B. Chang et al. (Eds.) (2010). Joint Proceedings of the Work-in-Progress Poster and Invited Young Researcher Symposium
at the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Conceptual Framework for Ambient Learning Displays

Dirk Börner, Marco Kalz & Marcus Specht
Centre for Learning Sciences and Technologies,
Open Universiteit Nederland, The Netherlands
dirk.boerner@ou.nl, marco.kalz@ou.nl, marcus.specht@ou.nl

Abstract: In this paper, we describe ongoing work focusing on the situated support of informal and non-formal learning scenarios. Relevant research findings, models, design dimensions, and taxonomies have been examined resulting in a conceptual framework, that facilitates the acquisition, channeling, delivery, and framing of contextualized information in the learning process.

Keywords: Ubiquitous Learning Support, Ambient Information Channel, Awareness, Conceptual Framework

Introduction

In the context of an ongoing PhD project - focusing on the situated support of informal and non-formal learning scenarios by enabling learners to view, access, and interact with contextualized digital content presented in an ambient way - a conceptual framework for *Ambient Learning Displays* has been developed. The project sets up to answer the research question: *What are the effects of ambient information presentation on learning in a situated learning context within ubiquitous learning environments?* In order to measure these effects the information presented in context first needs to be acquired, channeled, delivered, and framed in the learning process. Relevant research findings, models, design dimensions, and taxonomies have been examined and will be described in the following sections resulting in the proposed conceptual framework that defines the envisioned *Ambient Learning Displays*.

1. Acquisition: Awareness within Ubiquitous Learning Environments

For mobile and ubiquitous learning, adaptivity and awareness are considered as key concepts especially for informal learning support [1]. Awareness is a concept that can also be utilized to acquire relevant information for the design of *Ambient Learning Displays* within ubiquitous learning environments. In doing so learners can be kept continuously aware about the environment he is proactive in as well as the available resources matching the learning activity. Based on current CSCW and CSCL research social, task, concept, and workspace awareness have been identified for ubiquitous learning environments [2, 3]; completed by knowledge awareness "for inducing collaboration in a shared knowledge space" 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" [4].

Within a ubiquitous learning environment creating workspace awareness would mean to keep the learner aware on what is currently happening or what has happened in the environment.

Knowledge awareness would mean to keep the learner aware when someone enters the environment, who is using the same or related resources and therefore might offer learning support. Finally, creating context awareness would mean to keep the learner aware on relevant resources in the environment.

To set up the conceptual framework the above presented types of awareness are used as acquisition instrument of the relevant information for the learner within the ubiquitous learning environment.

2. Channeling: Ambient Information Channels

In order to present the acquired information in context an appropriate model is needed that can be used to process and transfer this information in the next step. The Ambient Information Channels model allows the description of contextual learning support patterns [5]. The model is based on four infrastructure layers encapsulating the sensor functionality, the informational aggregation, the instructional logic, as well as the visualization and interaction of a context-aware system. The sensor layer collects and handles all sensor information while the aggregation layer combines this information in a meaningful way, which is then used by the control layer to enrich the entities involved in the learning process. The indicator layer finally describes the user interface providing feedback to the user and enabling the interaction with the system.

The defined layer structure facilitates sensors, channels, and artefacts as components while using control structures to describe their functionality. The channels are the main component used to deliver information and services but also to feed information into the system. Therefore, the channels are bound to sensors and/or artefacts. Sensors provide the system with measures but can also be used as a direct source of information. While sensors within a mostly invisible information grid measure the user and the environment he is proactive in, artefacts form a direct interface for the user, enabling the user to interact with the environment. The combination of components complemented by aggregation, enrichment, synchronization, and framing processes finally leads to contextual learning support.

In order to develop the conceptual framework further the Ambient Information Channels are used as an instrument to inject the previously acquired information into the ubiquitous learning environment.

3. Delivery: Design Dimensions of Ambient Systems

To be able to present the information relevant to the learner in context appropriate systems and applications have to be designed and evaluated. Within the numerous research papers describing ambient information systems some include extended discussions of the covered design dimensions as well. Examining these dimensions is then likewise a common method to evaluate existing systems. Ideally this method results in the description of specific design patterns that can be used to build similar systems. For this purpose several design dimensions of existing ambient information systems have been compared and discussed [6]. As a major outcome the authors present the four design dimensions information capacity, notification level, representational fidelity, and aesthetic emphasis. Each dimension can be ranked from low to high in five grades covering to which degree the dimension specific attributes are implemented.

Furthermore the authors introduce four design patterns that illustrate coherent combinations of the design dimensions, e.g. Symbolic Sculptural Display or Multiple-Information Consolidators. With comparable design patterns for *Ambient Learning Displays* in mind the presented design dimensions of ambient systems are used as a design instrument to deliver the previously channeled

information within the ubiquitous learning environment. As a result the conceptual framework is completed by ambient systems utilizing the previously channeled information.

4. Framing: Revised Taxonomy of Educational Objectives

Learning involves various aspects of human beings including a cognitive, affective, and psychomotor part. In each domain learning is classified on the basis of taxonomies that give a structure starting from simple activities to more complex ones. Focusing on informal and non-formal learning support the project constrains to the cognitive domain of learning.

In this domain several attempts have been made to classify learning. Amongst others Benjamin Bloom and colleagues created a taxonomy of educational objectives for the cognitive dimension of learning. These cognitive processes include activities like knowledge recall, comprehending information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and evaluating ideas or actions. This work has been refined and adapted, mainly differentiated in the more useful and comprehensive additions of how the taxonomy intersects and acts upon different types and levels of knowledge [7]. This revised taxonomy of educational objectives describes several cognitive process dimensions and distinguishes factual, conceptual, procedural, and metacognitive knowledge. It can be used to match activities and objectives to the types of knowledge and the cognition processes.

Utilizing this capability, the taxonomy is used to frame the previously acquired, channeled, and delivered information in a learning context. Tentatively the conceptual framework is specifying ambient systems now framed in the learning process as *Ambient Learning Displays*.

References

[1] Syvanen, A., Beale, R., Sharples, M., Ahonen, M., & Lonsdale, P. (2005). Supporting Pervasive Learning Environments: Adaptability and Context Awareness in Mobile Learning. In *IEEE International Workshop on Wireless and Mobile Technologies in Education*, 251-253. IEEE.

[2] Goldman, S. (1992). Computer Resources for Supporting Student Conversations about Science Concepts. *ACM SIGCUE Outlook*, 21(3), 4-7.

[3] Gutwin, C., & Greenberg, S. (2002). A Descriptive Framework of Workspace Awareness for Real-Time Groupware. *Computer Supported Cooperative Work*, 11(3).

[4] Ogata, H. (2009). Assisting Awareness in Ubiquitous Learning. In *Proceedings of the IADIS Mobile Learning 2009*, 21-27. IADIS.

[5] Specht, M. (2009). Learning in a Technology Enhanced World. Maastricht, The Netherlands: OCÉ.

[6] Pousman, Z., & Stasko, J. (2006). A taxonomy of ambient information systems: four patterns of design. In *Proceedings of the working conference on Advanced visual interfaces*, 67–74. ACM.

[7] Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives* (Complete edition). New York, USA: Longman.