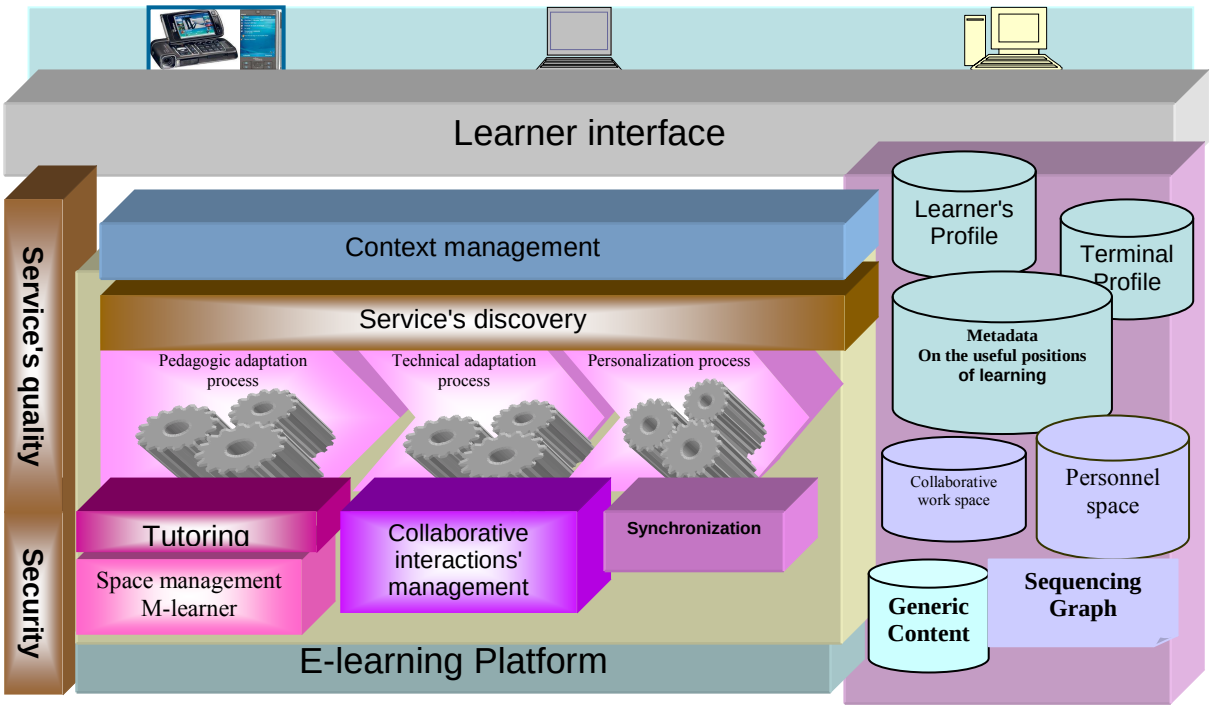
To create the continuum E & M learning we propose a layered architecture. It is based on an E-learning environment and takes into account the specificities of M-learning as well as the needs arising from the use of mobile technologies that are independent from the learning environment. MADAR learning suggests, furthermore, a deployment environment, which aims to ensure the technological level of interoperability between E & M learning. Also it provides a learner interface and a layer for data storage. In general, the functional architecture of MADAR learning is illustrated in the **figure N °3 .**

Figure N° 3 : MADAR learning: an overview



Most services of this architecture have been described in [4]. We limit ourselves in this paper to represent the layered model illustrated in figure N ° 4.

Figure N ° 4 : MADAR learning: The layered model



E. Evironment of MADAR learning deployment

The development of a technological environment conducive to the exchange, reuse of and communication between ELearning and M-Learning are extremely important elementsfor the sustainability of pedagogical materials. In this article, an attempt was made to reach technological interoperability through a deployment environment that recognizes the limitations of mobile terminals and wireless networks, while making the best use of new opportunities offered by these mobile learning technologies. It is therefore proposed that learning activities be presented as web-based services, KSOAP being strongly recommended for use with mobile devices. Taking into account disconnection periods, we have suggested the use of MOM for communications to avoid loss of messages. [3]

V. CONCLUSION

To achieve interoperability between E-learning and M-learning, we identified three levels of interoperability - semantic, organizational and technological - that respectively meet communication, collaboration and reutilization requirements.

To meet these levels of interoperability we suggested a general architecture MADAR learning which is layer based, modular, general, generic and open. We have also proposed technological deployment environment in order to take into account limited characteristics of small devices. So we opted for Web services combined with MOM in order to take into account the limited capabilities of mobile devices and disconnection periods. And to validate our proposal, we put in place a prototype enabling the user to avail a Web service without losing data, even disconnection happens. The use of KSOAP protocol allowed us to accommodate the limited capabilities of mobile devices. To be able to deploy the prototype, we chose to use open source software. This led us to select Jboss as an application server, and Java technology for learners. We also used Sun's WTK 2.5.2. emulators.

Based on our approach, we do not seek a restrained solution to E-learning and M-learning. On the contrary, we wish it to be open to possible future learning environments. In this vein, we suggested the principle of service encapsulation, whereby any service provided by an environment is to be used in subsequent learning environments, besides the very specificities of the latter. This principle offers the advantage of allowing extension of MADAR learning principle to other learning environments

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