ARIS MOBILE: Helping to define the future of mobile learning

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Abstract

The following article deals with the question on how mobile technology will be able to change and enhance the distribution of knowledge. After defining the term 'mobile learning', a summarization of how learning processes can be supported electronically is given. Moreover, chances and risks in the intersection between technology-enhanced learning and mobile business are revealed. Apart from that, prospects for the future of mobile teaching environments are scrutinized and delineated, based on the results of a research project carried out by the Institute of Information Systems (IWi) at the German Research Center for Artificial Intelligence. Deploying the prototype „ARIS Mobile", which is embedded in an integrated electronic learning environment, several test scenarios were examined in order to obtain information about matches and mismatches between state-of-the-art technology and actual applicability at the professional level.

1. Introduction

The society of the early 21st century is strongly influenced by a rapid technological development in which human knowledge and capabilities must constantly be renewed and enhanced. Internet and mobile technologies are recognized to be an innovative means to deliver the required knowledge and learning materials anyplace at anytime. Consequently, the traditional class rooms or lecture halls as physical places are loosing their importance for imparting knowledge.

After the first years of the general ubiquitous deployment of mobile systems, which was accompanied by initial enthusiasm and ensuing disappointment, subjective discussions about the potential deployments of mobile systems are increasingly to be noted. Therefore, it is time to take stock in order to scrutinize the economic and technical potentials of mobile systems. The topic of technology-enhanced learning, especially mobile learning has to be included in the aforementioned discussion as well.

2. The Mobile Learning Research Area

The foreseeable prevalent availability of wireless communication technologies in all areas of life opens new horizons for a constant support of learning and teaching processes regardless of location and time and adapted to individual needs. The development of mobile, wireless integrated learning and teaching processes as well as the provision of structured and unstructured knowledge contents is regarded as a central challenge [1]. From a scientific point of view, the different definitions of mobile learning lead to the assumption that there seems to be some disagreement in the current literature about what mobile learning actually is.

In the eLearning community mobile learning is considered under two main aspects [2, 3, 4]; on the one hand it is seen as a service providing electronic information independent of location and time. On the other hand mobile learning is researched from a technical point of view – the development of mobile terminal devices.

Current examples from real life demonstrate trends of how mobile technologies can possess a supporting function within the scope of learning and teaching processes.

The USA is today's forerunner concerning the deployment of personal digital assistants (PDA) for *school* purposes. Current projects, as the ones from Lessenger Elementary School, Madison Heights [5] or Consolidated High School District 230, Illinois [6] are less interested in providing mobile learning applications than in deploying PDA as appliances with a supporting function within the scope of these projects. In the U.S. co-operations between enterprises as Palm and educational institutions (schools and universities)

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already take place today by jointly developing software solutions.

In the field of a *university education***,** current projects are a complementation to the conventional learning and teaching scenarios. E.g. the focus of the project MeduMobile is on practically relevant training as well as on imparting knowledge within the scope of realistic situations. Furthermore the interaction between professors and students is improved by using mobile terminal devices [7].

First and foremost the project WILD supports communication and thus manages to improve the basic conditions for the interaction between professors and students in large lectures in which long-standing teaching methods are not revolutionized, but enhanced [8]. Such a strategy ensures an imperceptible transition to the application of new technologies, which has already been tried and tested with the deployment of other aids, such as overhead and video projectors with notebooks.

For the field of *professional training and further education*, the deployment of mobile learning has to achieve a productive contribution to economic increase in value. For an entrepreneur the aim and object of supporting the dissemination of knowledge by mobile technologies is to strengthen its competitive position, the increase in profit in the end. To achieve an ROI as quickly as possible on this occasion is an important decision criterion for or against the deployment of mobile learning in the enterprise [9].

Concerning *private further education* there are great obstacles to the deployment of mobile learning applications. Overpriced communication charges, low data transfer rates, lacking distribution of suitable terminal devices as well as the small availability of applications slow down the demand for mobile imparting knowledge.

3. Chances & risks of mobile learning

To identify the opportunities of mobile learning, the possible potentials for the added value of technology-enhanced learning as well as the technological value contribution of mobile business should be examined first. Yet, mobile learning as the intersection of the two aforementioned disciplines does not claim to entirely reconcile these potentials [10, 11, 12]:

- *Independence from location and time*: e-learning already creates surroundings for the learner in which he is able to grasp knowledge regardless of time. Enriched by ubiquity, mobile learning becomes a type of learning which is independent from location as well as time.
- *Personalised Adaptive Learning*: It can be proved that the success in learning is at its greatest when the learners can study in a contemporary way and oriented to an application case. By means of mobile learning a definite learning and qualification demand can immediately be identified from the respective situation and can selectively be covered.
- *Changes in the culture of learning*: technology-enhanced learning has already changed the culture of learning. Mobile learning as an extremely autonomous form of learning turns studying increasingly into an active process. Consequently, the learners are asked to take autonomously responsibility for their qualification level.
- *Integration into the course of work*: Mobile technologies are able to transfer the learning process to the current work place of an employee and unifies work and qualification. Therefore the learning process is imperceptibly integrated into the operating procedures.
- *Mobile learning in context of integrated, blended learning*: The deployment of mobile terminal devices might particularly support the communication and interaction between teachers and students during classes with obligatory attendance as the project WILD demonstrates.
- *Cost reduction*: By implementing mobile learning applications, an enterprise is able to reduce costs, e.g. traveling and accommodation expenses. Furthermore the traditional training infrastructure can be reduced. Another chance can be found in the fast and economical allocation of educational content. These can be centrally processed, updated and be put at employees' disposal.

Regardless of the aforementioned opportunities, risks can arise from disadvantages of mobile learning [11, 13, 14, 15, 16]:

- *Lack of autodidactic competence*: Many learners lack autodidactic competence, meaning the ability to organize learning processes by themselves. The reason for that is to be found in the present learning culture which is characterized by classes with obligatory attendance.
- *Lack of social contact*: Even though mobile technologies are considered as a medium for interaction and communication in particular, there is a risk that learners are isolated from each other and loose motivation. Lacking eye contact prevents the formation of real groups. That is the reason why it is especially significant to ensure the feedback between other learners or the tutor during the development of mobile learning environments.

- *Loss of privacy*: The user might feel obliged to continue his education during his leisure time. The added value of mobile scenarios runs the risk that the learners cannot withdraw from education. This can additionally be intensified by the pressure from the part of the employer as well as of the educational provider.
- *Lack of profitability*: To implement mobile technologies, high initial investments are required. Because of the shortage of business models at the moment, there is a disparity between the expenditure and a possible ROI. In terms of private users, lower mobile phone charges (compared to the fixed-line net-work connections) are crucial for the success.
- *Lack of acceptance*: Mobile learning, as a form of learning that is supposed to support lifelong learning in particular, requires that one is used to deal with technical infrastructure. Yet this is not true for each class of society or each age group. Furthermore, there is a poor social as well as emotional acceptance of computer media in wide sections of the population.
- *Lack of Standards*: So far, standardization bodies are still discussion how mobile learning scenarios and technologies will impact the common e-learning standards.

4. ARIS Mobile

At the Institute for Information Systems (IWi) in Saarbruecken/Germany, research in general is based on a close relationship between academic theory and entrepreneurial practice. IWi's research activities focus on business processes and information systems in the areas of industry, service providers and public administrations. An interdisciplinary team composed of scientific researchers is working on a wide range of topics reaching from basic research over applied research to the development of prototypes as well as technology transfer. IWi's lifelong learning competence centre deals with the design of current teaching methods and materials within the field of information systems in academic education and professional training. Also research activities in the fields of technology-enhanced learning and knowledge management are carried out.

The mobile learning application ARIS Mobile (ARIS stands for the online course "Architecture for Integrated Information Systems) was developed from 2002-2004, and is part of the technology-enhanced learning environment WINFOLine [http://www.winfoline.de], a German education network of different university chairs at the universities of Goettingen, Kassel, Leipzig and Saarbruecken. WINFOLine is a nation-wide project that is sponsored by the Bertelsmann foundation and the Heinz Nixdorf foundation as well as the German Ministry for Education and Research [17].

4.1. Why ARIS Mobile?

The lifelong learning competence centre at IWi does not see mobile learning as just another media or technology hype. It is one part of the evolution of technology-enhanced learning and has to be incorporated into a true blended learning solution. The focus of research is targeted towards:

- Encouraging new business opportunities and stimulating electronic learning products and services.
- Creating new opportunities for an extended access to learning in order to provide maximum learning opportunities to students and working professionals.
- Creating networking opportunities that stimulate new business from creative ideas.

In order to gain more knowledge about the integration of mobile technology systems into an integrated (blended) learning solution, the ARIS Mobile project aims at improving access to knowledge for selected target groups, giving them ubiquitous access to appropriate learning objects by linking to the Internet via mobile connections and devices. Direct project goals are:

- to create reusable learning objects that will be built or optimized for specific targeted subject areas chosen in the project;
- to define guidelines and identify best-practice examples of effective instructional content design for mobile environments;
- to design and implement a technology-enhanced learning reference architecture that supports the deployment of knowledge in mobile technology environments to a level where it works embedded into a complete, standard-compliant electronic learning system (represented by the WINFOLine learning management system Clix by imc Inc.) and being able to automatically restructure and re-engineer a learning object according to the requirements of technology-enhanced learning devices;
- Most importantly to answer the question whether mobile learning is a reasonable ingredient of an integrated learning solution.

However, the primary focus of ARIS Mobile is on an aspect of mobile learning that is of immediate economic significance: content delivery for adult learning and professional development enabled with adaptive interfaces. Therefore, ARIS Mobile is not addressing all the emerging areas of mobile learning in this project, but it will explore the chosen aspects in terms of all its different components.

Although the ARIS Mobile system clearly addresses a university setting, many of the project results are expected to be directly applicable and transferable to other learning areas, business sectors and knowledge domains.

4.2. A study of matches & mismatches in mobile learning

One starting point of the competence centre's research was the question whether a combination of technology-enhanced learning and mobile technologies would make sense at all. The studies within the research project lead to the following restrictions concerning the use of mobile terminal devices for the deployment of (technology-enhanced) learning:

- *System performance of mobile terminal devices*: The system performance, thus the computing power, is particularly relevant with regard to the presentation of complex learning objects (e.g. videos). Merely desktop computers, notebooks and portable computers fulfil the necessary requirements at the moment. PDAs, and cellular phones can be used for the illustration of video sequences only in a limited way.
- *Display/monitor features of mobile terminal devices*: Display and monitor features, in particular the colour depth and resolution, are of vital interest for the presentation of any content. Many appliances are still equipped with monochrome displays which impede the use of modern applications. Furthermore, the resolution of many displays does not allow a practicable application. The reason for that can be found in the lacking illustration skill of content.
- *Battery power of mobile terminal devices*: Contrary to the generic technological development in the computer industry no decisive progress with regard to the running time of batteries of mobile terminal devices has been made. Recent notebooks do render a similar system performance as desktop computers, but they are disadvantageous because of their battery power.
- *Network connection*: A sufficient transmission of text and pictures is guaranteed by means of the available cellular technology (GSM, GPRS) at the moment. A transmission of videos is connected to unacceptable delays though. Only the extensive implementation of UMTS, for example, is going to allow the transmission of broadband media.
- *Input devices / operating devices*: Because of the small size of PDA cases and cellular phones the size of their operating devices has to be reduced considerably. Cellular phones are exclusively controlled by an alphanumeric block and operational keyboards. Contrary to that, PDAs possess either a touch screen display or small foldable keyboards. The disadvantage of these operating devices becomes evident when frequent and complex user interventions are carried out.
- *Programming languages*: Cellular phones and smart phones merely support the programming language HTML insufficiently or not at all. Older PDAs are often only capable of illustrating HTML pages in a limited way as well. The performance of Java applets necessary for interactive learning environments is only partly possible. WAP offers a further opportunity to illustrate contents at the moment, yet it is only accepted poorly because of its bad image.

4.3. Preliminary observations for implementation

For ARIS Mobile, the development of learning objects itself and the system was first based on accessible results of the R&D community. E.g. the general requirements for technologies to support contextual lifelong learning by Sharples [19]:

- *high portability*, so that the system is available wherever the user needs to learn, and to enable communication with teachers, experts and peers;
- *individuality* for adapting to the learner's abilities, knowledge and learning styles;
- *unobtrusiveness*, so that the learner can capture situations and retrieve knowledge without the technology obtruding on the situation;
- *adaptability* to the context of learning and the learner's evolving skills and knowledge;
- *persistence*, so that resources and knowledge will be immediately accessible despite of changes in technology;
- *usefulness*, suited to everyday needs for communication, reference, work and learning;
- *easy to use* by people with little previous experience of technology.

In terms of guidelines for designing learning material, the own experience of the competence centre in content design was taken into account as well as results by highly recommended institutions like the Stanford Learning Lab [19].

Mobile learning applications have to be designed with special care and sometimes different to a technology-enhanced learning system that is used in an office environment. With respect to these preconditions ARIS Mobile meets the following requirements:

- *Minimized learning objects*: Learning chunks given to the user in a mobile environment are discrete in order to enhance the possibility of being grasped by the learner until the next distraction occurs.
- *Designing review concepts*: Distractions bar learners from digesting new learning content. Thus, learning objects for mobile environments give the opportunity to practice and repeat familiar content.
- *Minimized compulsory interactivity*: Learners should not feel pressured by the system to interact. The possibility to fade out if needed and to reengage afterwards where the learner left off is crucial.
- *Familiar and forgiving interactivity*: Because attention is divided complicated instructions may not be easy to follow. Therefore, simple and familiar interaction modes like quiz exercises are necessary.
- *Personalized, adaptive interactivity*: The learning experience is adaptive to personal learning styles. A learner should be able to specify the complexity of the lecture according to her/his personal and current state of mind and local situation.

4.4. Implementation

The additional implementation within the existing learning environment was divided into content creation and system implementation. The goal was to enable learners to access the WINFOLine LMS via any wireless, browser-based device, and to design the content in a way that would require no extra packaging for delivery via Mobile.

The content was realized by using the learning objects that had been created for the PC version of the ARIS online course, but using different XML-based style sheets that were designed for smaller displays of mobile devices. The XML templates produce the course pages during runtime in order to give the students just the right design for the technical device that they are using at that time. The offline content is stored in files that can be downloaded either as pdf files for notebooks and PDAs or as Palm text files if students wish to use Palm devices.

The learning objects are stored in a learning object repository (LOR) from which the proper illustrations and content are drawn automatically and processed for the respective device the student is using. E.g. the templates for PDA devices were designed in the manner of index cards (enriched by small videos and entertaining flash animations) that can be used for a quick reflection as the students are on a bus ride to university (see figure 1).

Figure 1: ARIS Mobile PDA client

The learning objects and XML-templates meet the design guidelines of the WINFOLine network that had been made for the use of PC-clients in the first place but were extended for mobile displays during the ARIS Mobile project. These guidelines are geared to international standardisation initiatives such as the one's of IEEE/LTSC, AICC and SCORM, but they are extended by certain media didactical rules that seemed to be more adequate for WINFOLine than the recommendations of the respective standardisation bodies.

Basis for the technical implementation was the existing technology-enhanced learning architecture of the WINFOLine network (figure 2).

A CLIX Campus® learning management system (LMS) serves as the technical basis that meets up-to-date standards, e.g. client-based course and user management, etc. It runs on a central server at the University of Goettingen, while the content is stored in decentralized LORs at all WINFOLine sites throughout

Germany. Therefore the content for ARIS Mobile is stored within the LOR at Saarbruecken, while students access it via the LMS in Goettingen. Learners connect to the LMS online with their mobile devices and either choose to learn online or download content for offline use. In terms of exercises for example they are able to solve questions while being offline and send back the results during their next online session.

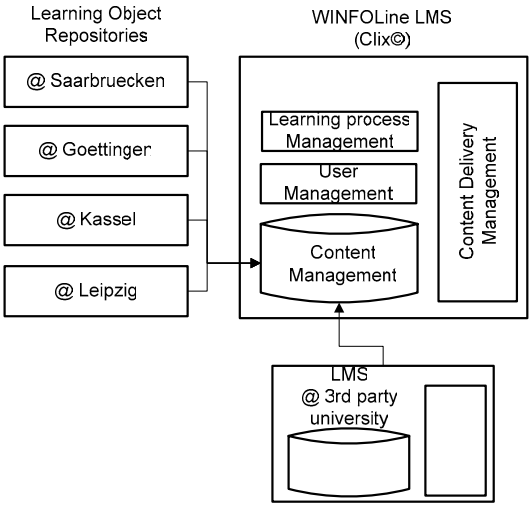

Figure 2: WINFOLine system architecture

5. Summary and Further Work

This paper illustrates that technology-enhanced learning has didactic as well as economic advantages over the traditional learning scenarios. For the learner this involves the flexible organization of his/her learning process with regard to study location, study time, study length, study method and learning content. From the learner's point of view a characteristic of technology-enhanced learning is the increased individualization of the learning process, which is particularly revealed by self-control to a large extent. From the supplier's point of view the fast, and location independent distribution of products, a quick, rather cheap, and efficient creation and update of new learning contents are the advantages over traditional learning scenarios.

The findings from the ARIS Mobile project are still being used and extended at the University of Saarbruecken. Also, they are shared with several European partners in the working group of the European PROLEARN project, called "Interactive Media".

Within the European 6th Framework Programme of the European Commission, IWi helps to co-ordinate a Network of Excellence (NoE) for the integration of R&D and practice in Technology Enhanced Learning. The network "Professional Learning" (PROLEARN) [http://www.prolearn-project.org] focuses on two key issues for future eLearning scenarios and contexts, namely state of the art technology enhanced learning resources and the use of these learning resources for professional training, especially in small and medium-sized enterprises (SMEs) [20].

PROLEARN brings together the most important European research groups in the aforementioned area, as well as key organisations from the corporate world in order to bridge the existing gap between research and education at universities and corporate training scenarios within companies.

Within the Interactive Media group, the results of ARIS Mobile are reflected and enhanced, in order to provide possible solutions that will be used in corporate, professional learning scenarios. As a result of the research work on the approach, SMEs are enabled to introduce technology-enhanced learning strategies.

The ongoing work on this topic is developed and validated at the IWi and disseminated through other projects as well, for example in the project KEG Saar

The Competence Centre for Electronic Commerce (KEG) Saar [http://www.keg-saar.de] is one of 22 nationwide regional Competence Centres that have been sponsored by the Federal Ministry of Economics and Labour over the last six years. The centre focuses on regional areas and supports SMEs in the introduction and use of modern information and communication technologies to increase their competitiveness.

KEG Saar started in October 1998 with a range of services for SMEs. It is aimed at all industrial and commercial companies as well as service and craft businesses. Building on the three areas of information, consulting and qualification, it developed numerous activities which were intended to increase the regional companies' awareness of electronic and mobile business. The team of KEG Saar covers a complete lifecycle, from analysis and consulting, to a complete concept definition, implementation and continuous improvement. Thus it helps SMEs to find the most suitable IT strategy and to implement tailor-made solutions for their special business requirements [21]. In this context KEG Saar also introduces enterprises to technology-enhanced learning and mobile business solutions.

ARIS Mobile and other prototypes serve as showcases in the project's demonstration centre where company representatives get a feel and look for state of the art IT solutions. Interested enterprises can test different types of mobile applications in real-life situations. Within the context of guided tours, workshops and trainings the entrepreneurs not only learn about the use of IT systems and application software, they also re-

ceive suggestions on how the use of mobile technology can help them to arrange their business processes more efficiently.

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