Enriching Learning Contexts to Support Communities of Practice

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Abstract: The theory of situated learning emphasizes the importance of authentic learning contexts and the central role of social interaction. In the light of this theory and based on our previous experience, we propose an approach for the development of **context-based virtual learning environments**. These are virtual worlds, which the learners themselves can create and modify. They therefore provide a customized learning context in which all learning processes and communications between learners can be situated. The characteristics of our approach are: the use of perceptual metaphors, the flexible combination of these metaphors within the learning environment, and the support for awareness of the context and the social interaction within it. Collaborative hypermedia technology is used to construct and to represent places and information in the environment and then to navigate within it. The prototype system provides rich and flexible learning contexts and supports various forms of social interaction for communities of practice.

Keywords: multi-user virtual environment, situated learning, groupware, communities of practice

Introduction

According to Lave and Wenger [Lave91], learning is "a function of activity, context and culture in which it occurs". Learning is difficult or even impossible in an anonymous, abstract situation. Therefore, an environment is needed which is as authentic as possible. It should provide authentic learning material that deals with real-life problems, and it should support both collaboration and lively interaction with people as well as objects in the environment. In this paper, we describe how to realize this approach in a collaborative virtual learning environment.

Designing a collaborative virtual learning environment is usually a process of abstraction, which models only the essential elements of conventional learning. Details in the context of collaborative learning are either ignored intentionally or because of the limitations of technology. The problem is that situated learning is difficult to implement in those virtual learning environments, which do not provide a flexible variety of contexts and which do not support very many forms of social interaction. For example, document-based systems primarily serve as a repository for documents and control the access to documents. People are not explicitly modeled in such systems, and social interaction can only be

performed indirectly by manipulating documents. In most room-based learning systems, relationships between people, rooms, tools, and documents are modeled rigidly, and social interaction is usually bound to rooms. To go beyond these restrictions, we argue that it is important to enable end-users to model and customize their learning environment. Furthermore, they should be able to consult an expert, currently staying in the same room or in another room, and to form and develop **communities of practice** (CoP) as described in [Wenger98]. With our design approach towards a context-based learning environment, we aim to provide rich and flexible learning contexts and thus to support various forms of social interaction for CoPs.

This paper is organized as follows: The first section describes the motivation for this research. The second and main part of this paper gives a description of our approach, defining the basic concepts of our context-based virtual learning environment, describing awareness aspects and how we propose to support social interaction. Finally, we compare our approach to related work and present our conclusions and future work.

Motivation

The motivation for this research comes from our considerations of pedagogical theories and our previous experience in developing and using a collaborative virtual learning environment (VITAL).

Theoretical Background

In the **constructivism** approach [Jonassen93] learners are active constructors of knowledge. In other words no strict curriculum guides students through the learning issues, rather the environment as a whole stimulates them to construct knowledge for themselves. Constructivism emphasizes the importance of the context in which students work and the importance of collaborative learning.

The theory of **situated learning** formulated by Lave and Wenger [Lave91] considers social interaction to be central for learning. Collaboration can lead to an elaboration of strategies that can afterwards be discussed, which, in turn, can enhance generalizing facts as knowledge, grounded in students' situated understanding. Wenger uses **Communities of Practice** (CoP) to describe the impact of social learning [Wenger98]. Members of a CoP are bound by shared practice, which means that they are engaged in a collective process of learning. They are fundamentally self-organized, even when external constraints influence the group. A CoP is determined by the value it provides to its members, not by a given schedule. It spans dynamic structures and hierarchies. A CoP is a dynamic group, which can be within an organization, across division units within an organization, or across organizations. People can simultaneously belong to different CoPs in the same way as they belong to other types of groups.

Experience with VITAL

A room-based system called VITAL [Pfister98a] has been developed and tested in our group for two years. VITAL is a virtual learning environment which supports co-located

and distributed collaborative learning of small groups. In VITAL, a virtual room consists of a shared hypermedia whiteboard, a library, and communication tools such as audio tool and group chat tool. The room metaphor is used to organize collaboration, to structure information, to represent group structure and inter-group relationships, to control access to information objects in a room, and to provide awareness about the presence of people in a room.

The room metaphor, as applied in VITAL, gives a relatively fixed predefined context for the learners to work in. Our experience with VITAL showed that the use of the room metaphor as described above is not flexible enough to support situated learning. The simple and rigid room structure and the internal structure of rooms limit the forms of social interaction which are possible. We recommend that in order to support situated learning settings, information structure and room structure should not be so tightly coupled. Unlike in VITAL, group structure should not exactly map to the room structure, and the structure of the group should be able to change dynamically.

Approach

In order to support CoPs and to overcome the limitations of VITAL, we have decided to de-couple the fixed relationships between room metaphor and other metaphors in VITAL. Our new approach treats the entity classes **place**, **people**, **document**, and **tool** equally. These elements can then be flexibly combined to form different **contexts** to support various types of collaborative learning activity. Collaborative hypermedia technology is used to represent and construct the learning context and to navigate in the learning environment. The use of collaborative hypermedia technology has two aspects. Firstly in terms of navigational pathways between places and secondly in terms of the navigation of information.

Basic Concepts of the Context-Based Virtual Learning Environment

The basic concepts of the proposed context-based virtual learning environment are:

People

People denote an **actor** or a **group** of actors. An **actor** has attributes (such as name, picture, expertise, learning interests, etc.) which identify and characterize the user of the system. A **group** is a set of entities, which may be **actors** or other **groups** (i.e. sub-groups). The structure of a group is represented as a directed acyclic graph (DAG). Examples of such groups might be the members of a division of an organization, or people working on a project, which could well cross real-world organizational boundaries or groups.

Place

A **place** is a computational space in which objects can exist and move. We distinguish three kinds of relationships between **places**: structural, proximate, and connected relationships. Structural relationship means that a place is a component of another place.

Proximate relationship means that two or more places have the same parent in the hierarchical structure and are connected by a publicly accessible place (e.g., a corridor). Connected relationship means that people can navigate directly from one place to another; this could be either to an immediately neighboring location or a shortcut to a more distant location.

Document

A **document** is a logical unit of information that will be handled (e.g., stored, moved, or destroyed) as a whole (e.g., a book, or a position paper). It has attributes such as title, keywords, type, owner, creation time, current users, and current place. A **document** consists of a set of **pages** connected by **links**. Each **page** contains a collection of information items. An information item can be described using different media such as text, image, graphics, tables, etc. There are three different kinds of **links**: structural links, internal reference links, and external reference links. Structural links traverse the branching structure of the document. Internal reference links are used as shortcuts to navigate within one document without having to follow the structure of the document. External reference links are used to navigate to other documents.

Tool

A **tool** helps the end-user to deal with documents, to interact with other people, to navigate from one place to another, etc. General-purpose tools are: whiteboard, bookshelf, computer, message box, telephone, calendar, bell, desk, suitcase, garbage can, hypermedia document editor, door, etc. Some tools, such as course registration tool, document search engine, learning net editor, experimental instruments, are domain-specific tools.

Relationship

Various **relationships** exist among entity classes, e.g.,

- people, documents, and tools are related to places,
- documents are attached to tools,
- people use tools to interact with other people, to manipulate documents, to navigate, and to search resources.

A **context** is defined as a set of **places**, **actors**, **documents**, **tools**, and their **relationships**. A context specifies an environment where necessary resources are provided and maintained for performing certain kinds of activities. The nature of the **context** is dynamic and evolves over time. To support CoPs, our virtual learning environment enables end-users to define elements (e.g., people, places, and documents) and their structures and to combine the elements in a flexible way by using collaborative hypermedia tools. The virtual learning environment supports numerous possibilities to create new constellations, to span new structures and hierarchies within and between contexts on demand. Special areas of the environment, which contain domain-specific tools and corresponding learning materials, can be configured to support specific situated

contexts (e.g., project-based learning, language learning). For example, a room (the most simple place, which can exist in the environment) can be created for a certain purpose; in the room necessary tools and relevant documents are arranged, and the room is assigned to people. End-users can group multiple rooms together as a building for a specific purpose. Thus, the proximity of locations increases the probabilities of co-presence of people, who are interested in similar topics, who have a common learning goal, who work on similar projects, or who are experts of special related topics, etc. Increasing probabilities of co-presence of people in the same place at the same time in turn also increases the likelihood of social interaction.

Awareness of Context

To enable people to interact with their learning environment, people must be aware of the context and its current internal structure.

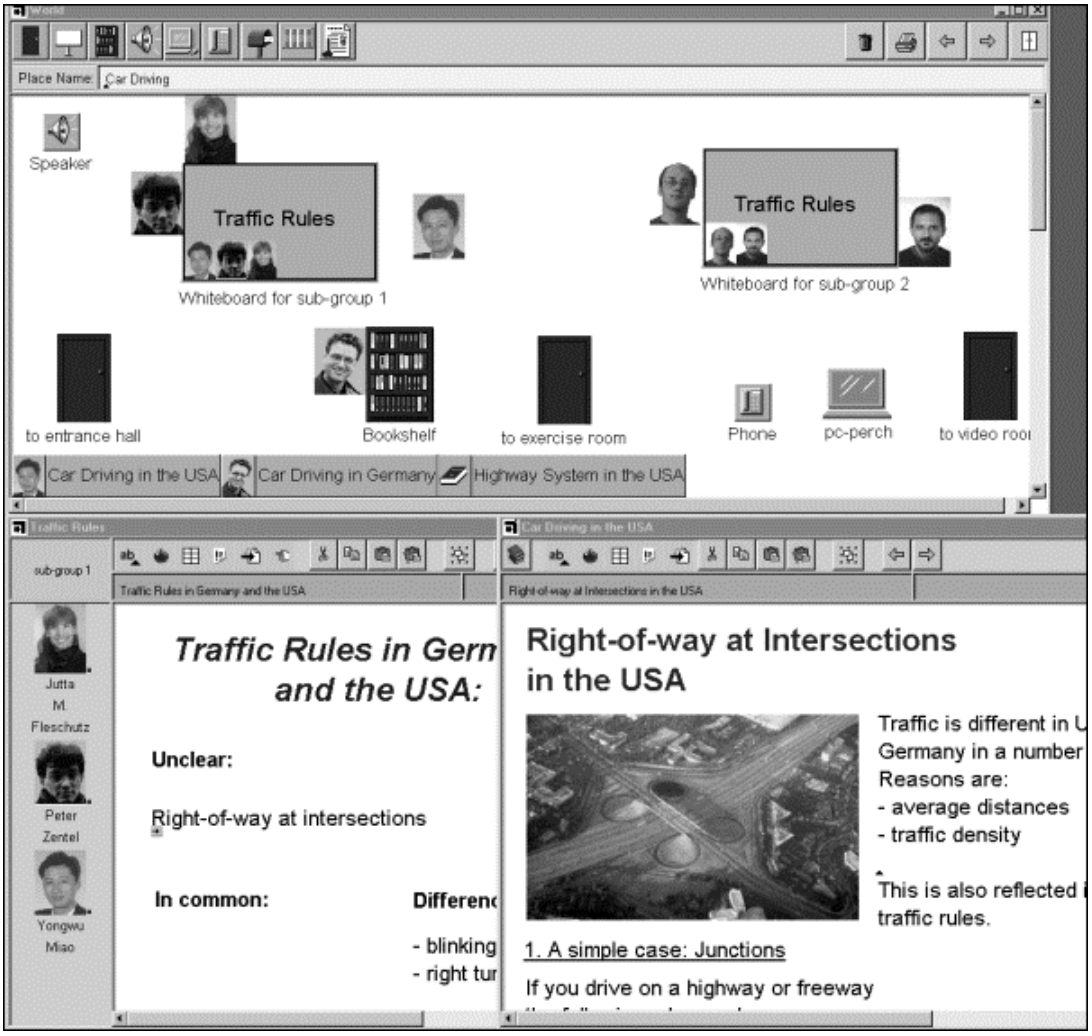

Figure 1: Example learning environment from an actorís point of view

Our environment enables people to be aware of

- co-actors (position, movements, expertise, etc.),
- the place (current activities, historical information, scheduled events, etc.),
- documents (title, author/s, user/s, etc.),
- tools (availability, state (in use or not), users, etc.)

by observing the window or by clicking corresponding icons.

An example for this awareness of context is given in the upper window of figure 1: Six people are working in the room "car driving". They can all observe who is working in which sub-group (indicated by small pictures on the whiteboards), who is reading which document (see the tabs in the bottom left-hand corner of the upper window), and that a document has been taken from the bookshelf which is not in use at the moment. Some tools are in use (e.g., the bookshelf and two whiteboards), others are available, but not in use (e.g., computer and phone). By clicking on the icon of a co-actor or a document, the user obtains more detailed information in a pop-up window.

Flexible searching for suitable resources is enabled by a combination of various navigation steps through document and place structure. For instance, our example user reads the hypermedia document "Car Driving in the USA" (see figure 1, lower right window). He then wants to get more detailed information on the topic, and so he looks for the author of the document and finds out that the author is currently staying in the exercise room. He can then click on the corresponding door icon to move to that room in order to enhance his knowledge, using the additional resources provided there.

Social Interaction

As Wenger [Wenger98] points out, members of a community are informally bound by what they do together and what they learned through their mutual engagement in these activities. Social interaction occurs in all stages of development of CoPs. We focus on the provision of an integrated support for **communication**, **collaboration**, and **coordination**.

Communication

Using an audio tool and a group chat tool installed in each place, an actor can hear other people who are in the same place and talk to them. There are a number of ways to initiate a private conversation with somebody in the same place; for example an actor simply has to draw an arrow from his or her picture to the picture of the chosen conversation partner. A communication connection for both is then established, and a link labeled "talk" connects the two pictures. Unlike strictly room-based systems, our learning environment supports communication between people who are located in different virtual places. By using a telephone metaphor, the system can help to establish conversation channels between partners in different rooms directly. Asynchronous communication in the same place is supported by the use of a bulletin board metaphor. Asynchronous communication between different virtual places is supported by the use of a message box metaphor.

Collaboration

The collaborative construction of knowledge can be realized asynchronously or synchronously. For supporting synchronous collaboration, we use a whiteboard metaphor to establish a synchronous session for all users in the same room. Documents dragged onto the whiteboard can be edited collaboratively by using a hypermedia document editor. Any change to the hypermedia document will be propagated to other usersí windows, and all users move through the hypermedia document together. As they do this, they share the same view of the document; specifically, all users share one scrollbar and change pages simultaneously. This is a pure WYSIWIS (What You See Is What I See) collaboration mode [Stefik86]. Furthermore, if people in the same place want to split into two or more sub-groups such that each sub-group works on different documents in a pure WYSIWIS collaboration mode, then they can simply create a whiteboard for each sub-group and drag the corresponding documents onto the whiteboard. If all sub-groups want to work on the same document, but on different positions of the document, they can create a whiteboard for each sub-group and drag a reference copy of the document onto their whiteboards. In this case, people in the same sub-group work in a pure WYSIWIS collaboration mode and people in different sub-groups work in a relaxed WYSIWIS collaboration mode [Stefik86], but they all work on the same document. For example in figure 1, two sub-groups work on the same document, "Traffic Rules", on different whiteboards (i.e. as a whole they work in relaxed WYSIWIS collaboration mode), but each sub-group works in strict WYSIWIS collaboration mode (as shown for sub-group 1 in the lower left window of figure 1).

Our environment also supports collaboration among people who are located in different virtual places. **Computers** and **network** are used as perceptual metaphors to establish a session for people in different places [Miao99]. Users working in different virtual rooms can share the same information without leaving their current virtual rooms by connecting their virtual computers and dragging documents onto the computer icon. A participant can leave the session by closing the shared window. Even when all participants have left, the session is still active. When someone joins the session later, s/he finds the working context unchanged and can work continually. Thus, asynchronous collaboration is supported as well.

Coordination

When social interaction takes place in the real world, people normally use social protocols to coordinate their actions. In a virtual collaborative learning environment, weak communication channels complicate the coordination of using social protocols. Our context-based virtual learning environment supports coordination of group interaction in two aspects: Firstly, we enable people to use social protocols intuitively by using metaphors of entities existing in a real-world learning environment. As a consequence, users of the system can intuitively use their experience and skills of coordination. Secondly, learning protocols are used to control and guide social interaction and the social construction of shared knowledge. To perform group activity effectively, a group can use predefined protocols to control and guide its interaction. Example learning protocols are described in [Pfister98b, Wessner99].

Related Work

Currently, there are three categories of virtual learning environments: document-based, conferencing-based, and room-based systems. In the following, we look briefly at each of these systems and compare them to our approach of a context-based virtual learning environment.

Document-based learning systems primarily serve as a repository for documents and control the access to documents. The users of this kind of systems can interact only indirectly with each other by navigating through the information space, and by viewing and manipulating information items in the shared database (e.g., CSILE [Scardamalia94]). Unlike context-based systems, these systems do not attempt to provide a very sophisticated context, but one which is based mainly on a document structure and supports limited social interaction.

Conferencing-based systems support real-time learning activities. They support typical class and seminar style activities such as discussion and lecture. For example, the learning systems based on Microsoft NetMeeting [Summers99] are developed by adopting this approach. Unlike context-based systems, these systems provide limited persistence of documents and do not support asynchronous activities.

Room-based systems are often based on a number of virtual rooms, which often include a fixed set of embedded tools such as whiteboard and audio/video tools. Users in the same room can view and edit information items in a shared workspace simultaneously, and they can talk to others and see others in the same room (e.g., VITAL [Pfister98a]). Context-based systems derived from our former experience with room-based systems, but both types of systems differ in several aspects: Firstly, in room-based systems, the organization of people, and the structure of documents (if any) rely upon the structure of rooms, and tools belong to certain rooms. In context-based systems, the organization of people and documents is dynamic and flexible, rather than being fixed in a particular place, some tools can belong to actors and be carried around. Secondly, in room-based systems, the room structure and the internal structure of a room are rigid. In context-based systems, the place structure and the internal structure of a place can be reorganized and customized to establish a set of rich, dynamic, purpose-specific environments for situated learning. Thirdly, in room-based systems, social interaction is limited within the scope of certain rooms. In context-based systems, a context may be formed beyond the boundaries of certain places. Thus, social interaction can be carried out across places.

Conclusion and Future Work

Based on the theory of situated learning and our practical experience, we developed an approach to build context-based learning environments. To support the formation and development of CoPs in a virtual learning environment, the designers have to respect several criteria which we described in this paper: Firstly, the flexible combination of people, places, tools, and documents supports rich contexts for situated learning. Secondly, a virtual learning environment must provide integrated support for

communication, collaboration, and coordination in order to nurture CoPs. In addition, collaborative hypermedia technology is used to construct places and information in the environment and then to navigate within it.

The first version of the prototype has been developed and tested in our group. In the near future, our efforts will focus on completing the implementation of all features and on evaluating the usability of the system. The evaluation will focus on the target group of adult learners. First evaluations will be made with students, and later on we plan to use the system to support adults engaged in continuous learning programs. In addition, tools for acquiring and applying domain-specific knowledge (such as experimental instruments for science learning) are very important for supporting the idea of a context-based learning environment. Another example would be a learning environment which supports language learning and needs the implementation of tools like a cooperative vocabulary trainer or a dictionary.

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