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ABSTRACT

A method to facilitate collaborative learning in complex learning environments was developed and evaluated. Sixteen college students of educational science were given the CoStructure-Tool, a task-specific computer-based tool developed on the basis of concept mapping techniques to support the processes of knowledge construction in collaborative learning. The tool includes concept cards for case information and cards for theoretical concepts, with a screen divided into empirical and theoretical planes. Sixteen other students collaborated without this support in a control condition. Students in both conditions had to work on complex cases in the domain of education. The use of the mapping tool had substantial effects on collaborative knowledge construction. Dyads in this group produced more on-task contributions and used more theoretical concepts. Use of the mapping tool also facilitated transfer of prior knowledge, but no differences were found in the use of theoretical concepts provided in the learning environment. The CoStructure-Tool proved to be a method for facilitating cooperation that was effective in supporting specific processes and in improving the transfer of prior knowledge. (Contains eight references.) (SLD)

Mapping-Enhanced Collaborative Knowledge Construction

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Mapping-supported collaborative knowledge construction in complex learning environments

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a) Perspectives and objectives of the study

Situated and constructivist approaches emphasize the advantages of collaborative learning in complex learning environments (e.g. Collins, Brown & Newman, 1989). However, empirical studies in different domains have shown that even advanced adult learners often are overwhelmed by the multiple demands imposed on them in complex learning environments (e.g. Mandl, Graesel & Fischer, in press). In particular, learners often have severe difficulties with collaborative learning. Frequently, discourse quality is low and so is the outcome (e.g. Salomon & Globerson, 1989; Cohen, 1994).

Discourse in collaborative learning. In order to better understand the effects of collaborative learning, and, as a consequence, to improve instructional support, there is a growing emphasis on the analysis of discourse processes. Among the most important discourse processes concerning the learning issue are processes of collaborative knowledge construction. Besides semantic analyses, most approaches to analyzing collaborative knowledge construction focus on some or all of the following four groups of processes: Externalization, elicitation, integration-oriented consensualization, and conflict-oriented consensualization. We assume these processes as beeing of crucial importance for the effects of collaborative learning in complex learning environments. Therefore, our instructional method to facilitate collaborative learning should support these processes.

Facilitating collaborative learning. Besides the improvement of the initial conditions (which often cannot easily be changed) like for example the certification issue, methods for structuring interaction are succesfully used to facilitate collaboration (e.g. King, 1994;). The prescription of roles, e.g. teacher and student in reciprocal teaching (Palincsar & Brown, 1984; Rosenshine& Meister, 1994) and scripts for the collaboration procedure (like the jigsaw method) are well-established methods. Unfortunately, most of these methods have been developed in school contexts and are not completeley adequate for an important component of higher/further education: collaborative learning of adults in complex learning environments.

In *mapping-supported collaborative knowledge construction* learners in complex learning environments are provided with adequate tools which help them to collaboratively construct solutions for complex tasks. Different from other approaches, *mapping-supported collaborative knowledge construction* does not include prescribed roles. Moreover, it does not restrict the degrees of freedom in discourse as is the case in the tool-constrained discourse approach (e.g. Baker & Lund, 1997). The basic idea is that the tool provides the learning partners with an *additional symbol system* to represent concepts and relations between concepts. The task-specific computer-based CoStructure-Tool has been developed on the basis of simple concept mapping techniques to support the crucial processes of knowledge construction described above.

The *main goals of this study* have been (a) to develop and evaluate a method for facilitating collaborative learning in complex learning environments by supporting processes of collaborative knowledge construction and (b) to analyze in detail the influences of this method on the processes of collaborative knowledge construction in order to improve our understanding of how these processes can be supported by instruction.

b) Method and data sources

Sample and design. In dyads, thirty-two university students of educational science were randomly assigned to one of two experimental conditions. Sixteen learners were provided with *CoStructure-Tool*, sixteen learners collaborated without this support in a control condition.

Learning environment. Students in both conditions had to work on complex cases in the domain of education. In these cases, teachers describe a plan for an instructional unit and ask the participants for an evaluation of the plan from a theoretical perspective. The students' task was to prepare a common evaluation of the case. While working on a case, students were provided with a collaborative computer tool (which was different in experimental and control group) to represent their developing solution graphically. After each case, students were asked to give a short oral evaluation of the case from a theoretical perspective.

Mapping-supported collaborative knowledge construction. Dyads in this condition were provided with the CoStructure-Tool, a computer-based graphical mapping tool, that includes concept cards for case information and cards for theoretical concepts, in which text could be typed in directly. Positive and negative relations can be used to connect cards. Moreover, the screen of the CoStructure-Tool is divided into an empirical and a theoretical plane. Both learners were provided with a keyboard and a mouse and could access the different objects on the screen virtually simultaneously.

Learners in the *control condition* worked on a computer tool which comprises the functionality of a simple graphic editor. The learners could type in and edit text, draw lines, circles and rectangles and change the colours of these items.

Procedure. After a pre-test of domain-specific prior knowledge, students were made familiar with the learning environment, especially with the use of the computer tool. Next, learners worked together on three cases. During their work on the cases learners were allowed to use a text with a small selection of relevant theoretical concepts and their descriptions, which above all was supposed to examplify what is meant by a "theoretical concept".

Variables and data types. As the data source for the variables of collaborative knowledge construction and outcome we used tape recordings of discourses and final evaluations. These tape recordings were transcribed and analyzed (e.g. segmented and classified in the case of the knowledge construction process variables).

Variables. (1) Processes of collaborative knowledge construction. In addition to the semantic or content dimension (theoretical concepts, case information, relation between case and theory), a combined analysis of the content (e.g. theoretical concept) and the functional dimension (e.g. statement) were conducted to get indicators for the four important processes of knowledge construction described above: externalization, elicitation, integration-oriented consensualization and conflict-oriented consensualization. (2) Outcome. As outcome measures, the integration of different kinds of theoretical concepts into the final oral case evaluation was examined. The different kinds of theoretical concepts were concepts given in the learning environment and prior knowledge concepts (transfer).

c) Results and conclusions

The two groups were comparable in so far as they did not differ in their domain-specific prior knowledge.

The most important effects were the following:

The use of the mapping tool had substantial effects on collaborative knowledge construction: Concerning the content, dyads in this group produced more on-task contributions, in particular, they used more theoretical concepts, i.e. elaborated more on theoretical concepts. No differences could be found concerning the relations between theoretical concepts and case information, i. e. the use of the abstract theoretical knowledge in the case context. The combined analysis of content and function showed that the use of the mapping tool had a positive effect on the processes of conflict-oriented consensualization, e.g. learners rejected a partner's propositions more frequently in the mapping tool condition.

The use of the mapping tool had substantial effects on the outcome: The use of the mapping tool substantially facilitates prior knowledge transfer. No differences could be found concerning the use of theoretical concepts provided in the learning environment.

Processes of knowledge construction are associated with outcome: In particular, the use of theoretical concepts, and of relations between theoretical concepts and both case information (content variables) and conflict-oriented consensualization (process variable) are substantial predictors of prior knowledge transfer.

A more general conclusion that could be drawn is that mapping-supported knowledge construction has three important functions that correspond to three difficulties often reported in the literature on collaborative learning: (1) task-focusing by providing the learners with task-relevant structural features (2) improving quality of discourse processes by supporting more abstract/theoretical content of the knowledge construction processes, and (3) reducing illusion of consensus and fostering socio-cognitive conflict.

d) Scientific and educational importance of the study

Concerning scientific importance of the study two points are made: (1) *Contribution to the descripion and measurement of collaborative processes*. The classification scheme developed and applied in this study to measure collaborative knowledge construction in discourse is a practicable and reliable instrument. (2) *Contribution to the palette of evaluated methods for the design of collaborative learning environments. The CoStructure-Tool as a tool for mapping-supported collaborative knowledge construction* proved to be a method for facilitating cooperation which is effective in supporting specific processes and in improving transfer of prior knowledge.

We see the most promising field of application in collaborative learning in complex learning environments in higher/further education. *Tools for mapping-supported collaborative learning* in multimedia and net-based learning environments are relatively easy to implement as well as easy to use by the learning partners.

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