Awareness for Contextualized Digital Contents in Ubiquitous Learning Environments

Abstract. This paper describes the idea for a research project at the Open University of the Netherlands, focusing on awareness in ubiquitous learning environments. The characteristics of the research field are identified as well as different types of awareness for the learner in action and on the move. The paper outlines the related problems and challenges. Furthermore it formulates the associated research questions related to the utilization of contextualized digital contents to support and enhance learning and reflection in ubiquitous learning environments. Based on a detailed analysis and a technical design research an experimental prototype is presented. The paper concludes with the projects relevance within the field of Technology-Enhanced Learning (TEL) and future work.

Keywords: Mobile learning, ubiquitous learning, awareness, learning support, contextualization

1 Introduction

There is considerable interest in exploring the possibilities of mobile technologies and ubiquitous computing for learning. On the one hand there is the promise of a seamless integration and enhanced support for learning in action and on the move, while on the other hand the diversity and continuous modification of technologies, changed interaction modalities, and the overwhelming amount of contents challenge the learner as well as demand high standards for corresponding learning environments.

In mobile and ubiquitous learning, adaptivity and awareness are more and more considered as key concepts especially for informal learning support [1]. Ubiquitous access to learning support fosters new opportunities, such as content filtering by context or contextualized access to interaction facilities. Context in that sense is described as a broad concept, which allows adaptation “according to the location of use, the collection of nearby people, hosts, and accessible devices, as well as to changes to such things over time.” [2], but might also include environment-induced aspects, e.g. illumination, noise, and network connectivity. Among others creating awareness for additional learning resources related to the learners environment is one way to assist the learner in context. In the following paragraphs we describe the idea for a research project with the intention to support learning and reflection by enabling learners to view and access on demand, contextualised digital contents from manifold sources using desktop, mobile, or web clients facilitated through different types of awareness.
2 Background & Research Field

Along the way to a knowledge and information society we are creating a constantly growing number of digital contents using the means of digital media, such as pictures, videos, bookmarks, or web-log entries. Following the principles of participation, syndication, and tagging [3], the contents are distributed all over the Web and get more and more enriched by metadata. Contents are not only annotated and categorized collaboratively, but also linked to physical and virtual objects, e.g. by adding a geo-location to a picture. Also the other way round more and more physical and virtual objects get enriched with contents and functionality and thus becoming service interfaces for digital media [4]. We consider the amount of digital contents created by the means of digital media as valuable resources to support learning and reflection.

Beside that another aspect facilitates the relevance and usage of digital contents - the emerging propagation of mobile technologies, which enables anywhere and anytime access. This mobile accessibility establishes a basis for formal and informal mobile learning scenarios complemented by an increasing personalization and contextualization of content. The mobile learning paradigm encourages learning that is personalized, authentic, and situated [5]. Based upon this paradigm but differentiated in its level of embeddedness in the environment is ubiquitous learning. This concept rests upon the idea of ubiquitous computing [6], offering mobility combined with pervasive computing functionality [7]. Enhancing learning environments with ubiquitous computing then creates ubiquitous learning environments, in which different channels of information and interaction are synchronized and orchestrated by instructional designs.

Permanency, accessibility, immediacy, interactivity, situatedness, and adaptability have been identified as the main characteristics for ubiquitous learning [8]. A closer examination reveals that permanency, accessibility, immediacy, as well as adaptability deal with informational aspects. Considering the amount of available digital information finding the right information becomes more and more important [5]. This indicates a need of information navigation competences and postulates the support and assistance of learners in order to enable them to navigate more efficiently through information and find the right information in any given situation [9]. One essential aspect to implement this concept is to keep the learner continuously aware about the environment he is proactive in, including digital contents that are available in a real world context. Identifying relevant contents can be done using the enriched metadata, e.g. social classifications that offer a promising information retrieval potential [10].

Considering the mentioned awareness several types of awareness need to be distinguished. Based on current CSCW and CSCL research four types of awareness for ubiquitous learning environments have been identified; completed by knowledge awareness and context awareness as crucial “to provide the right information to the right person at the right time and the right place with the right form” [11]. The different types of awareness are listed in Table 2.
Table 1. Types of Awareness [11]

<table>
<thead>
<tr>
<th>Awareness</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>Who can help to solve the problem?</td>
</tr>
<tr>
<td></td>
<td>How can I interact with the peer(s)?</td>
</tr>
<tr>
<td>Task</td>
<td>Which task can I do?</td>
</tr>
<tr>
<td></td>
<td>How much time is required?</td>
</tr>
<tr>
<td>Concept</td>
<td>What kind of concepts is necessary to complete the task?</td>
</tr>
<tr>
<td></td>
<td>Do I need to revise any of my current ideas in light of this new information?</td>
</tr>
<tr>
<td>Workspace</td>
<td>What are they doing?</td>
</tr>
<tr>
<td></td>
<td>What have they already done?</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Who is using, changing, or discussing the same knowledge?</td>
</tr>
<tr>
<td></td>
<td>What knowledge did they use, change, or discuss?</td>
</tr>
<tr>
<td>Context</td>
<td>What objects are available around them?</td>
</tr>
<tr>
<td></td>
<td>Where are they?</td>
</tr>
</tbody>
</table>

In this project we want to focus on the different types of awareness and their improvement capabilities in terms of accessibility and thus the utilization of digital contents resulting in an enhanced learning and reflection support.

3 Problems, Challenges, and Research Questions

The strength of ubiquitous learning environments is the variety of display and interaction modalities that can be utilized by the learner. The learner is free to select the currently best-suited learning support for his purpose. This main strength implicitly holds a major problem as learners are confronted with missing awareness indicators reflecting the available learning support in their current environment including the relevant digital contents. The main reason for that is the described wide distribution among different devices, platforms, and providers. Finding the appropriate contents is difficult as it often takes more time and effort than it actually benefits. Once identified accessing the desired content is also difficult, as the different service interfaces differ in design and implementation as well as the used interaction metaphors differ among the learner’s different devices, systems, and platforms. What makes it even more difficult is that contents are not linked and accessible in a contextualized manner, e.g. links between cross-system & mixed-reality contents. The other way round it is mostly not possible to create these links. Furthermore the threshold to reach the desired awareness gets insuperable, due to the vast amount of available contents, which is constantly growing. For the given reasons we argue that learning and reflection utilizing digital contents is currently not supported in a sustainable manner.

Therefore the challenges are to improve the identification of relevant digital contents, to simplify the access mechanisms, as well as to enable and facilitate contextual relationships between digital contents. New techniques of aggregation, visualization, and interaction need to be elaborated, as common techniques do not support ubiquitous learning environments and the required awareness for relevant digital
contents in a sufficient way. The outlined problems and challenges lead to the following research questions:

- Which types of digital contents can support learning and reflection in ubiquitous learning environments?
- Which sensors can be used and how must they be aggregated, filtered, and implemented in ubiquitous learning environments?
- Which methods of visualization, sonification, haptification, and so forth can be used to create awareness in ubiquitous learning environments?\(^1\)
- How are the awareness methods assimilated and perceived in ubiquitous learning environments and what are the implications for the design?
- Does the utilization of contextualized digital contents support and enhance learning and reflection in ubiquitous learning environments and what are the effects?

### 4 Approach & Experimental Prototype

We plan to analyze the outlined problems, review the existing research about the different awareness types, and derive their influences on learning as well as the pros and cons for the learner in this context. We will then identify the involved entities enriched and linked to digital contents, e.g. people, objects, rooms, or concepts. Analyzing the different types of content emits the required infrastructure for ubiquitous learning environments made up of interconnected and embedded devices, systems, and platforms. This allows us to examine the necessary aggregation and exploitation processes as well as the associated filter and synchronization mechanisms based on context parameters. An approach we want to elaborate in greater detail is the utilization of artifacts, represented by physical or virtual objects exploited as input/output instruments for uniquely aggregated information and interaction channels. Furthermore we want to analyze innovative interaction techniques that enable learners to interact seamlessly and intuitively within the ubiquitous learning environment without the need to proactively configure the information and interaction channels.

Based on this analysis and technical design research we want to set up an experimental prototype. Realizing the vision of ubiquitous computing all embedded devices, systems, and platforms shall be able to create on the move a dynamic context model according to the environment and configure the offered services to that, being able to remember familiar environments and also adapt to new environments [5]. The offered services will ensure the different types of awareness for digital contents, applying ambient and collective intelligence methods utilizing the embedded devices, systems, and platforms. Within this prototype we want to perform experiments covering different design dimensions for the selected awareness types. In such an

\(^1\) Sonification and haptification are alternative techniques to convey information or perceptualize data. Sonification exploits auditory perception, while haptification is based on haptic perception. [12]
experiment creating workspace awareness could mean to visualize the digital contents that have been used, are currently used, or will be used in a shared workspace. Concerning knowledge awareness audification methods could be used to create awareness when someone enters the environment, which uses the same or related digital contents and offers learning support. And to provide a last example, vibration could be used as a possible haptification method to create context awareness for relevant physical and virtual objects.

5 Relevance & Future Work

The project offers rich opportunities for the design of environments following the mobile and ubiquitous learning paradigm, which gain in importance for Technology-Enhanced Learning (TEL). Recently the EU-funded project STELLAR identified the grand research challenges for the future of TEL. As a guideline three themes have been formulated: connecting learners, orchestrating learning, as well as contextualizing virtual learning environments and instrumentalizing learning contexts [13]. Our project is strongly devoted to the contextualization theme; implicating manifold overlaps with the other themes. The main idea behind the contextualization theme is to encourage situated learning, while supporting the learner’s mobility. Building on that the key research questions in this theme are:

- How can new forms of contextualized learning enable novel experiences for learners and for development of human competences?
- How to support the mobility of the learner in distributed and multi environment learning settings, like the transition between real and virtual contexts?
- Which standards are needed to achieve interoperability and reusability of learning resources in this field? How to harmonize the existing learning standards?

Comparing these key research questions with our approach, clarifies the projects relevance within the field. The project highlights the challenges and explores the possibilities that lie in the convergence of mobile and ubiquitous learning in combination with the utilization of contextualized digital contents as valuable resources to support learning and reflection. An extensive literature review covering mobile learning in general and ubiquitous learning in particular as well as the different types of awareness and the utilization of digital contents for learning will establish the basis for an experimental prototype that can then be evaluated. Framed by surveys that sort out the relevant digital contents and sensors in ubiquitous learning environments several experiments shall be used to collect data in order to test hypotheses and answer our research questions regarding the support of learning and reflection through the utilization of contextualized digital contents.
References