Team Awareness in Personalized Learning Environments

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Abstract

In most of today's campus-like learning settings students are frequently confronted with e-learning systems that do not only deliver and display learning content, but are equipped with a number of integrated tools for file sharing, communication, personalisation (personal annotations, text marking etc.) and cooperation. However, recent observations show that these functions are rarely used. One reason for not using the technological opportunities for informal communication and interaction is the misdesign of such systems with respect to team awareness in learning teams. The poor support for synchronous and asynchronous communication and collaboration in today's e-learning systems has motivated the development and prototypical implementation of a context-aware team interaction support system, offering up-to-the-moment information about location, state and activities of learning teams and thus helping to build up awareness of the surrounding, in which team learning processes can take place. In this paper, we present an extensible awareness system, which is capable of providing context information in a presentation independent format. A team space is provided for mobile learning teams, integrating state and task awareness functionality with synchronous and asynchronous communication means.

Keywords: mobile learning, team awareness, context awareness, learning context

1. Introduction

Until the last few years, the understanding of learning was to be a one-way knowledge-transfer from a teacher to a learner, either directly or via media (e.g. books). Obviously, this is no longer true. Learning takes place everywhere and implicitly, thus becoming more and more informal: *"Informal learning is implicit learning, which means it is derived from direct interaction ... and a range of cues given by peers and instructors that go well beyond what is explicitly being taught."* [Ewel97]

Furthermore, it has been recognized, that learning is much more effective, if the learned information can be put in context with the existing knowledge: *"According to contextual learning theory, learning occurs only when learners process new information of knowledge in such a way that is makes sense to them in their frame of reference (their own inner world of memory, experience and response). This approach to learning and teaching assumes that the mind naturally seeks meaning in context – that is, in the environment where the person is located – and that it does so through searching for relationships that make sense and appear useful."* [Hull93]

Both informal and contextual learning lead to learning settings, where no longer a teacher transfers knowledge to learners, but where learners form teams to gain knowledge by discourse and dialogue, building a sort of team knowledge, that goes beyond the sum of individual understanding.

In the last years, many means to support learning processes on computers have been developed (see Fig.1). There is a broad range of systems that enable or support *presentational learning* or *self-study*. These systems are designed to present content in a way the learner can easily conceive. There are possibilities of presentation that could not be realized in "traditional" presentational learning or self-study. One step further, *instructor initiated learning* additionally is supported by means of communication, like chats, forums or email. At this stage, systems are not able to provide the same quality of service that could be reached in face to face settings, although there are many, widely used means supporting interaction.
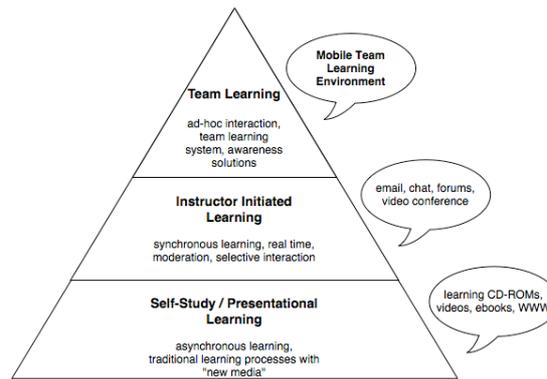
Figure 1: Computer mediated learning

The most sophisticated support is needed for *team learning*. Building a team-learning environment, that can provide the features a physical meeting room provides, is still an open issue in research. Especially the lack of possibilities to keep the team members aware of each other's state has motivated the development of the presented system.

1.1. Support for Mobile Learning Teams

In [Fers00], the following organisational systems have been identified to be crucial for the successful support of effective mobile teams: *Information and Knowledge Management System (Team Memory), Awareness System (Team Awareness), Interaction Systems (Meeting Support), Mobility Systems (Mobile Teams) and Organisational Innovation Systems (Team Workplace Innovation)*. While all of these systems are important for effective team collaboration, we will now focus on Team Awareness. As it is hard to draw borders between the mentioned supporting systems, we will also partially cover aspects of Interaction and Mobility Systems, as they can be enhanced utilizing awareness information.

1.2. Team Awareness – Notion and Deficits

Dourish and Bellotti [Dour92] proposed one of the first and most common definitions of awareness in CSCW settings: "*Awareness is an understanding of the activities of others, which provides a context for your own activity.*" This general definition applies to "group" or "team" awareness tools, which goal is to convey some information about the state and activities of people within a team.

Supporting the learning process in distributed teams by awareness information has been an issue for over a decade now. In [Gutw95] Gutwin, Stark and Greenberg identify four general types of awareness a learner should have to support him in the team learning process: *social awareness, task awareness, concept awareness* and *workspace awareness*. While some of these types are possibly more important than others in most settings, *team awareness* is the more general term, thus being a superset of these four types.

Jang et al. [Jang00] identified four specific types of awareness deficiencies in today's virtual (distributed) teams. Generally speaking, there is a lack of awareness about others *activities* (what are they doing?), about other's *availability* (when and how to reach them?), about *process* (where we are in the project?) and about the *perspective* (what are the others thinking and why?).

Ferscha [Fers00] defined a team awareness system to be responsible for the perceptualisation of the effects of team activity by communicating work context, agenda and workspace information to the user interfaces of involved team members just-in-time, and granting anytime access to team memory.

2. Team Awareness to enhance Learning in Context

To enable people to not only learn side by side but together, to form teams and interact with each other, it is crucial to utilize information not only about the individual learner's context but also about the context of the whole learning team, supporting the members' interaction in those teams.

2.1. What is Context?

Many approaches have been made to define the notion of context. Most definitions of context are done by enumeration of examples or by choosing synonyms for context. In the work that first introduces the term 'context-aware,' Schilit and Theimer [Schi94a] refer to context as *location, identities of nearby people and objects, and changes to those objects*. In a similar definition, Brown et al. [Brow97] define context as *location,*

identities of the people around the user, the time of day, season, temperature, etc. Ryan et al. [Ryan97] define context as the *user's location, environment, identity and time*.

A widely used definition is the one given in the PhD-thesis of A. Dey [Dey00]: context is "*any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.*"

Following this definition, Dey [Dey00] defines a system to be context-aware "*if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task*". Other definitions of context-aware systems include *systems that adapt themselves to context* [Schi94] or *systems having the ability to detect and sense, interpret and respond to aspects of a user's local environment and the computing devices themselves* [Ryan97].

2.2. Context Dimensions

To systematically design context-aware applications, it is useful to identify categories of context (so called context dimensions) that help designers to uncover the most likely pieces of context to be used. Although a manifold of classifications have been proposed, we will present the categories Dey identified [Dey00], as these are the most common ones.

There are nearly uncountable dimensions, that could be identified, but in practice, some of them are more important than others. These are *location*, *identity*, *activity* and *time*, which could be seen as the primary context types for characterizing the situation of an entity, as they can serve as indices into other sources of contextual information (secondary context types). If we know a person's identity, we could easily derive related information from several data sources such as birth date, list of friends or email addresses. Knowing the location of an entity, we could determine the nearby objects and people and what activity is occurring near the entity.

There are some situations in which multiple pieces of primary context are required to index into an information space to acquire secondary context information. For example, the forecasted weather is a context dimension for outdoor activity and can be obtained by querying a forecast database with the desired location and time.

2.3. Mobile Learning Context

Tailored to mobile learning settings, the notion of context can be defined slightly different. The learning context as defined by Wang [Wang04] reads "*any information that can be used to characterize the situation of learning entities that are considered relevant to the interactions between a learner and an application.*"

[Wang04] identifies six dimensions that are relevant in computer-aided mobile learning: *identity, spatio-temporal, facility, activity, learner* and *community dimensions*.

Location has been proven to be one of the most important and effective contexts in many applications. Besides identifying the geographical position of the user, it makes sense to introduce some sort of meta-information that enables the system to distinguish between locations used for different purposes. In learning settings for example these "meta-locations" could be classroom, home or outdoor, thus enabling the system to adapt to the current learning situation.

In our approach we are adding team awareness as a seventh dimension, as the six predefined context dimensions are single-user centred and do not cover issues, that can only be obtained by looking at the learning team as a whole. The context of the team is distilled out of the individual contexts of its members. Therefore, the team awareness dimension might seem to strongly overlap with several of the dimensions defined by Wang, especially the community dimension and the activity dimension. As the context of a team is much more than the sum of the contexts of the team's members, the difference is that Team Awareness focuses on the team itself and not on the single users, enabling us to gather high-level context-information about the team by combining the members' contexts. For example, it now would be possible, to notify the user of a meeting of other team members occurring somewhere else.

2.4. Architectural Model

Taking into account all the issues stated above, we now could construct an architectural model (see Fig. 2), which shows the role of context in a team learning setting. Context is sensed, transformed and represented in the context module. This module on the one hand holds the individual learners' contexts but on the other hand, it also generates and holds the team-learning context, taking into account team awareness information.
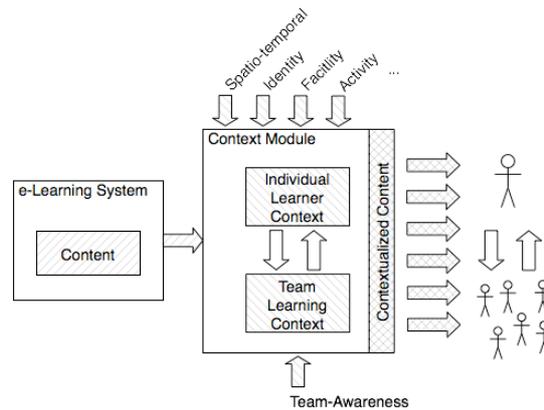
Figure 2: Architecture

The context module serves as an interface for the learners, not only adapting content to the current context of the learner but also providing additional information about the context of the learner and his colleagues. A comparable architecture has been developed by Lonsdale et al. [Lons03] as a part of the MOBIlearn project. The main difference to our approach is that we explicitly use team awareness as a context dimension, focusing on the team as a central part of (mobile) learning settings.

3.   Team-Awareness and Interaction Support

With the presented system, we developed and implemented an extensible architecture that uses several dimensions of context gathered from individual users to compose team awareness information. This information is presented to the team members and used to support interaction within teams.

For now, only a subset of team awareness is supported. We focus on parts of workspace and social awareness that can be used to enhance the interaction among team members. As the whole architecture is built upon a highly extensible and dynamic framework [Beer03], it is fairly simple to add further context sources, thus extending the covered aspects of team awareness.

3.1.   Gathering individual context information

The context dimensions that are used in our system at current stage of development are identity, time, location and activity. Time could by easily obtained by querying the RTC of the learner's computer. Much more sophisticated is the detection of the learner's current location. For this purpose we have developed a technology-independent positioning system (using WLAN-, RFID- and Bluetooth-sensors at the moment). Asour user-interface is built upon an instant messenger utilizing an existing messaging network (namely ICQ), we are using the features of this network to obtain identity and activity information.

3.2.   Triggering context-aware services

Having gathered information about the context of the learner and his co-learners, we can now trigger context-aware actions to acquire team awareness and support team interaction. A context-aware action is one of the following types [Dey00]: *context-aware presentation* (passive context-awareness [Chen00]), *automatic execution of services* (active context-awareness) or *tagging of context for later retrieval*. To realize context-aware actions, we use the SiLiCon Context-Framework, an event-based system, which is described in [Beer03]. As mentioned before, the open architecture of this framework allows us to easily extend the used context-sources but also the behaviour of our application to improve the support for team awareness and interaction.

3.3.   Presentation of Team Awareness Information and Support of Interaction

Utilizing the available pieces of context, we identified several functionalities that are useful for the support of synchronous and asynchronous interaction in teams and the presentation of team awareness information. As already stated before, our user-interface is based on an existing instant messenger, already using the features it provides.

Synchronous interaction for individuals and groups: While current messaging systems often only support peer-to-peer interaction, it is also necessary to support synchronous group interaction, also in cases where team members initially to not know each other (as it may be the case in settings, where the participants of a

lecture form a learning team). For that reason we have developed team contacts, that are displayed in the contact-list of the messenger and can be used like standard contacts.

Asynchronous interaction for individuals and groups: While in general email or forums cover this aspect, we extend the concept of asynchronous interaction by messages (post-its) being bound to physical locations, thus enabling users to leave messages for others in the context of the current location. Those virtual post-its can also have an expiry date and visibility can be restricted to certain teams. Furthermore it is also possible to comment post-its. For example, users could leave a note at their office when they leave, telling others (but maybe only the members of their department) where they can be found. Another possible application is the virtual blackboard, where people could post requests, offers or simply relevant information.

Team Formation Support: Teams differ in their purpose, so that it is necessary to provide different types of teams: closed teams (with an owner) and open teams, which can be joined and left manually by the users and dynamic teams, which are formed automatically by the system using the current context of possible members and meta-information about the dynamic team's location (whether it makes sense or not to build a team at the current location).

Team Meeting Support: using the available context information, we are trying to recognizing team meetings to provide several supporting services, including registering members joining and leaving the meeting, notifying absent members and supporting protocol storage and distribution among team members.

To support awareness about activity and location of team members (as a subset of team awareness) we allow automatic availability adoption (depending on user-defined rules using location and time as triggers). We also display the current location of all team members in the contact list and optionally in a floor plan based graphical viewer. Several more tools to support individual task and awareness management are available but not presented here.
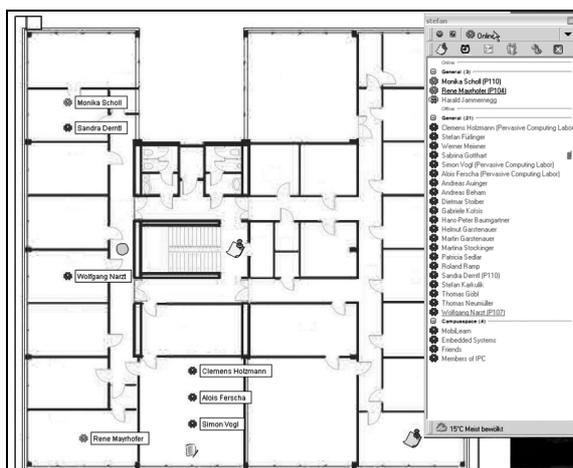

Figure 3: Running system with enabled 2D-viewer

The current version of our system (see Fig. 3) is in internal evaluation stage right now. After this evaluation is completed, it will be made available for students at the University of Linz, enabling them to be aware of their friends' and team members' availability and position and simply extend their interaction possibilities without the necessity of getting used to a new interface (as our system is built upon an existing instant messenger). This field-test will also be a chance for us to evaluate the scalability and acceptance of our approach.

4. Summary

We have motivated the need for using context information to support learning in teams. It is necessary not only to utilize the individual learner's context but also team awareness information to allow content adaptation and context-aware presentation of information as well as context-aware support for interaction in groups.

We believe that it's crucial to build awareness systems upon flexible and extensible frameworks, thus providing a platform that can easily be adapted to the available context sources and to the required form of presentation.

With the implemented system, we show means for context-aware interaction support in teams and the presentation of team awareness information to the team members, providing a starting point for a comprehensive team awareness support system.

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