Supporting Cooperative Learning with Learning Protocols: Structured Cooperation of Learning Groups in Distributed Net-Based Learning Environments

Goals
The project aims at experimentally studying the effectiveness of structured discourse in net-based learning environments. Learning protocols, defined as implemented and system-controlled cooperation scripts, are assumed to overcome some of the deficiencies of unstructured text-based computer-mediated learning discourses. Specific versions of learning protocols, such as providing explanations, summarizing and discussing texts, are examined in order to identify which features improve knowledge acquisition, and to establish task and situational constraints relevant for successful application.

Background
In distributed net-based settings, cooperative learning typically takes place by employing text-based tools, such as email and chat. Lack of coordination and coherence concerning the participants’ contributions is a persistent problem with text-based discourse. Presumably, this is due to the lack of information implicitly available in face-to-face communication, such as non-verbal cues or deictic gestures. As a consequence, situational awareness is reduced, grounding of contributions and the construction of shared knowledge is obstructed, and the emerging discourse suffers from incoherence. Most likely, such suboptimal discourses will lead to suboptimal learning outcomes.

In face-to-face classroom settings it has been shown that cooperative learning can be improved by using so-called scripted cooperation. Cooperation scripts impose a set of rules on how cooperation proceeds in a structured way in a learning group; the rules are either provided via instruction or controlled by a human moderator. We suggest that scripted cooperation is even more useful in net-based discourses. Focusing on synchronous text-based communication, cooperation is accomplished by what we term learning protocols, i.e., implemented types of scripted cooperation on a fairly microscopic level. Generally, a learning protocol coordinates the succession of as well as the relation between participants’ contributions; in particular, it is defined by four characteristics: (i) Typed contributions, i.e., each contribution is categorized by the contributing participant by choosing from a menu of predefined types, such as ‘question’, ‘explanation’, or ‘comment’; (ii) explicit references, i.e., the concept, statement, or previous contribution to which a participant refers is indicated and visually depicted on the interface by a connecting line from the contribution to the referred object; (iii) distinct roles, i.e., each participant is assigned a role (e.g., tutor, learner, commentator) which constrains the types and sequencing of allowed contributions; (iv) sequence, i.e., order of participants’ turn-taking is controlled by a predefined schema.

From this general definition, specific learning protocols for particular discourse purposes can be derived. Two kinds of learning protocols have been implemented and are currently investigated: an ‘explanation protocol’ and a ‘text processing protocol’. The explanation protocol serves to support a structured discourse which aims at explaining concepts, theories, and principles; the text processing protocol supports structured discussion and the reviewing of summaries of textual information. With the explanation protocol a group of three or more learners starts with an initial text about some knowledge domain, and then iteratively exchanges questions, explanations, and comments with respect to any aspect of that domain.
Learners are supported by a tutor whose task is to give explanations on request. A typed contribution is delivered by each learner in strict order, always explicitly indicating the intended reference.

**Project work**

At present, two experiments have been conducted to test the effects of using the explanation protocol in comparison to a control group using ordinary non-structured chat. For experimental purposes, a special client/server-based learning environment was developed in order to implement the learning protocol features, such as role and turn-taking indicators, menus for contribution typing and functions for referencing. Distributed synchronous learning was simulated by seating participants in separate cubicles with a computer, connected via a network. Participants communicated by typing text contributions and reading the contributions of their co-learners. All interactions were recorded as logfiles.

In experiment 1, groups of three participants cooperatively learned about two knowledge domains by carrying out a learning discourse either controlled by the explanation protocol or freely using a standard chat tool. One knowledge domain dealt with the origin of earthquakes, the second domain dealt with Kant’s philosophical notions of ‘knowledge’ and ‘belief’. One learning session took 25 minutes. Performance was assessed individually with a knowledge test. It was hypothesized that knowledge gains will be greater in the experimental group guided by the protocol.

In study 2, the experimental design was expanded in two ways. Group size was varied from two to four participants; it was hypothesized that the impact of the learning protocol increases with group size, since normal chat-based communication has a strong tendency to become incoherent with increasing numbers of participants. Second, the learning protocol was employed in two variants, one complete version (as in experiment 1), and a second variant without the referencing function. Theoretically, the requirement for explicit referencing is expected to be a key determinant of discourse coherence; it is hypothesized that without referencing the impact of the learning protocol will drop notably. Otherwise, experimental conditions and measures were equivalent to experiment 1.

**Results**

Results of experiment 1 confirm the hypothesis of increased knowledge gains using learning protocols in the knowledge domain ‘earthquake’, but not in the philosophical domain. Knowledge about earthquakes proved to be significantly greater when the learning discourse was controlled by the explanation protocol. However, knowledge about the philosophical domain yielded no significant difference between the experimental and the control group.

Results of experiment 2 replicate this finding, but yield an important additional insight: Only in the condition with the referencing function, i.e., when using the complete protocol, performance significantly increased; the difference in knowledge between the learning protocol condition without referencing function and the control group turned out non-significant. Also, there was a tendency for the larger groups with four participants to benefit more from the complete learning protocol than smaller groups, though the interaction between group size and learning protocol did not reach significance. As before, these findings only refer to the knowledge domain ‘earthquake’, whereas with respect to the philosophical domain, the variation of the learning protocol proved to be non-effective. However, a significant effect for Group Size was found; unexpectedly, groups consisting of three participants performed better when using a learning protocol (in either version), whereas groups with two or four participants showed no difference in performance across conditions.
In sum, our findings suggest that learning protocols can improve knowledge acquisition in net-based settings; however, this positive effect is domain dependent. Learning protocols seem to be advantageous for scientific-factual knowledge domains, but not for philosophical domains. The effects of group size are less clear-cut.

**Future research**

At present, experiments to investigate the impact of a ‘text processing’ learning protocol are set up; in contrast to the explanation protocol, cooperative text processing is entirely self-organized and does not involve a tutor. Further research will aim at clarifying why and how learning with protocols depends on the type of knowledge domain. Also, the relation between discourse coherence and the ensuing mental representation needs further clarification. In addition to the study of individual knowledge acquisition with learning protocols, a major focus will be on group phenomena such as the formation of shared and distributed knowledge.

**Research output**

- **Conference contributions:**

- **Products / Software:**

- **Funding period**
  June 2001 – May 2003

- **Other team members**
  - Dipl. Psych. Werner Müller (IWM, Tübingen)
  - Cand. Psych. Annette Conzelmann (IWM, Tübingen)
  - Cand. Psych. Mareike Geisen (IWM, Tübingen)
  - **External cooperating partners**
  - Dipl. Psych. Dipl. Inform. Martin Mühlpfordt (Fraunhofer IPSI, Darmstadt)
  - Cand. Psych. Mareike Hennings (Fraunhofer IPSI, Darmstadt)

- **Project address**
  - Prof. Dr. Hans-Rüdiger Pfister
  - Institut für Wissensmedien IWM (Knowledge Media Research Center KMRC)