Mobile Learning contexts for problem-solving competence assessment at higher education

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Abstract. The leitmotiv and the real objective of this dissertation are to focus on new learning paradigms and contexts around mobile devices and problem-solving competence. This research begins with a thorough review of literature and other related works. It analyses them and extracts a number of conclusions regarding the reasons for the lack of specific Knowledge and Learning Technologies for mobile learning scenarios at higher education. Then, based on the trend of mobile computation and doing many activities in mobility, and the limitations encountered in the existing current teaching-learning processes, the dissertation proposes to create a new framework for mobile teaching-learning at higher education. Although some researchers offer a framework for theorizing about mobile learning, lecturers do not have yet a guideline about how to integrate mobile learning into their teaching more effectively.

Keywords: mobile learning, collaborative learning, competence based learning, Knowledge and Learning Technologies

1 Introduction

Across the past two decades Information and Communication Technologies (ICT in advance) have become ubiquitous in many aspects of life, changing the practices and procedures within organizations and having the potential to improve many aspects of them. Generally, ICT is a tool that any sector can use to deliver its services, since communication among people has become independent of physical distance and time. ICTs, in consequence, are transforming all human activities that depend on information, including education services. Education and learning, as a social process of individual growth and skill acquisition is derived from its social context. However, this social frame has been radically changed by technology in general, and ICT particularly; therefore these technologies should be included in the educational processes, in all the stages of the education process (designing and developing educational resources, teaching, evaluation, tutoring, etc.). Accordingly, the ICTs for education we use at the University of Deusto, what we call Knowledge and Learning Technologies (KLT in advance), are particularly stressed in the uses we can make of them for learning and knowledge acquisition.

A report from the McKinsey Global Institute[1] of May 2013, selects a dozen of disruptive technologies, being Mobile Internet the technology with the most outstanding one. Mobile learning technology is gaining a wide acceptance in education as it is opening many possibilities. Current smart phones are not just phones; they are computers in students' pockets. If mobile technology is an effective learning tool, it is especially among active mobile technology users, such as most university students. According to comScore's 2013 Europe Digital Future in Focus report[2], 57% of EU5 (France, Germany, Italy, Spain and United Kingdom) mobile users owned a smartphone in the 3 month average ending December 2012. And, according to comScore's 2013 Spain Digital Future in Focus report[3], 81% of new phones acquired in December 2012 in Spain were smartphones, so that is the country in EU5 which shows a highest penetration in Smartphones with 66%. Already, almost 4 million Spanish people had a Smartphone as well as a Tablet in December 2012.

In general, m-learning is a learning activity that takes place without considering a fixed location [1]. It emphasizes the ability to facilitate the learning process without being tied to a physical location [2]. A number of researchers have investigated the applicability of mobile technology in the learning context. Taylor et al. [3] have identified a number of examples for how mobile technology can be adopted in the learning environment, taking into consideration the user behavior, technology infrastructure, and environment structure. So, the interest in this dissertation is not only how learning occurs in a variety of settings and contexts, but also how learning progresses across contexts using mobile devices.

Besides of the new teaching-learning context produced by the new human-computer interaction paradigm mobile learning provokes, there is a new education model oriented to the development of competences among the students. Society is demanding new competences of its professionals and citizens in general, who are required to have specific skills and abilities. So two positions can be adopted: building on these competences in the professional sphere, or developing them within the academic sphere prior to a career. Among these competences, this dissertation wants to focus the analysis in problem-solving competence due to the increasing relevance is getting in developed countries. In an analysis with data of the U.S. Department of Labor made by Greiff et al. [4], it was found that computerization was associated with a reduction of routine tasks and a correspondent increase of complex tasks [5], as well as a boost on demand for professionals who perform non-routine tasks, so-called abstract tasks that require problem-solving, intuition, persuasion and creativity. These tasks are characteristic of professional, managerial, technical and creative occupations, like science, engineering, advertising, law, or medicine among others. People in these jobs typically have high levels of education and analytical capability, and they benefit from computers that facilitate the transmission, organization and processing of

[1] http://www.mckinsey.com/insights/business_technology/disruptive_technologies
[2] http://www.comscore.com/Insights/Blog/2013_Digital_Future_in_Focus_Series
[3] http://www.comscore.com/Insights/Presentations_and_Whitepapers/2013/2013_Spain_Digital_Future_in_Focus

information. This development has been observed in a number of countries and appears particularly distinctive in service-oriented Western economies ([6], [7]).

However, traditional instructional design models and classroom settings, which remain the norm in formal educational settings such as the one we have at higher education, have some limitations when it comes to addressing problem complexity. So, accordingly, in this dissertation, we are going to consider Bloom's Digital taxonomy to classify KLT that could be applied in mobile learning contexts for the development and assessment of problem-solving competence. We consider this taxonomy as a proper reference because all the communication spectrum's actions fit to the activities that we develop within the teaching and learning processes under our University of Deusto's Learning Model [8], which allow accomplishing deeper level of knowledge generation, besides promoting creativity, personal initiative, critical thinking and the achievement of shared learning objectives [9]. Corbeil et al. [10] summarized the benefits of mobile learning as great for people on the go, having access to content on mobility.

When technology-based tools serve as frame in learning environments, they are often called cognitive tools, which, according to Jonassen [11], are "*computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher order learning*". Research has shown that cognitive tools have the potential to facilitate knowledge construction, support conceptual understanding, and scaffold higher-order cognitive tasks within complex learning environments ([12], [13], [14]).

2 Problem description and motivation

The leitmotiv and the real objective of this dissertation are to focus on new learning paradigms and contexts around mobile devices and the development and assessment of problem-solving competence. This research begins with a thorough review of literature and other related works. It analyses them and extracts a number of conclusions regarding the reasons for the lack of specific KLT for previously stated contexts. Then, based on the trend of mobile computation and doing many activities in mobility, and the limitations encountered in the existing current teaching-learning processes, the dissertation proposes to create a new set of web services to gather and later exploit data from the interaction the student makes with the selected KLT for supporting of the activities proposed by the professor for problem-solving competence assessment.

Although some researchers offer a framework for theorizing about mobile learning, lecturers do not have yet a guideline about how to integrate mobile learning contexts with the support of KLT into their teaching more effectively. The University of Deusto, under its 2011-2014 Strategic Plan, is committed with the integration of learning technologies in the teaching-learning process to achieve academic excellence. So, a major task for educational evaluation is to identify and analyze learning within and across contexts. However, competence-based learning and its later assessment in mobile contexts has not been faced yet. At the same time, the use of mobile

devices at class with learning purposes and the mass introduction of KLT at class, have to get off the ground in the field of higher education. There are a number of reasons for this:

- There is no sufficient consensus for efficient and useful KLT at class, and thus, there cannot be an institutional push for the use of them.
- As a consequence, it has not yet been possible to establish neither a common or standard framework, nor a methodology, nor specific tools to model competence-based learning scenarios.
- Other research projects propose the use of mobile devices to enhance and complement some teaching and learning activities, but not for the sake of studying learning contexts itself.
- Other researchers have approached the notion of mobile devices at class regarding the tool, without considering its possible uses and integration in teaching-learning environments.
- Existing mobile learning successful experiences have been developed in an adhoc manner and need a number of pre-requisites in order to work properly. Besides, this experiences require huge hardware investments and heavy data-load applications, what greatly restricts the use of mobile devices
- Although Mobile learning settings show positive benefits, there has been little empirical work done to translate them into the learning outcomes to get after the competence development and its correspondent assessment.

3 Goals, hypothesis, assumptions, limitations and scope

Based on what has been explained so far, this dissertation aims to: firstly, construct a theoretical framework to model mobile teaching-learning contexts with the support of KLT at higher education and, secondly, to carry out an experiment to test the suitability of introducing those contexts at higher education for the development of problem-solving competence throughout KLT at mobile devices. The information gathered will be used to help ascertain the methods and strategies that should be incorporated in future courses to improve learning effectiveness, so that we present a forecast of experimentation and evaluation of formal experiences and proposes future research.

The focus will be problem-solving competence, since it is considered one of the most challenging ability students must gain, and one of the most important skill students could develop throughout mobile devices. We propose a catalog of KLT to use in mobile devices conducive to the assessment of this skill in those scenarios. Under the main question of exploring Mobile Learning effectiveness in the assessment of problem-solving competence, the general research questions that have guided the piece of work proposed in this dissertation are: 1) Is the integration of mobile learning experiences in higher education effective in terms of students' perception and results?; 2) Are KLT in mobile applications suitable to support the development and

assessment of competences?; 3) How do Mobile Learning and KLT influence students' work while solving problems proposed by the teacher?

Considering these three questions, this dissertation describes a framework proposing Knowledge and Learning Technologies that could be used in Mobile Collaborative teaching-learning scenarios for the assessment of problem-solving competence at higher education. Rather than developing new KLT suitable for the research questions proposed, the Framework uses existing KLT and students' Smart Devices, taking into account the following premises: Students' Smart Devices is the gadget that will allow the interaction for the activity completion; WiFi and 3G/4G connections, depending on the availability, will be mobile communication technologies; Bloom's Digital Taxonomy will be employed to classify KLT suitable for each context and learning outcomes of problem-solving competence.

The work presented here addresses two very important research areas: Mobile Learning and Competence Assessment. The previous paragraphs introduced the challenges that must be faced, so based on them; we enunciate the main hypothesis of our research as follows:

> *It is possible to develop a set of web services that extract interaction data between the student and KLT on mobile learning contexts to assess students' performance. Those web services will gather data from institutional KLT, these are Google Apps for Education and Moodle, that will allow teachers to provide feedback to the students of the followed resolution process, and thus, improve their results in the future.*

In order to validate the hypothesis, we must design and develop a data gathering web services and validate them experimentally. So, the general goal of our research is:

> *The development and test of a set of web services that will gather interaction data between the student and the KLT proposed by the teacher in mobile learning contexts, capable of providing to the teacher enough data to improve students' problem resolution strategy.*

Four specific goals arise from this general goal, as described below:

- **Specific Goal 1.1**. Provide an API to integrate these web services in and across Moodle Learning Management System and other related educational software.
- **Specific Goal 1.2**. To design and model Mobile Learning contexts supported in KLT that result in a new definition of teaching-learning settings.
- **Specific Goal 1.3**. To check if we can improve technology enhanced digital learning scenarios taking advantage of existing mobile communications, mobile devices and users' knowledge.
- **Specific Goal 1.4**. Identify interesting interaction parameters between the student and the KLT in mobile learning contexts.

These specific goals focus on the need to study these new teaching-learning scenarios from a completely new perspective and address on of the major limitations of current

educational settings: not to be taking advantage of mobile devices, which generates an opportunity cost in the whole educational processes (contents cannot be studied from mobile devices, lecturing at class is not adapted to be compatible with mobile devices, cheating at traditional exams is quite easy with mobile devices, etc.).

These specific goals will be accomplished, and hence the general goal and hypothesis, by means of a number of operational goals:

- **Operational Goal 1**: To establish the state of the art in Mobile Learning and its use in competency-based learning models.
- **Operational Goal 2**: To establish taxonomy of KLT to use in Mobile Learning contexts for competence assessment.
- **Operational Goal 3**: To design and implement a data acquisition web services over Google Apps for Education according to the indicators of problem-solving competence.
- **Operational Goal 4**: To design and implement a procedure for the automatic analysis of the results.
- **Operational Goal 5**: To apply, implement and use these web services to obtain model results.
- **Operational Goal 6**: To design and implement a set of metrics to measure the results of these new learning contexts.
- **Operational Goal 7**: To design and implement a set of criteria to select the best KLT, according to the requirements and nature of a given subject.
- **Operational Goal 8**: To test and validate the proposed methodology.
- **Operational Goal 9**: To design and implement experiments by using for the assessment and the improvement of students' strategy our web services.

4 Research methodology

Seeking to achieve the goals marked and defined to validate the hypothesis, we propose a research strategy that includes the following steps:

1. **Acquisition of knowledge** through constant review of publications that advance the state-of-the-art techniques for spam filtering and detection, and by attending conferences that bring together scientists involved in advancing the state-of-the-art.
2. **Design and development** of models and applications that allow endorsing the validity of the partial hypotheses and open new avenues of research.
3. **Experimentation and evaluatio**n of the results obtained with the aforementioned models.
4. **Redesign the models** created, following the feedback obtained in the experimentation.

5. **Presentation of preliminary results** to the scientific community to obtain feedback to help validate the followed path and see if the contributions manage to offer a real advance in the state-of-the-art.
6. **Validation and diffusion** of the acquired knowledge and learned lessons to the scientific community.

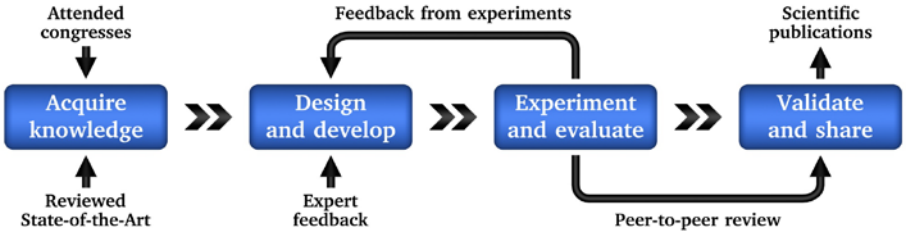

Figure 1. Schematic view of the research process.

The figure shows graphically the schematic view of the research process, with the main activities that take place and the flow of input and output that feeds the process. In addition, in order to implement and evaluate the prototypes and the partial approaches resulting from the investigation, we choose the Action Research methodology [15], a cyclical methodology that comprises the following steps [16]:

1. **Diagnosis**: identify or define a problem.
2. **Planning**: consider the different alternatives of action.
3. **Action**: select the action to take.
4. **Evaluation**: study the consequences of the action.
5. **Definition**: identify and detail the overall findings.

These steps will be taken into account throughout the research process to provide scientific rigor and critical thinking to all the activity.

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