

Team awareness in personalised learning environments

Alois Ferscha

Clemens Holzmann

Stefan Oppl

ferscha@soft.uni-linz.ac.at

clemens.holzmann@jku.at

stefan.oppl@jku.at

Institut fuer Pervasive Computing

Johannes Kepler University Linz

Altenberger Strasse 69

4040 Linz

Austria

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 poor design 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. This offers up-to-the-moment information about the location, state and activities of learning teams, thus helping to build up awareness of the surroundings 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 a means of synchronous and asynchronous communication.

Keywords

mobile learning, team awareness, context awareness, learning context

1 Introduction

Until the last few years, learning was generally conceived as a one-way knowledge transfer from a teacher to a learner, either directly or via media (eg books). This view has now largely been superseded by one where learning takes place everywhere and implicitly, thus becoming more and more informal: 'Informal learning is implicit learning, which means it is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.' (Ewell 1997).

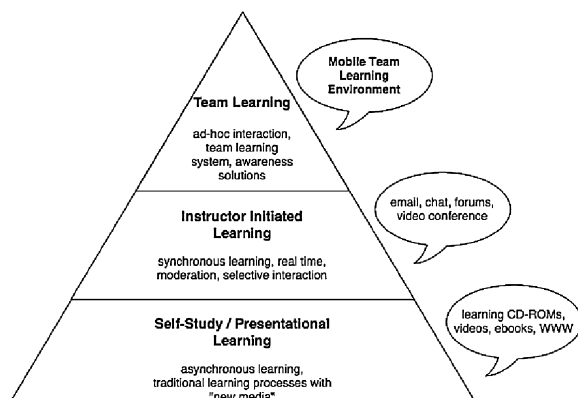
Furthermore, it has been recognised that learning is much more effective if the learned information can be put into context with the learner's existing knowledge. Hull (1993) makes the point that:

According to contextual learning theory, learning occurs only when learners process new information of knowledge in such a way that it 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.

Both informal and contextual learning lead to learning settings, where it is no longer the case that a teacher transfers knowledge to learners, but instead 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 recent years, many means to support learning processes on computers have been developed, as shown in **Figure 1** overleaf. 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 that the learner can easily understand.

Figure 1
Computer-mediated learning



There are possibilities of presentation that could not be realised in 'traditional' presentational learning or self-study. Furthermore, instructor-initiated learning is also supported by means of computer-mediated communication like chats, forums or e-mail. 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 of supporting interaction.

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

1.1 Support for mobile learning teams

Ferscha (2000) has identified the following organisational systems as 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)
- 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 supporting systems listed above, we will also partially cover aspects of interaction and mobility systems, as they can be enhanced utilising awareness information.

1.2 Team awareness – notion and deficits

Dourish and Bellotti (1992) proposed one of the first and most common definitions of awareness in CSCW (computer-supported collaborative work) 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, the aim of which 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 a topic for research for over a decade now. Gutwin, Stark and Greenberg (1995) identify four general types of awareness that a learner should have to support him or her 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, being thus a superset of these four types.

Jang, Steinfield and Pfaff (2000) 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 others' *availability* (when and how to reach them?); about *process* (where are we in the project?); and about the *perspective* (what are the others thinking and why?).

Ferscha (2000) defined a team awareness system as being responsible for facilitating awareness of team activity by communicating work context, agenda and workspace information just-in-time to the user interfaces of relevant team members and granting anytime access to team memory.

2 Team awareness to enhance learning in context

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

2.1 What is context?

Many attempts have been made to define the notion of context. Most definitions of context are made by enumeration of examples or by choosing synonyms for context. In the work that first introduces the term 'context-aware', Schilit and Theimer (1994) refer to context as 'location, identities of nearby people and objects, and changes to those objects'. In a similar definition, Brown, Bovey and Chen (1997) define context as 'location, identities of the people around the user, the time of day, season, temperature, etc'. Ryan, Pascoe and Morse (1997) define context as the 'user's location, environment, identity and time'.

A widely used definition is the one given in the PhD thesis of Dey (2000), who says that 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 (2000) defines a system as being 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' (Schilit and Theimer 1994) 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' (Ryan, Pascoe and Morse 1997).

2.2 Context dimensions

In order to design context-aware applications systematically, 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 many and various classifications have been proposed, we will present the categories that Dey (2000) identified, as these are the most common ones.

The number of dimensions that could be identified is nearly uncountable, 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 characterising 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 can easily derive related information (such as birth date, list of friends or e-mail addresses) from several other data sources.

Knowing the location of an entity, we can 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 differently. The learning context as defined by Wang (2004) reads as follows: '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'.

Wang (2004) identifies six dimensions that are relevant in computer-aided mobile learning:

- identity
- spatio-temporal
- facility
- activity
- learner
- community.

Location has proved 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 outdoors, thus enabling the system to adapt to the current learning situation.

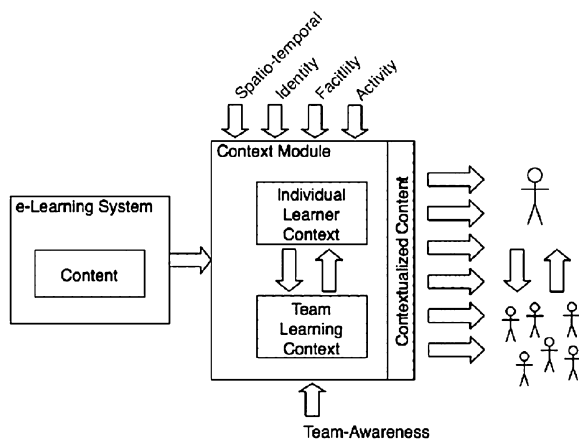
In our approach, we are adding team awareness as a seventh dimension, as the six predefined context dimensions are single-user centred and do not cover issues that can only arise when looking at the learning team as a whole. The context of the team is distilled out of the individual contexts of its members. Therefore, the team awareness dimension might seem to overlap strongly 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 would now 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 could now construct an architectural model (see **Figure 2**), which shows the role of context in a team learning setting. Context is sensed, transformed and represented in the context module. This module holds the individual learners' contexts, but it also generates and holds the team learning context, taking into account team awareness information.

Figure 2
Architectural model showing the role of context in a team learning setting



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/her colleagues. A comparable architecture has been developed by Lonsdale *et al.* (2003) as part of the MOBlearn project (2005). The main difference in 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 system presented here, we have 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 (Beer *et al.* 2003), however, it is fairly simple to add further context sources, thus extending the aspects of team awareness that are covered.

3.1 Gathering individual context information

The context dimensions that are used in our system at the current stage of development are identity, time, location and activity. Information on time could easily be obtained by querying the RTC (Real Time Clock) 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, currently using WLAN (wireless local area network), RFID (radio frequency identification) and Bluetooth sensors. As our user interface is built upon an instant messenger that utilises 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

Once information has been gathered about the context of the learner and his/her 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 (Dey 2000):

- context-aware presentation [passive context awareness (Chen and Kotz 2000)]
- automatic execution of services (active context awareness)
- tagging of context for later retrieval.

To realise context-aware actions, we use the SiLiCon Context-Framework, an event-based system, which is described by Beer *et al.* (2003). The open architecture of this framework allows us easily to extend not only the context sources used, but also the behaviour of our application to improve the support for team awareness and interaction.

4 Summary

We have shown the need for using context information to support learning in teams. It is necessary to make use of both the individual learner's context and team awareness information to make possible content adaptation and context-aware presentation of information as well as context-aware support for interaction in groups.

We believe that it is 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 ways of having context-aware interaction support in teams and presenting team awareness information to team members, providing a starting point for a comprehensive team awareness support system.

References

- Beer W, Christian V, Ferscha A and Mehrmann L (2003). Modelling context-aware behavior by interpreted ECA rules. In *Proceedings of the International Conference on Parallel and Distributed Computing, Klagenfurt, Austria, 26–29 August*. Austria: Springer Verlag, 1064–1073.
- Brown PJ, Bovey JD and Chen X (1997). Context-aware applications: from the laboratory to the marketplace. *IEEE Personal Communications*, 4(5), 58–64.
- Chen G and Kotz D (2000). *A survey of context-aware mobile computing research*. Hanover, NH: Computer Science Department, Dartmouth College.
- Dey A (2000). *Providing architectural support for building context-aware applications*. PhD thesis: Georgia Institute of Technology.
- Dourish P and Bellotti V (1992). Awareness and coordination in shared workspaces. In *Proceedings of the 1992 ACM Conference on Computer-supported Cooperative Work, Toronto*. New York: ACM Press, 107–114.
- Ewell PT (1997). *Organizing for learning: a point of entry*. Draft paper prepared for discussion at the 1997 AAHE Summer Academy at Snowbird. National Center for Higher Education Management Systems (NCHEMS). At www.intime.uni.edu/model/learning/learn_summary.html
- Ferscha A (2000). Workspace awareness in mobile virtual teams. In *Proceedings of the IEEE 9th International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises, Gaithersburg, Maryland, 14–16 March*. IEEE Computer Society Press, 272–277.
- Gutwin C, Stark G and Greenberg S (1995). Support for workspace awareness in educational groupware. In *Proceedings of the Conference on Computer Support for Collaborative Learning, Bloomington, Indiana, 17–20 October*. New York: ACM Press, 147–156.
- Hull D (1993). *Opening minds, opening doors: the rebirth of American education*. Waco, TX: Center for Occupational Research and Development.
- Jang CY, Steinfield C and Pfaff B (2000). Supporting awareness among virtual teams in a web-based collaborative system: the TeamSCOPE System. *SIGGROUP Bulletin*, 21(3), 28–34.
- Lonsdale P, Barber C, Sharples M and Arvantis T (2003). A context awareness architecture for facilitating mobile learning. In *Proceedings of MLEARN 2003, London, 19–23 May*.
- MOBIlearn (2005). *Website*. At www.mobilearn.org
- Ryan N, Pascoe J and Morse D (1997). Enhanced reality fieldwork: the context-aware archaeological assistant. In V Gaffney, M van Leusen and S Exxon (eds) *Computer Applications in Archaeology*.
- Schilit B, Adams N and Want R (1994). Context-aware computing applications. In *Proceedings of 1st International Workshop on Mobile Computing Systems and Applications*, 85–90.
- Schilit B and Theimer M (1994). Disseminating active map information to mobile hosts. *IEEE Network*, 8(5), 22–32.
- Wang Y (2004). Context awareness and adaptation in mobile learning. In *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education, Jhongli, Taiwan, 23–25 March*. IEEE CS Press, 154–158.