Mobile learning in a Real-World Construction Engineering Scenario

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Abstract

In this paper, we will present a learning scenario dealing with health and safety aspects in construction engineering. The scenario consists of two parts: first, a number of classical classroom sessions dealing with the theory, and second construction sites will be explored to identify and learn more about the health and safety aspects in a real-world context. The real-world scenario will be mediated using mobile devices, which will be used to deliver learning content tailored to specific learning situations. Moreover, students will use mobile devices to create their own learning content; a range of multimedia annotations portraying possible health and safety aspects in real constructions that can be used as a basis for later discussions.

1. Introduction

Mobile devices offer unique possibilities for supporting authentic learning in real-world contexts. Apart from the ability to access relevant course information on-spot, the portability and increasing capacity to create multimedia content allows learners to create their own learning content, whenever and wherever they encounter it. Moreover, in combination with more traditional, classroom-based settings, mobile learning makes it possible to apply theoretical knowledge learned in a practical scenario and reflect on the applied knowledge later, possibly even in a classroom wide discussion.

In construction engineering, students have to learn how to apply the theoretical knowledge in the curriculum to real-world construction work scenarios. While currently most of the teaching is theoretical and classroom-based, students would benefit by actually seeing the principles applied in real construction work. Not only does such an exploration give students the opportunity to encounter real-world examples of knowledge applied, it also actively involves the students in the learning process and compel them to apply the theory just learned [1]. To try and reap most benefit out of these practical learning situations, in this paper, we will present an application example scenario for supporting on-the-spot health and safety risks management learning mediated by mobile devices.

The paper is laid out as follows. The next section, gives a short overview of how e-learning is used to support construction engineering education. After that, section three presents the advantages of mobile learning in general that is immediately followed by section four that gives one specific example of applying mobile technology to support learning the health and safety aspects in a real-world construction engineering scenario. Section five will then describe the context of our research and bring forward the ContextBlogger tool that we will use in our scenario. Last, section six concludes the paper with a discussion and an outlook to further research in the field.

2. E-learning in Construction engineering higher education

The implementation of e-learning into the construction education domain has had a slow start but is now catching up with other fields[2]. As a consequence, its potential has just started to be explored and applied within this domain.

The instruction methods used in the majority of construction, engineering, and management curricula rely on traditional methods such as exposing students to applied science courses [3]. However, most of the times, the theoretical concepts learnt with these traditional teaching methods are not effective enough in providing students with all the knowledge necessary in the real construction world. Students need to complete their construction and management courses by participating in real-life simulations improving and

motivating them to learn by doing, learn by practising, making mistakes, reflecting on why those mistakes were made, proposing remedial actions and trying them out. Therefore, the use of information technology for educational purposes, such as e-learning in general and simulations in particular, have the potential to act as excellent tools to complement construction and management education [3]. This conclusion was also obtained after a three-year longitudinal study carried out by the University of New South Wales, Australia [4], aimed at investigating the feasibility, effectiveness and viability of e-learning in construction management education and the students' preference between e-learning and traditional face-to-face learning.

In any case, bearing in mind the advantages of e-learning and the studies carried out by lecturers and students in higher education, the use of e-learning solutions in construction management education seems to become more and more popular, being it total e-learning, or blended with face-to-face teaching, depending on the nature and purpose of a course [4]. Consequently, the development of e-learning tools specifically for construction education is nowadays continuously growing [2, 4-7]. A majority of these tools, however, address the formal, theoretical learning, while the practical, on-site scenarios are mostly left unsupported. The use of mobile technology to support the learner in real-world construction site scenarios could have, we think, an important role in getting the most benefit out of these practical sessions.

3. Using mobile technology to support learning in the real-world

The recent popularity of mobile devices has made access to a wide range of multimedia content, personal information, and social peers, available nearly anywhere, anytime, anyplace, and with one device [8, 9]. The processing power and multimedia capabilities of modern day smart phones have made mobile devices more and more interesting to support learning outside a normal classroom context. Already, several projects have considered and investigated mobile learning support, most notably [10, 11]. Recent research, increasingly takes into account some context information about the learner, to tailor the delivery of learning content [12]. Especially location-based systems, aimed at providing suitable learning content at a certain location, have been largely considered [13, 14].

In this sense, Ogata & Yano [15] have also identified five characteristics of mobile technology, that make it suitable for learning. First, mobile technology offers *permanency*; learning processes are recorded continuously which allows for later reflection of learning about knowledge. Second, learning content is *accessible* anywhere, and third, *immediate access* to content allows learners to store and retrieve learning content at anytime. The accessibility and immediacy of content access makes it possible to use content in authentic situations, and to tailor it to the current need of the learner. In this sense, also the fourth characteristic, *interactivity*, and the fifth, the *situating of instructional activities*, allow for a better adaptation to the learner's current situation and for a more active learning situation. One way of adapting to the learner's current situation is by using information about the context of the learner. Context information can give details about individuality, time, locations, environment or activity, and social relations of a learner[16], which can be used to tailor the delivery of learning content.

A blended learning scenario that integrates mobile learning combines de-contextualisation and contextualisation of knowledge; theoretical knowledge learnt in a classroom setting could be transferred into practical knowledge in a real-world scenario. Moreover, through using context information, in combination with the creation or retrieval of learning content, several educational effects can be achieved:

- *Multiple perspectives on real-world objects*: by viewing and creating content in a real-world context, several opinions can be perceived and expressed, from which people can benefit through an indirect learning process [17].
- *Community-generated content* connected to relevant real-world objects and locations; an example for the effect and importance of self-generated contents in a learning community is presented in [18] about learning to operate medical devices.
- *Community interaction* and the creation of communities of interest around certain objects and locations, supporting contextualised learning [19].
- *Different views on objects based on personal preferences*. Real-world objects can also be linked electronically to create relations between those objects and to create a so-called "internet of objects" [20].
- *Recording of learning events;* allows for later reflection and eliciting of expert's knowledge,

carried in a work context during or shortly after the actual action performed, are given by [21, 22].

- *Learning content tailored to a specific learning activity*; in the sense of cognitive apprenticeship [23] the learner is guided towards appropriate levels of knowledge by a constant process of contextualisation and de-contextualisation of knowledge. Cognitive apprenticeship furthermore assumes this guidance takes place in an authentic learning situation.
- *Increasing motivation through active learning*, by actively involving the learner in the learning process, the learner involvement and motivation is increased. This as opposed to passive learning in a formal, classroom setting [1].

Summarising, contextualised media enables the learner to create, retrieve, and use digital media in a relevant real-world context for notification, documentation, problem solving, reflection, communication and a variety of other learning activities.

4. An application example

Construction cannot be learnt purely from theoretical and linear lessons; it must be investigated, attempted, engaged with. This use case scenario is concerned with the application of e-learning solutions in a Health and Safety Management course, which is part of some Construction Engineering Masters.

The aim of this course is to provide basic knowledge of health and safety risks identification, health and safety preventive measures and health and safety regulations. Therefore, the course provides the know-how that will enable the future construction project managers to analyse and identify the health and safety risks, existing in a real construction site, in a clear, concise and comprehensive way and to choose the better and more efficient preventive measures to solve these risky situations.

By now, this course is based on face-to-face classes where all the theoretical contents related to health and safety management are taught. All the contents are verbally conveyed by the instructor, who acts as the expert on the subject matter. Most of the times, these contents are enriched and complemented with images, schemas, and sometimes even videos, which are used as examples of real situations in construction sites.

However, and aforementioned, this kind of knowledge is not enough for future construction project managers, who will be working most of the day at a construction site and not only in an office. Therefore, students need to know how a construction site works, as well as all the aspects that involve it in order to better understand the need and the complexity of the health and safety management and all the theoretical concepts learnt at class.

For this reason, some changes are introduced in the structure of the subject that now is divided in three different modules. First, in module one the instructor exposes all the theoretical contents (health and safety risks identification, health and safety preventive measures and health and safety regulations) stressing the importance of the real-world construction examples and the use of digital contents, existing in repositories in the web, easily accessible for students.

Second, module two aims at developing a workshop based on a real construction site. Students are provided with drawings of the current real state of the building. Then the group of students (15 people maximum) is moved to the construction site, where the person in charge of the security of the site guides them through the site. Students are asked to identify the existing health and safety risks, and the applied or missing preventive measures which they should draw on the provided drawings. Digital contents exposed by the instructor in the theoretical lessons can be reviewed by using their smart phones which allow the owners to access the World Wide Web. Hereby, students can check their work and improve their learning outside of a normal classroom context and without the need to carry their paper notes everywhere. Additionally, students are also advised to take some pictures of the applied or missing preventive measures to be used afterwards in the reflective session at class.

Last, module three is aimed at collecting and sharing all the students' reflections and observations using the drawings and pictures or videos recorded along the construction site visit.

At the end of the course, students have gone through all the theoretical concepts related to health and safety management, they have been involved in a real construction site where all these theoretical solutions are applied and finally they have been asked to assume the role of the health and safety risk manager checking the security of the site. Most of the learning process can be supported by e-learning solutions, some of which are described in the next section.

5. E-learning supported by MACE

In order for students to build a better understanding of the concepts contained in the course, it is important that all the concepts exposed in the theoretical lessons can be reviewed by the students in real-world construction site scenarios. For this reason, the digital educational material available in the theoretical lessons should also be easily accessible during the practical session, for instance by using smart phones capable of displaying rich media content.

Different web-portals focused in architecture and construction have been developed, however most of them present gaps in accessing information, the content provided is unstructured or only related to a specific field. To solve these problems the MACE project (Metadata for Architectural Contents in Europe) sets out to transform the ways of e-learning in architecture and construction in Europe. It will integrate vast amounts of content from diverse repositories created in several large projects in the past, and build a framework for providing community-based services such as finding, acquiring, using and discussing about e-learning contents that were previously not reachable. Furthermore, MACE aims at providing innovative tools to search, create content and enrich it with new metadata, which can be used to support the learning scenario described in this paper [24, 25]. Several kinds of metadata are used in these tools to provide different perspectives on the learning content, and find new ways to combine them. For teachers, it will become easier to find and organise appropriate content based on the competence, context, and process metadata provided.

Also, the ContextBlogger tool makes it possible to access the learning content almost anywhere on mobile devices. Additionally, mobile access makes it possible for learner to create their own learning content and store contextualised metadata, like for example location context, with it. Hence, the tools available in MACE will offer unique opportunities to address the various modules mentioned in the application example.

6. Discussion and Outlook

In this paper, we presented an application example of learning health and safety aspects in construction engineering via a blended learning scenario. The presented scenario integrates different forms of learning; traditional classroom-based instruction, an on-site real- world learning scenario supported with mobile devices, and finally a reflective session to summarise the learning experiences.

The example integrates several tools of the MACE project that will be used to support the three modules; in module one, the mace portal and the search tools will be used to provide the teacher, as well as the students, with the theoretical background needed. The ContextBlogger software will then be used to support module two, by allowing the students to create their own learning content, as well as reviewing the already learnt theoretical knowledge in an applied context. Finally, by being able to record the learning experiences in the real-world context, we think the sharing of experiences, reflections and observations in module three will improve. In order to evaluate the potential, effectiveness, and the advantages of the available MACE tools for construction education, we plan to carry out an experiment that has the application example as a guideline. Especially, the effect of mobile learning tools in a practical construction engineering context will be evaluated. The experiment will be carried out with fifteen students, currently involved in a health and safety management course which is part of the International Master in Construction Project Management taught at the Technical University of Catalonia (UPC).

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