Fostering Audience Design of Computer-Mediated Knowledge Communication by Knowledge Mirroring

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Abstract. Higher education is increasingly realized by net-based scenarios often incorporating collaborative activities. This is accompanied with specific benefits but also constraints. In computer-mediated peer-tutoring for example it is more difficult to construct mutual models, thus impairing collaborators´ grounding, audience design and coordination. In this paper `Knowledge Mirroring`, that is providing information about the partner's knowledge, is introduced as technological support developed to compensate for these problems. Effects of Knowledge Mirroring on audience design and knowledge acquisition are studied in a simulated peer-tutoring scenario with explaining as basic activity. Analysis of explanations revealed audience design with respect to usage of elaborations and references. Results regarding knowledge acquisition show that learners provided with Knowledge Mirroring were able to draw more inferences on information distributed across the learning material.

Computer-mediated knowledge communication

Higher education is increasingly realized by net-based collaborative scenarios. Thus, by analysing the specific constraints of computer-mediated collaborative learning effective support can be developed. *Knowledge Mirroring* (KM) follows recent interest in *group awareness tools* (Soller, Martinez, Jermann, & Muehlenbrock, 2005). As KM provides learners with relevant information without explicit instruction on how to use the information it is classified as implicit learner support. The effects of KM on communication are investigated in an experimental study. Among the various tasks that can be implemented within collaborative learning this study focuses on two basic activities within peer-tutoring: question-asking and explanation-giving.

For peer-tutoring to be effective learners need to construct adequate models of their partner's knowledge (Chi, Siler, & Jeong, 2004). However, initial models are biased towards the model of one's own knowledge (Nickerson, 1999). Even worse, common strategies of verifying models are frequently ineffective (Person, Graesser, Magliano, & Kreuz, 1994). In addition to these problems also arising in face-to-face tutoring, particular affordances and constraints are being introduced when peer-tutoring is realized through computer-mediated communication (e.g. mail, chat). More specifically, costs of grounding vary with the medium (Clark & Brennan, 1991). Altogether, in computer-mediated peer-tutoring it is more difficult to construct mutual models, establish common ground and adapt utterances to the specific partner, i.e. perform audience design (Clark & Murphy, 1982). KM is introduced in this paper as a method to compensate for these specific problems by providing information about the partner's knowledge. This is assumed to improve *adaptation of communication* and knowledge acquisition. KM offers information on which to adapt utterances for more efficient communication (Grice, 1979). Support for *knowledge acquisition* is suggested as audience design of explanations elicits additional elaboration and re-organisation of knowledge. Giving as well as receiving elaborated explanations was shown to enhance learning (Webb & Palincsar, 1996).

Research method

The primary goal of this study was to facilitate audience design in peer-tutoring by providing KM. As the focus was on production rather than reception of explanations a simulated peer-scenario was chosen. Thus, participants were not interacting directly with a learning partner but formulated explanations for a simulated partner in asynchronous communication.

Design. 42 participants were randomly assigned to two conditions (with versus without KM). Subjective estimations of understanding were assessed. In the control condition (CC) only Ss´ own knowledge was presented in the KM-Tool as knowledge (see green tags in Figure 1) or deficit (not tagged). Ss in the experimental condition (EC) were additionally provided with the knowledge of a simulated partner. The partner's knowledge was computed systematically relative to the participants´ knowledge resulting in three types of combinations: shared knowledge (both tagged), shared deficit (neither tagged), complementary knowledge (only participant tagged).

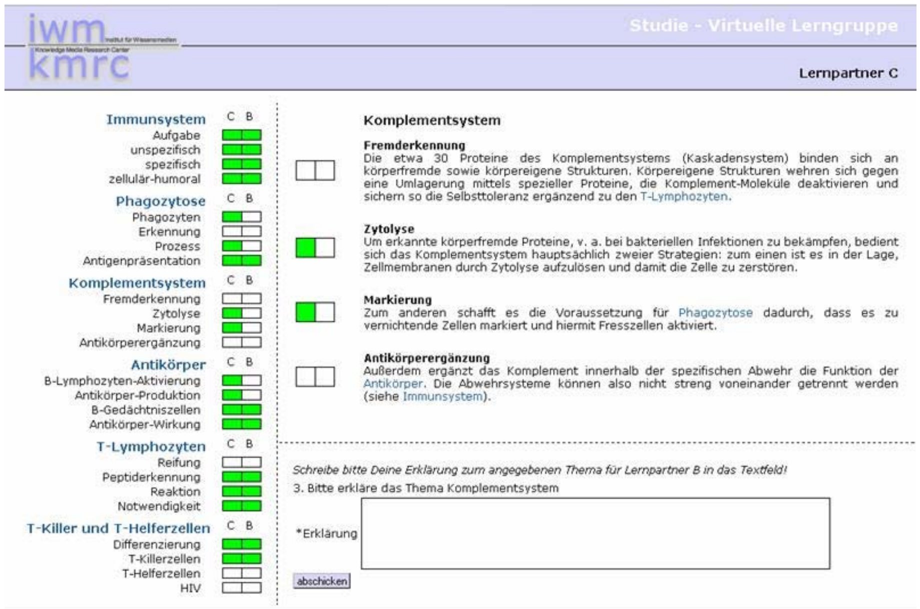

Figure 1. Explanation-giving task within EC. On the left side KM is realized by two columns next to the topic list. The left column displays participants´ knowledge and the right knowledge of the simulated partner. Only the left column is displayed in CC. On the right upper part learning material is presented along with KM-information for the respective topic. In the right lower part a field is available for formulating explanations.

Procedure and Analysis. First, participants learned individually for 25 minutes with a hypertext providing information on the immune system. For the following 25 minutes they wrote explanations for a partner on four pre-selected topics. KM was available during the explanation task in the EC. KM was assumed to induce audience design and thereby activities beneficial for learning. Audience design was assessed by analysis of formulated explanations, whereas learning outcome was measured after the explanation task by a 48 items multiple-choice test capturing factual (24 items) as well as local (information on one page of hypertext) and distant (information distributed over pages of hypertext) inferential knowledge (12 items each).

Results

Audience Design

Explanations were coded for the following indicators of Audience Design: number of words, elaborations, and references. An elaboration was assigned if the explanation provided additional information (e.g. from prior knowledge) that was not contained in the learning material. References were assigned when other parts of the learning material were used as a basis for the current explanation.

Audience Design (i.e. adaptation to the partner's knowledge) was assumed to result in different mean numbers of words, elaborations, and references (see Table 1) between tagging combinations in the EG. A within-subject ANOVA revealed significant differences between tagging conditions for number of words ($F(2,11) = 4.4$, $p < .05$), and references ($F(2,14) = 5.1$, $p < .05$), but not for number of elaborations ($F(2,14) = 0.8$, $p = .48$). T-tests for paired samples revealed significantly more words for complementary knowledge than shared knowledge ($t(17) = 3.6$, $p < .01$) and shared deficits ($t(12) = 2.4$, $p < .05$) as well as more references to shared knowledge than to complementary knowledge ($t(20) = 3.5$, $p < .01$) and shared deficit ($t(20) = 2.7$, $p < .05$).

Knowledge acquisition

An ANOVA performed on achievement in the knowledge test revealed a significant effect of condition only for distant inferential knowledge (53% vs. 41%; $F(1,40) = 4.4$, $p < .05$). In the remaining subtests a consistent but non-significant better performance of EC was found. Correlative analyses showed that performance in the distant inferential test was moderately associated with absolute (i.e. number of elaborations and references) but not with relative audience design indicators (e.g. ratio of references per type of tagging combination). However, according to additional regression analyses neither of the absolute indicators mediates the effect of experimental condition on performance in the distant inferential knowledge test.

Table 1: Indicators of Audience Design for each tagging combination in the experimental condition.

	Mean number of words	Mean number of elaborations	Mean number of references
EC: shared knowledge	11,7	0,10	0,67
EC: complementary knowledge	16,9	0,29	0,05
EC: shared deficit	10,4	0,24	0,19

Theoretical and educational significance

Enhancing efficiency and effectiveness of computer-mediated knowledge communication is the main purpose of this research project. Evidence of support for audience design and knowledge acquisition by KM during explanation-giving is presented. As a next step it will be investigated whether recipients benefit from audience-designed utterances. KM is flexibly and easily applicable to a multitude of collaborative learning settings and domains (e.g. physics), particular value in complex learning domains of higher education is supposed.

Recently, a multitude of tools providing awareness of group characteristics was developed (Soller et al., 2005). Empirical validation of awareness tools can be found e.g. in research on expert-layperson-communication (Nückles, Wittwer, & Renkl, 2005). This study complements this body of research by investigating processes triggered by awareness tools within a peer-tutoring scenario.

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Acknowledgements

The author is member of the Virtual PhD-Program "Knowledge Acquisition and Knowledge Exchange with New Media" (VGK) sponsored by the German Research Association (DFG).