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ABSTRACT

It is assumed that cooperative learning continuously constructs and extends the shared knowledge of a group of learners with respect to a specific learning domain. Experiences with Computer-Supported Collaborative/Cooperative Learning (CSCL) environments indicate that an explicit representation of the shared knowledge is helpful with regard to two aspects. First, it can preserve (intermediate) results of the cooperative learning process. Second, it can also improve the process itself by providing the context and means for learners' orientation and navigation in the learning domain, awareness of the learning process, and the construction and negotiation of knowledge. This paper introduces the Learning Net as an interactive representation of shared knowledge and illustrates how it can be integrated and used in a CSCL environment. (Contains 11 references.) (AEF)

The Learning Net – An Interactive Representation of Shared Knowledge

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Abstract: It is assumed that cooperative learning continuously constructs and extends the shared knowledge of a group of learners with respect to a specific learning domain. Experiences with Computer-Supported Collaborative/Cooperative Learning (CSCL) environments indicate that an explicit representation of the shared knowledge is helpful with regard to two aspects: First, it can preserve (intermediate) results of the cooperative learning process. Second, it can also improve the process itself by providing the context and means for learners' orientation and navigation in the learning domain, awareness of the learning process, and the construction and negotiation of knowledge. In this paper, we introduce the *Learning Net* as an interactive representation of shared knowledge and sketch how it can be integrated and used in a CSCL environment.

1. Introduction

Computer-Supported Collaborative/Cooperative Learning (CSCL) is regarded as an emerging paradigm in educational technology (Koschmann 1996). It is based on cooperative learning methods (Slavin 1995) and on constructivist viewpoints of learning as (1) active construction of knowledge, (2) bound to a complex situation, and (3) a social process. CSCL environments respond to these views by providing (1) authoring facilities to create and modify artifacts within the CSCL environment, (2) means to represent complex, authentic, context-rich information using hypermedia technology, and (3) communication and cooperation facilities in various ways such as e-mail, chat, audio/video conferencing, or shared whiteboards.

In the course of a (successful) cooperative learning process, information provided by a teacher, by peer-learners, or from other sources is jointly processed by a group of learners. The result of the cooperative learning process is a jointly structured information base as well as the learners' shared knowledge of this domain. As material is continuously added, learners need an easy way to access the material, and they have to organize and manage this knowledge and uphold an overview.

Problems known from hypertext, especially the loss of orientation in hyper-documents ("lost-in-hyperspace") and cognitive overload caused by navigation in the document, are amplified in hypermedia-based CSCL environments: Documents may be changed anytime by peer-learners working on the same document, and coordination with peer-learners is needed in order to maintain a common understanding.

In face-to-face situations non-verbal cues provide helpful information to cope with these problems, e.g. a learner can show disagreement with gestures or facial expressions upon a statement and thereby initiate a discussion. Reduced communication channels in distributed CSCL settings render the construction of shared knowledge more difficult. Learners must make non-verbal signals such as gestures or facial expressions explicit in order to communicate the to their peer learners. In our research, we aim at supporting learning groups by providing an interactive representation of the shared knowledge, the so-called *Learning Net* (LN). In the remainder of this paper we present how knowledge is represented in learning nets and how leraning nets can be used to support navigation in the shared knowledge, awareness of the shared knowledge, communication and cooperation in the learning group.

2. Knowledge Representation with the Learning Net

A common assumption in cognitive science is that most declarative knowledge can be represented according to the metaphor of a "net", or, more formally, as a directed graph (Churcher 1989; Sowa, 1998). In cognitive psychology, various types of nets are used to represent structural knowledge, i.e., the pattern of connections among concepts in memory, and nets are often used in educational settings to convey knowledge (Jonassen et al. 1993). Also, in the CSCL field net-like representations are used to visualize relations between concepts, statements, data, or hypotheses , e.g., in the Belvedere software environment (Suthers, 1999). Here, we aim at representing the essential structure of socially shared knowledge as it is dynamically constructed during the cooperative learning process in a more active way by linking documents and persons with the net.

A LN scheme is defined by the types of nodes, the type of relations between nodes, and the type of links to documents and persons. With respect to the types of nodes and relations between nodes empirical studies lead to the hypothesis that variation in these types can significantly affect the learning process and outcomes (Suthers, 1999). Therefore in our approach, the LN scheme can be user-defined, e.g., by the teacher, according to the kind of learning situation. An appropriate LN scheme then can be selected for each instance of the LN by the teacher or the learners. Specific LN schemes have been developed and implemented for the domain of problem-based learning (Miao et al., 2000). In the remainder we use a simple general-purpose LN scheme consisting of goals, topics, definitions etc. and focus on the connection of the LN to documents and persons.

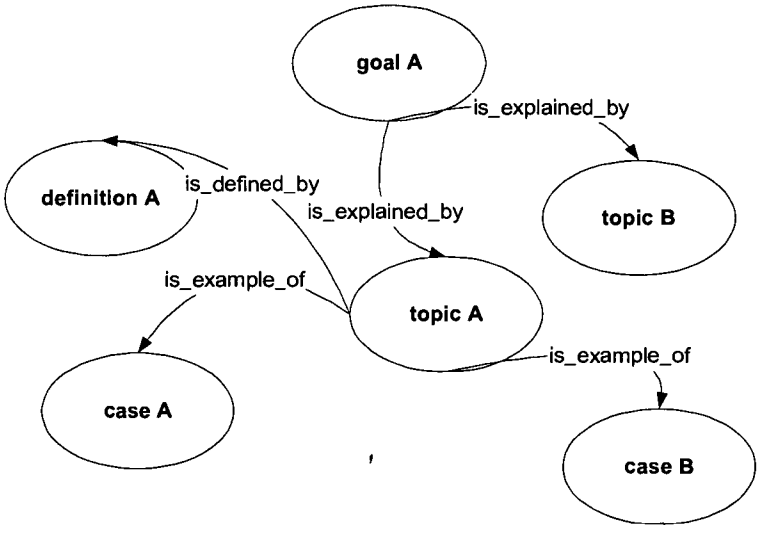

Figure 1: An example of concepts and relations in a Learning Net

Using the general-purpose scheme the LN is structured in the following way: A learning goal is the central node of the LN. To achieve the goal, several topics need to be tackled; a topic can be any concept, principle, or problem. To understand a topic, special cases can be presented as examples or analogies; e.g., a case-study on phobia treatment can serve as an example for the concept of behavior therapy; similarly, a topic can be introduced just by definition.

3. Usage of the Learning Net

3.1 The Outcome Perspective

From the outcome perspective, the LN should provide a common frame of reference and represent the current state of shared knowledge in a CSCL environment.

In cooperative learning it is (mostly) unclear a priori what the exact boundaries of the learning domain are. This

problem becomes more severe when the learning process evolves over time. Here, the LN provides a frame of reference, i.e., a structure that denotes what is part of the domain of concern and what is not. It is a kind of index all participants agreed upon. It is not fixed, since it dynamically changes during learning; changes, however, are not arbitrary, since they presuppose some kind of consensus among the participants. A LN supports various situations, e.g., informing a new person joining the group about what the learning process is about, or let a group continue where it left the learning process previously. The problems associated with the concept of shared knowledge (e.g., Nickerson 1993), especially how to measure it in a CSCL environment, are discussed in Pfister et al. (1999).

3.2 The Process Perspective

Besides the static viewpoint of the LN presented above, there is also an important dynamic aspect: The construction of a LN is a cooperative process during which knowledge is negotiated, different perspectives are integrated, and conflicts are made explicit. The degree of agreement (Pfister et al., 1999) on each element of the LN is reflected on the user interface, e.g. by different colors of nodes or links. This visualization provides an easy overview with respect to the "hot spots" of the group, e.g., conflicting concepts of group members. These hot spots can help to decide on the next steps in the learning process.

The construction of a LN can proceed *optimistically* or *pessimistically*. In the optimistic case, whenever a participant creates a new element, it is assumed that consensus is above a certain threshold. Anybody who thinks this element should not be part of the LN must actively object; a participant who does not object is assumed to agree. Hence, as long as nobody objects, the construction can proceed very smoothly by participants synchronously or asynchronously adding or deleting elements. To enforce active learning, a possibility is to proceed pessimistically, i.e., each element introduced in the LN by some person has to be explicitly accepted by everyone else, or by a majority defined by the consensus threshold. We assume the latter to be more time consuming but that it leads to more elaborated and deeper knowledge, both on the individual as well as on the group level. Anyway, the mode of the LN construction has to fit to the collaboration mode of the group. The mode should be determined in consideration of the group size, productivity, synchronicity etc. For example, in an asynchroneous collaboration of a large and productive group, the pessimistical construction hampers the progression of the LN: Each learner has to wait till the other learners agree before his or her contribution is included in the LN.

4. Realization

We distinguish the "document level" and the "conceptual level" in CSCL environments. The (hypermedia) document level comprises all basic documents created and imported, i.e., texts, graphics, etc. These documents are all related to concepts, i.e., the basic issues and topics the learning process is about. On the conceptual level, all concepts can be linked by semantic relations, e.g., "is example of", "is definition of". By defining the relation types users can model a wide range of domains and learning strategies. The LN is a representation of the conceptual level. It contains the concepts and relations between these concepts. Figure 2 shows a screenshot of the current implementation of a LN for problem-based learning (Miao et al., 2000).

4.1 Supporting Navigation: Connecting LN and Documents

In addition to the relations within the LN, there are links between the LN and the document space, i.e., each node refers to one or more specific documents, which provide detailed information relating to that node (e.g., a text, a diagram, etc.). Thus, by looking at the LN representation, learners are able to orient themselves and gain an overall and common understanding of the domain, but may then "dive" into the document space by following a link from a node of the LN to an associated document.

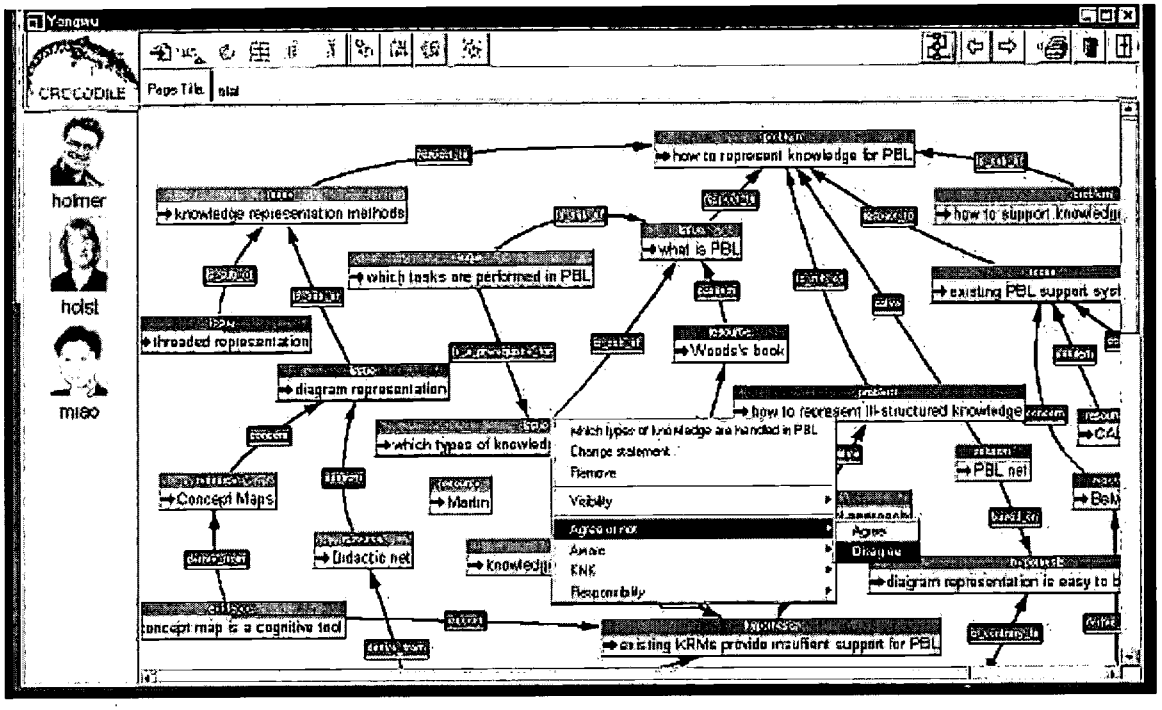

Figure 2: A screenshot of the current implementation of the Learning Net for problem-based learning

4.2 Supporting Awareness: Visualizing the Group State and Progress

The LN provides a color bar for each node and relation on the user interface (a line at the bottom of each node and relation in figure 2). Using a context-sensitive mouse menu (see figure 2) a learner can express her or his oppinion with repsect to a number of scales, e.g. whether he or she agrees or disagrees with a certain node or relation, whether he or she has knowledge about the topic of a certain node. The color bar visualizes the percentage of learners which agrees/disagrees, which has knowledge about this topic. Thus, the LN can be used to get a quick overview of the state of the learning group as a whole, e.g. with respect to the consensus in the group or the progress of a group with acquiring a certain knowledge domain.

4.3 Promoting Cooperation (1): Connecting LN and Persons

More generally, persons, who are also a knowledge resource - especially, in the context of cooperative learning, are represented in the same way as documents. Thus, persons can also be linked to concepts, for example, an expert in spreadsheets can be linked to the concept "Table creation" with a link labeled "is expert of".

4.4 Promoting Cooperation (2): The Construction of the LN

Access to the LN is available from everywhere in the CSCL environment. When a user opens the LN, a collaborative LN editor starts for the user and all other users in the same group. There are two ways to construct the LN. Nodes, relations, and anchors can be generated directly, or they can be the output of a system-controlled cooperative learning method, a so-called learning protocol (Wessner et al., 1999). In addition, some modifications could be initiated automatically according to the system's knowledge about the learning process, e.g., enforcing specific nodes according to the learning strategy.

For direct construction and modification the collaborative LN editor contains separate functions to construct and modify the LN, especially to create, edit, and delete nodes, relations, and anchors to documents or persons. Node types and relation types are fixed, so the direct construction is more or less the same as working with a graphical editor. However, the LN must not be independent of documents and participants, i.e. in general, each node should reference at least one information resource. Thus, there are smooth transitions between the LN, the

documents, and the participants in the CSCL environment: From each node in the LN, one can navigate to the associated resources.

Learning protocols systematically support a special kind of communication or cooperation activity in a group of learners. For example, the explanation protocol controls a dyadic explanation process by systematically switching roles (explainer and explainee), providing a specialized interface to enter explanations and questions. If both agree, the dialogue can be stored for future use or further discussions, and the information (x is an explanation dialogue concerning topic y) can be incorporated appropriately into the LN. While in this example the modification of the LN is a side-effect of the learning protocol, there are other learning protocols specially designed to modify the LN.

5. Summary and Open Questions

We have proposed the Learning Net (LN) as an interactive representation of shared knowledge for cooperative learning. The learning net is a socially constructed, dynamic meta-level above the hypermedia learning artifacts, (1) providing orientation and navigation in the learning domain and (2) supporting cooperation between learners. The LN is part of a learning environment called CROCODILE, developed in the internal research project CLear at GMD-IPSI (Pfister et al., 1998; Miao et al. 2000). For further information on the CLear project and downloads see http://www.darmstadt.gmd.de/concert/projects/clear.

Preliminary evaluation results at GMD-IPSI indicate that the learning net can be used in various ways, e.g.,

- Tool for scaffolding: A teacher builds a LN as a skeleton for the intended learning process. The students take this LN as a starting point for their learning, "fill" it step-by-step with related documents, extend and modify the LN as the learning proceeds.
- Tool for summarizing and reflecting: The group starts with an empty LN. After each learning phase the group summarizes what they have collected and discussed by creating and extending the LN. They use the LN to reflect on the last learning phase.
- Inductive vs. deductive learning: The learners can start with examples or cases and proceed towards more general concepts and rules and vice versa.

Some problems we encountered and which we plan to investige in the future are:

- Participation of absent learners: How can and must absent learners be involved in the maintenance of the LN? Should absent learners block changes in the LN?
- Reducing the cognitive load: Can we reduce the additional cognitive load for maintaining the LN by prompting learner(s) to update the LN under certain conditions, e.g., at the end of a session or after creating a certain number of new documents?
- Scalability: Preliminary evaluation results indicate that the usability decreases rapidly in groups with more than three or four members. How can we improve the usability in larger groups?

6. References

Churcher, P.R. (1989). A common notation for knowledge representation, cognitive models, learning and hypertext. In: *Hypermedia* 1, 235-254.

Jonassen, D.H., Beissner, K., & Yacci, M. (1993). *Structural knowledge. Techniques for representing, conveying, and acquiring structural knowledge.* Hillsdale: Erlbaum.

Koschmann, T. (Ed.) (1996). *CSCL: Theory and practice of an emerging paradigm.* Mahwah, NJ: Erlbaum.

Miao, Y., Holst, S., Holmer, T., Fleschutz, J., & Zentel, P. (2000). An Activity-Oriented Approach to Visually Structured Knowledge Representation for Problem-Based Learning in Virtual Learning Environments. *Proceedings of the Fourth International Conference on the Design of Cooperative Systems (COOP'2000).* May 23-26, 2000, Sophia Antipolis, France.

Nickerson, R. S. (1993). On the distribution of cognition: some reflections. In G. Salomon (Ed.), *Distributed cognitions. Psychological and educational considerations* (pp. 229-261). Cambridge: Cambridge University Press.

Pfister, H.-R., Wessner, M., Beck-Wilson, J., Miao, Y., & Steinmetz, R. (1998). Rooms, protocols, and nets: Metaphors for computer-supported cooperative learning of distributed groups. In A. Bruckman, M. Guzdial, J. L. Kolodner

& A. Ram (Eds.), *Proceedings of ICLS 98, International Conference of the Learning Sciences 1998* (pp. 242-248). Charlottesville, VA: Association for the Advancement of Computing in Education (AACE).

Pfister, H.-R., Wessner, M., & Holmer, T. (1999). Negotiating about shared knowledge in a cooperative learning environment. *Proceedings of CSCL'99 – Computer Support for Collaborative Learning*, December 12-15, 1999 - Palo Alto, California, pp. 454-457.

Slavin, R. (1995). *Cooperative learning: Theory, research, and practice.* Needham Heights, MA: Allyn and Bacon, 2nd Edition.

Sowa, J.F. (1998). *Knowledge representation. Logical, philosophical and computational foundations*. Pacific Grove: Brooks/Cole.

Suthers, D. (1999). Representational support for collaborative inquiry. In Proceedings of *HICSS '99, Hawai'i International Conference on System Sciences*, January 5-8, 1999, Maui, Hawai'i.

Wessner, M., Pfister, H.-R., & Miao, Y. (1999). Using learning protocols to structure computer-supported cooperative learning. In *Proceedings of ED-MEDIA '99*. Seattle, Washington, June 19-24, 1999.

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