Fostering Collaborative Knowledge Construction in Desktop Video-conferencing. Effects of Content Schemes and Cooperation Scripts in Peer Teaching Settings

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ABSTRACT

Video-conferencing is expected to become increasingly important for tele-learning environments. In contrast to asynchronous, text-based computer-mediated communication, video-conferencing facilitates cooperation tasks that require highly frequent and continuous coordination. Typical kinds of such cooperation tasks are found in peer teaching settings. Despite the growing application of video-conferencing, only little is known about possibilities of enhancing collaboration in video-conferencing settings. This study investigates the effects of different types of support for cooperation on the learning outcomes of peer dyads in a video-conferencing scenario. The main research question is how cooperation scripts and content schemes enhance the students' cognitive activities and foster the outcomes of cooperative learning. Two factors were varied experimentally: The content scheme (with/without) and the cooperation script (with/without). 86 university students of educational psychology participated in the study. Each student of a dyad received a text dealing with a psychological theory in the field of the nature-nurture-debate. The students' tasks were (1) to teach their partners the relevant contents of their text and (2) to reflect ideas that went beyond the scope of the text. Results indicate that in particular the cooperation script enhances learning outcomes of collaborative knowledge construction.

Keywords

Collaborative knowledge construction, video-conferencing, content schemes, cooperation scripts

INTRODUCTION

Research on cooperative learning in video-conferencing has become increasingly interesting for educational psychology. The rapid developments in the field of information and communication technology suggest that video-conferencing will be intensively applied in educational institutions in the near future, since it enables synchronous forms of collaborative distance learning which allow very frequent and complex interactions. So far, research in this field has mainly aimed at investigating differences with respect to interaction and communication between video-conferencing and other modes of cooperation, in particular face-to-face and asynchronous text-based cooperation. Yet, only a few studies in the field of video-conferencing have focused on processes and outcomes in the context of learning. This study tries to bridge this gap by investigating effects of content schemes and cooperation scripts on processes and outcomes of collaborative learning in video-conference settings.

THEORETICAL FRAMEWORK

Contents, processes, and outcomes of collaborative knowledge construction in face-to-face and video-conference settings

Learning contents and learning processes

So far, only a few studies on video-conferencing have analyzed collaborative knowledge construction systematically. The analyses and descriptions of collaborative knowledge construction basically discriminate content-related and process-related aspects. Regarding the content level, a major question concerns the distinction between *on-task* and *off-task* contents. In particular, it has been analyzed to what extent, how frequently, or how adequately learners talk about relevant contents of the learning task (e.g. Cohen, 1994). Another aspect of content-related aspects that is especially relevant in the context of video-conferencing concerns the *coordination* of learning activities. When analyzing discourse processes in video-conference settings, Fischer, Bruhn, Gräsel, and Mandl (in press, b) distinguish between *task-related* and *technology-related* coordination. According to them, task-related coordination during collaboration is positively correlated with individual learning outcomes. Moreover, they conclude that there are no significant differences between collaboration in video-conferencing and in face-to-face settings, neither concerning task-related coordination nor concerning technology-related coordination.

In addition to discourse contents, other approaches include the analysis of process-related aspects of collaborative knowledge construction. Webb (1991), for example, analyzed explanations with different levels of elaboration, whereas Graesser and Person (1994) focused on questions in tutoring discourse. Fischer, Bruhn, Gräsel, and Mandl (1998) presented an approach that analyzed four processes of collaborative knowledge construction: (1) *Externalization* refers to the process of contributing prior individual knowledge. This exchange of different individual concepts is considered to be the starting point of negotiating common meaning. (2) *Elicitation* refers to the strategy of using the learning partner as a resource (Dillenbourg, Baker, Blaye, & O'Malley, 1996). Learners cause each other to externalize task-related knowledge: By asking questions, for example, they induce their partners to give explanations. Thereby, elicitation can be responsible for activating deeper comprehension processes (e.g. King, 1994). (3) *Conflict-oriented negotiation*, another aspect of collaborative knowledge construction, refers to the concept of socio-cognitive conflict (cf. Dillenbourg et al., 1996; Doise & Mugny, 1984). Socio-cognitive conflict occurs in situations in which learning partners externalize different or contrasting interpretations related to the learning task. This conflict often results in modifications of knowledge representations. (4) Apart from conflict-oriented negotiation, another way of reaching a consensus is the *integration* of different individual perspectives into a common interpretation or solution of the given task. However, although this form of consensus-building can be helpful under some conditions, it involves the risk of turning into a conflict-avoiding cooperation style. Considering current empirical findings, Fischer and Mandl (2000a) conclude that there are no substantial differences between video-conferencing and face-to-face settings concerning the processes of knowledge construction described above.

Learning outcomes

Research on cooperative learning focusses on different concepts of *learning outcomes*. Frequently, individual outcomes of cooperative learning are in the center of research interest. Therefore, cooperative learning efforts aim at the development of individual cognitive, socio-cognitive or affective abilities. In contrast to the focus on individual learning outcomes, other approaches emphasize the importance of collaborative outcomes, which are achieved by a joint solution of the given cooperation task (e.g. Scardamalia & Bereiter, 1993). In a recent study, Bruhn (2000) found that (1) dyads in the video-conferencing environment attained similar collaborative outcomes compared to dyads in a face-to-face setting, and that (2) learners in the two different settings did not differ with respect to individual outcomes. Similar to the findings concerning the learning processes, these results show that the different measures of learning outcomes do not differ substantially from each other in video-conferencing and face-to-face settings.

Another aspect concerning learning outcomes is the extent of *knowledge convergence* between the learning partners of a dyad or group. The concept of knowledge convergence refers to the degree to which individual learning outcomes of former learning partners are comparable in quality and quantity (Fischer & Mandl, 2000b). Aspects of knowledge convergence have rarely been considered up till now. Fischer, Bruhn, et al. (in press, b) presented empirical findings of a recent study that indicate that knowledge convergence is neither lower nor higher in video-conferencing than in face-to-face settings.

Fostering collaborative knowledge construction in face-to-face settings

The interactions described above, which are seen to be critical for effective cooperative learning, do not occur automatically. Typical barriers to effective cooperative learning are for example the diffusion of responsibility, social loafing, the dysfunctional division of labor, or a lack of learning skills on the part of the students (Johnson & Johnson, 1992). Renkl and Mandl (1995) specify important factors that are responsible for the success of cooperative learning: It depends on the nature of the given task, individual characteristics of the learners (which either support or interfere with cooperative learning activities) or the reward structure of the learning situation. Yet, the most critical kinds of interventions aim at fostering learning processes by guiding learners' interactions during collaboration.

One well-known and effective way to evoke learning activities in cooperative settings is to distribute different learning materials among the learners that should first be worked through individually. The subsequent cooperation task is to teach the learned material to each other. We label this kind of arrangement *peer teaching*, assuming that the learning partners possess similar learning skills but vary concerning the knowledge they acquired in the individual learning phase. Thus, peer teaching is distinguishable from peer-tutoring arrangements in which partners differ from each other in status and learning experiences with respect to the content (O'Donnell & Dansereau, 2000).

Peer teaching arrangements evoke learning activities by defining two different roles: the explainer and the learner. While the role of the explainer generally involves processes like providing information and responding to questions, the learner-role is defined by activities like asking questions. In this way, peer teaching settings trigger processes of collaborative knowledge construction in a 'natural' manner. Thereby, both the explainer and the learner may benefit from collaborating. For the explainer, learning by teaching is a significant mechanism that provides an opportunity to reformulate and extend knowledge structures. The learner, on the other hand, benefits from the one-to-one interactions in peer teaching settings: He or she not only gets the chance to immediately ask questions if necessary, but also to receive individual feedback by the explainer. Empirical findings (e.g. O'Donnell & Dansereau, 2000) indicate that peer teaching is an effective method of instruction. Yet, it has to be considered that peer teaching is a complex and complicated process of interaction which demands a great deal of the learners. Therefore, the question is how interaction and collaborative knowledge construction can be improved in peer teaching settings. At least two possibilities of fostering the interaction processes are conceivable: (1) supporting learners with content-specific structures which can facilitate the construction of new knowledge and (2) providing a cooperation script in order to evoke conducive processes of collaborative knowledge construction. Both treatments are considered to be helpful for cooperative learning in general. Therefore we will discuss both strategies in a broader context that goes beyond the scope of peer teaching settings below.

Pre-structuring task-specific contents. In order to improve collaboration by content-specific structuring methods, the learners receive some kind of visualization, such as a diagram or a table with central, yet abstract characteristics of the contents discussed during their collaboration. Fischer, Bruhn, Gräsel, and Mandl (in press, a) present empirical findings which indicate that content-specific structuring methods can foster processes and outcomes of collaborative knowledge construction. Dyads which worked with a pre-structured visualization tool not only externalized and elicited more task-related knowledge, but also benefited with respect to the quality of a collaborative problem solution when compared with dyads of a control group that received a non-structured visualization-tool. Suthers (in press) compares different kinds of representations (textual, graphical, and matrix) learners had to work on during collaboration in order to facilitate their learning processes and outcomes. According to him, the variation in the features of the representational tools can significantly affect the learners' knowledge building discourse. We assume that these kinds of content-specific structuring methods facilitate interaction processes in peer teaching by supporting both the peer in the explainer role and the peer who takes the role of the learner. They (1) can support the explainer in structuring the contents to be taught and (2) can provide 'anchors' for the learner to integrate the new knowledge.

Providing Cooperation Scripts. One of the most well known techniques which defines roles including specific cognitive activities is the *scripted cooperation* technique. It was developed for learning dyads and can be applied to a variety of tasks. A prototypical cooperation script used with a text comprehension task includes the following steps: (1) Both partners read the first section of a text, (2) partner A recalls the text information without using the text, (3) partner B provides feedback without looking at the text, (4) both partners elaborate on the text information, (5) both partners read the second section of the text, switch roles and continue with steps 1 to 4. Several studies have documented the effectiveness of this technique for cooperative learning (O'Donnell & Dansereau, 1992).

Another well-known instructional method for cooperative learning is *reciprocal teaching* (Palincsar & Brown, 1984). The reciprocal teaching technique designates roles that include the strategies questioning, summarizing, clarifying and predicting (Palincsar & Brown, 1984). Evidence for the effectiveness of these techniques results from numerous studies (Rosenshine & Meister, 1994). Studies about the effects of cooperation scripts usually compare groups who have been trained in applying the collaboration strategy with control groups which received no training. Thus, in contrast to methods merely using resource interdependence to evoke cooperation processes, techniques like scripted cooperation or reciprocal teaching generally include a prior training for the students working on a cooperation task.

A major advantage of techniques that explicitly aim at scripting cooperation – as described above – is that they support learners in effectively interacting with each other. So far, the effectiveness of these techniques has been documented mainly within face-to-face settings. Our approach is to apply these techniques within a video-conference setting.

Fostering collaborative learning in video-conference settings

Due to the rapid progress in the field of communication technology, video-conferencing is more and more becoming an application for everyday use and can also be expected to be a helpful extension concerning the design of new learning environments. Yet, up to now only a few studies on video-conferencing have raised the question of how to foster collaborative learning in video-conferencing. The question is, to what extent the approaches developed in face-to-face settings can also be applied to the context of video-conferencing. In general, we believe that interventions that have been shown to be effective in face-to-face settings as described above can also be helpful for fostering cooperative learning in video-conferencing. Yet, we also see some differences. Whereas techniques like peer teaching and the provision of content structures or cooperation scripts can be transferred to video-conference settings, the training of role skills in distance learning is an obstacle since the learners are located in different places. Yet, net-based learning environments provide the possibility to implement treatments not only by preliminary training but also by structured interfaces. This implementation strategy is well known in text-based computer-mediated learning environments. For example, Baker and Lund (1997) structured the text-based communication among learners working together on a problem-solving task by providing a structured communication interface which included so-called "communicative act buttons". These buttons aimed at facilitating the interaction between the learners and at encouraging the learners to engage in effective collaboration activities. Buttons labeled for instance with "Where do we start?" or "What should we do now?" tended to facilitate coordination and evoke meta-cognitive processes. Empirical findings indicate that the structured interface is able to promote interactions that enable learners to collaborate effectively on a problem-solving task.

AIMS OF THE STUDY

The aim of the presented study is to investigate two different possibilities to facilitate collaborative knowledge construction in video-conferencing. Therefore, we arranged a peer teaching setting in which two similarly experienced university students collaborated on a text comprehension task. Both learners were asked to teach each other the contents of a theoretical text they had read individually in a preceding text acquisition phase. The two variables varied in the experiment were (1) a text-based content scheme including guiding questions to facilitate collaborative text comprehension and (2) a cooperation script aiming at directing processes of collaborative knowledge construction. Both treatments were not implemented as a preliminary training of the participants. Instead we pre-structured the shared visual interface the learners worked on during collaboration. Our research questions are:

- How does the content scheme influence the learning outcomes in a video-conferencing peer teaching setting?
- How does the cooperation script influence the learning outcomes in a video-conferencing peer teaching setting?
- How does the interaction of the content scheme and the cooperation script influence the learning outcomes in a video-conferencing peer teaching setting?

METHOD

Setting

The scenario consisted of a desktop video-conferencing system including audio- and video-connection and a shared screen to support the dyads' knowledge construction. In this way, the setting allowed synchronous verbal communication and joint creation of text material. The shared application was realized with MS-Netmeeting 3.01. As text-editor we applied MS-Word 2000, an application that we expected to be well known among our participants and therefore easy to handle. This technical solution enabled the learners to alternately type or edit notes in the text-editor. Since we de-activated most of the Word-facilities, the participants were merely able to create text-material. The creation of tables or diagrams was not possible. The reason for this restriction was to focus the participants' activities on learning-relevant processes by reducing the amount of non-content talk.

Participants

96 students in their first semester who were enrolled in educational introductory courses at the Ludwig-Maximilians-University of Munich took part in this experiment. Participation was required for receiving a course credit at the end of the semester, even though learning outcomes of the experimental session were not accounted for the final students' performance appraisals. Dyads were set up and randomly assigned to one of four conditions (three experimental conditions and a control group). Learning partners in general did not know each other before the experimental session. The partners were seated in two different rooms where they stayed during the experiment. For data analysis we excluded 5 dyads, since in these groups at least one member had substantial problems with the German language.

Design

The design of the study is shown in Table 1. A 2x2 factorial design was formulated. The two factors were (1) content scheme and (2) cooperation script. Three experimental groups and a control group were formed. The experiment was conducted in one session that consisted of two main phases. During the individual text acquisition phase two different theory texts were distributed, one for each partner. In the following collaborative learning phase, the dyads were asked to work together using a desktop video-conferencing system to teach the contents of each text to the fellow learner. Thus, each learner took two roles: the *explainer-role* when explaining his or her theory to the fellow learner and the *learner-role* when receiving information from the partner. Two text documents (one per theory) were provided on the shared screen to allow the documentation of important discussion contents. In the *unscripted/scheme group,* the text documents were structured in such a way that they included several guiding questions stressing the content of that text which were supposed to direct the dyads' discussion throughout this phase. In the *scripted/non-scheme group*, the two text documents included instructions about the explainer- and learner-role in order to effectively direct the learners' interaction. Dyads in the *structured/scheme group* worked with text documents that included the guiding questions as well as the cooperation script. Participants in the *unscripted/non-scheme group*, which served as control group, worked with two text documents that only included the name of the particular theory as a headline without any further aids.

Table 1: Experimental design of the study.

		Cooperation script	
		Without	with
Content scheme	without	**unscripted/non-scheme group** (n = 12 dyads)	scripted/non-scheme group (n = 11 dyads)
	with	**unscripted/scheme group** (n = 10 dyads)	**scripted/scheme group** (n = 10 dyads)

Content scheme. The content scheme was implemented by a pre-structured shared text document that contained eight guiding questions. Table 2 shows the questions of the content scheme.

Table 2: Questions included in the content scheme.

Theory	**Empirical Findings**
• What are the most important concepts of the theory? • What are the main ideas of the theory?	• How was the theory examined? • What were the results of the empirical studies?
Consequences	**Individual Estimation**
• Which pedagogical interventions can be concluded from the theory? • Which limits of pedagogical interventions can be concluded from the theory?	• What do I like/dislike about the theory? • Which of my own experiences support/do not support the theory?

The structure of the scheme was adopted from Brooks and Dansereau (1983) and adapted in accordance with the purposes of our study. As can be seen in Table 2, the content scheme was divided into four sections comprising two questions each. The different sections stressed important aspects including concepts and main ideas of the theory, empirical findings, consequences and individual estimations regarding the theory. Participants were asked to generate answers to all questions and write them down in the text document. Both theory texts did not provide any information concerning the questions regarding the consequences and the individual estimation. By answering these questions, the participants were expected to draw conclusions that go beyond the scope of the texts.

Cooperation script. Learners in these conditions also received a pre-structured text document. This text document included a short description of the explainer- and learner-role and directed the learners' interactions during the collaborative learning phase by defining four steps of interaction: (1) explaining the text material (explainer) and asking comprehension questions (learner), (2) typing the information received (learner) and supporting the learner (explainer), (3) generating own ideas concerning the theory (explainer and learner individually), and (4) discussing (explainer and learner) and writing down the results of the discussion (learner only, see Table 3). An observer, who stayed in one of the two rooms, supervised the correct application of the specified roles and controlled the time in which the different tasks were to be completed. After the discussion of the first theory had finished, the partners changed roles and repeated the same procedure, now discussing the second theory. Time-on-task for each theory was 40 minutes.

Table 3: Steps and learning activities included in the cooperation script.

	Explainer	***Learner***
Step 1 (approx. 10 min.)	Explaining the text material	Asking comprehension questions
Step 2 (approx. 15 min.)	Supporting the learner's activities	Explaining and typing the information received in the shared text document
Step 3 (approx. 5 min.)	Elaborating on text information individually	
Step 4 (approx. 10 min.)	Discussing generated ideas with the partner	Discussing generated ideas with the partner and writing the results in the shared text document

Dyads in the unscripted groups received no instructions in structuring their interactions. According to the given time in the scripted groups, time-on-task for both theories was 80 minutes. The partners in the unscripted groups were able to decide how much time within this time period they wanted to spend discussing each theory. For example, if they decided to take 50 minutes discussing the first theory they only had 30 minutes left for the second theory.

Text materials

As mentioned above, two different theory texts were distributed between the two partners of each dyad. Both texts contained theories associated with the nature-nurture-debate. One partner read a text about "Attribution Theory" as developed by Bernhard Weiner, the other one about the "Theory of Genotype-Environment Effects" by Sandra Scarr. Both texts comprised approximately 1400 words each. The texts provided information on the foundations of the particular theory, its main concepts and on important empirical findings.

Procedure

Introduction and Pretests. At the beginning of the experiment, the dyad partners were seated in two different rooms and were informed about the aims of the session. They were told that at first they would learn about one theory with implications for the nature-nurture-debate individually, while their partner would learn a different theory, also concerning this topic. The task of the whole session would be to learn two important psychological-pedagogical theories. After that, the participants received the pretests as described below.

Individual text acquisition phase. In this phase, participants received a text either about the attribution theory or about the theory of genotype-environment effects. Each learner was informed about his/her task to explain the contents of the studied text to his/her partner after the individual acquisition phase. Both learners were given 25 minutes to read the text, underline important parts and take notes of the most important aspects if they wanted to. After that, the participants were given 10 minutes to think about how to explain the contents to their partners.

Collaborative learning phase. Prior to the actual learning interaction, participants were instructed on how to use both the video-conferencing system and the shared text documents. It was demonstrated how each partner could work on the same text document. Further, the participants were familiarized with the different tasks they had to accomplish according to the different conditions. The dyads were told that they should use the text documents as a worksheet providing a basis for discussion. The cooperation task required both participants to comprehend both theories as deeply as possible.

In all sessions, an observer stayed in one of the two rooms to supervise the correct performance of the particular tasks. In the scripted conditions, he/she also provided the participants with information about the time and switched from one phase to another. The collaborative learning phase took 80 minutes.

Posttests. After the collaborative learning phase, the participants were asked to complete three tests assessing their level of knowledge acquisition. The first test was a free recall-test for which participants were given 10 minutes to summarize both theories in approximately five sentences each. The second and third tests were the same as the tests conducted prior to the individual text acquisition phase (short answer- and multiple choice-test). For each test, the participants were given 5 minutes time for completion. At the end of the experiment, the participants were asked to complete a questionnaire concerning their motivation and the quality of their collaboration.

Data sources

Pretests. At the beginning of the experimental session, the participants were asked to fill out a questionnaire regarding biographical information and interest, social anxiety, uncertainty orientation, and text-processing strategies. Additionally, we conducted two knowledge pre-tests (one short answer- and one multiple choice-test) concerning concept-knowledge and deeper understanding of the theories to be learned. For analyzing the previous knowledge, we computed a combined cued recall measure consisting of the short answer and the multiple-choice test. In both cued recall tests the highest possible score was 12 points.

Posttests. The posttests included knowledge-tests regarding concept-knowledge and deeper understanding which were similar to the pretests described above. Both cued recall tests (short answer and multiple choice) are assumed to measure a deeper and more detailed understanding of the theoretical concepts and their relations. Again we computed a combined cued recall measure consisting of the short answer and the multiple-choice test. In both cued recall tests the highest possible score was 16 points. In addition, the students were asked to take a free recall-test concerning their recall of concepts of the theories learned during the experimental session. The maximum scores in the free recall tests were 22 points (Attribution Theory) and 27 points (Theory of Genotype-Environment Effects). Finally, we asked the participants to fill out a questionnaire regarding their motivation, and the quality of collaboration during the learning session.

Process data. All experimental sessions were recorded on videotapes. Additionally, we recorded processes (screen recording) and outcomes (Word-files) of activities concerning the collaborative representations. All process data serve as sources for discourse and other process analyses.

RESULTS

In order to control the effects of the pre-knowledge we computed a 2x2x2 Analysis of Variance (ANOVA) with the cued recall pretests as dependent measure. The between-groups factors were cooperation role (explainer or learner), content scheme (with or without) and cooperation script (with or without). Results showed no statistically significant differences between the groups neither regarding “Attribution Theory” nor “Theory of Genotype-Environment Effects”.

In order to check if the two test types (free recall vs. cued recall) used in this study represent relatively independent knowledge measures, we computed correlations between the different outcomes. In fact, it turned out that the free recall and cued recall measures in both theories did not correlate significantly: The correlation between free recall and cued recall of "Attribution Theory" was $r = .06$ (*n. s.*), the correlation between free recall and cued recall of "Theory of Genotype-Environment Effects" was $r = .04$ (*n. s.*). Yet, we found that both free recall measures correlated significantly. The correlation between free recall of "Attribution Theory" and free recall of "Theory of Genotype-Environment Effects" was $r = .22$ ($p < .05$). There was no significant correlation between the two cued recall measures ($r = -.06$, *n. s.*). These results confirm our assumption that the free recall and cued recall measures represent two different types of knowledge. Therefore, we will treat each knowledge measure separately in our further analyses.

Below, results concerning learning outcomes in the different knowledge tests are presented. For a better illustration the results are described separately for each theory.

Attribution Theory

In order to analyze effects of the factors cooperation role, content scheme and cooperation script on learning outcomes we computed a 2x2x2 ANOVA with free and cued recall tests of “Attribution Theory” as dependent measure. Means and standard deviations of both measures are presented in Table 4. A significant effect of the cooperation role was found for the analysis of the cued recall score ($F(1,78) = 19{,}78$; $p < .01$). The participants who taught the Attribution Theory information significantly outperformed those who took the role of the learner ($M = 11{,}03$, $SD = 1{,}91$ and $M = 8{,}92$, $SD = 2{,}37$, respectively). Neither concerning the free recall nor the cued recall test no other effects reached statistical significance. That means that both treatments – content scheme and cooperation script – did not lead to significant effects on learning outcomes concerning “Attribution Theory”.

Table 4: Results concerning free and cued recall of "Attribution Theory".

•		***Free recall*** of "Attribution Theory" M (SD)	**Cued recall** of "Attribution Theory" M (SD)
Explainer	unscripted/ non-scheme group	6,58 (5,16)	11,43 (1,56)
	unscripted/ scheme group	8,00 (4,16)	10,67 (2,65)
	scripted/ non-scheme group	7,36 (3,17)	10,78 (3,36)
	scripted/ scheme group	5,40 (4,67)	11,21 (3,94)
Learner	unscripted/ non-scheme group	7,55 (3,50)	9,28 (2,31)
	unscripted/ scheme group	7,90 (3,67)	8,14 (3,02)
	scripted/ non-scheme group	7,45 (4,95)	8,94 (1,71)
	scripted/ scheme group	6,00 (4,69)	9,26 (2,54)

Theory of Genotype-Environment Effects

With respect to the "Theory of Genotype-Environment Effects" we also computed an ANOVA with the factors the factors cooperation role, content scheme and cooperation script. Means and standard deviations of both measures are presented in Table 5. Again a significant effect of the cooperation role was found for the analysis of the cued recall score (F (1,78) = 8,15; $p < .01$). The peers who took the explainer role significantly outperformed those who took the learner role (M = 9,50, SD = 2,54 and M = 7,93, SD = 2,56, respectively). A slight effect of the cooperation role was also found in the free recall measure (F (1,78) = 2,83; $p < .1$). Again, the explainers outperformed their partners in the learner role (M = 10,90, SD = 3,81 and M = 9,35, SD = 4,29, respectively).

Table 5: Results concerning free and cued recall of "Theory of Genotype-Environment Effects".

•		***Free recall*** of "Theory of Genotype-Environment Effects" M (SD)	**Cued recall** of "Theory of Genotype-Environment Effects" M (SD)
Explainer	unscripted/ non-scheme group	11,25 (2,73)	9,19 (2,89)
	unscripted/ scheme group	10,20 (2,97)	9,31 (1,78)
	scripted/ non-scheme group	11,91 (4,16)	9,30 (2,91)
	scripted/ scheme group	10,10 (5,30)	10,29 (2,52)
Learner	unscripted/ non-scheme group	8,91 (4,78)	7,15 (3,50)
	unscripted/ scheme group	9,50 (4,03)	7,28 (1,79)
	scripted/ non-scheme group	10, 27 (3,50)	9,07 (5,98)
	scripted/ scheme group	8,70 (5,17)	8,27 (1,70)

Additionally a significant main effect was found concerning the free recall measure with respect to the factor cooperation script. This effect almost reached the .05 significance level (F (1,78) = 3,27; $p = .07$). Peers who cooperated in the scripted conditions outperformed the participants working without the cooperation script (M = 9,23; SD = 2,46 and M = 8,22; SD = 2,77, respectively). No other effects concerning the free and cued recall tests reached statistical significance. Hence, the content scheme did not show to have significant effects on learning outcomes concerning the "Theory of Genotype-Environment Effects".

DISCUSSION

Results show that peer teaching is an effective mean for structuring cooperation between two learners. Obviously, compared to traditional classroom instruction, peer teaching helps students to actively engage in beneficial learning processes (Graesser & Person, 1994). Yet, it must be considered that peer teaching supports particularly the learners who take the role of the teacher. The results presented above clearly indicate these advantages on the explainer's part: In both theories the peers in the teacher role outperformed their partners who were taught the learning material. These results correspond to findings of studies that also focussed on peer teaching (e.g. O'Donnell & Dansereau, 2000). At least two reasons can be assumed for explaining the teachers' advantages. First, the better outcome performance can be ascribed to the higher amount of time on task that the explainers received due to individual acquisition of the material to be taught. The second explanation refers to the relevance of the so called *generation effect.* Due to the generation effect overt verbal activity leads to better recall of information than listening to it (Slamecka & Graf, 1978). Therefore, learners who get the chance to explain knowledge to others in particular benefit from cooperative learning. The design of this study does not permit to decide which of both interpretations is more relevant. Yet, when findings of other studies are taken into account, both factors (more time-on-task and higher level of activation) should be responsible for the advantages on the teacher's part (cf. Lambiotte et al., 1988).

The results of this study showed no significant effects of the content scheme on learning outcomes. Therefore one might deny the relevance of this treatment. Yet, this conclusion is precipitate when considering (1) the learning activities evoked by the content scheme and (2) the knowledge tested in the outcome measures. The content scheme supported students particularly in elaborating on the learning material. Elaborations are assumed to mainly facilitate long term retention since they help connecting the learned material to the knowledge base. That means that the effects of the content scheme might have failed to appear because of testing the outcomes immediately after the learning session. Perhaps advantages of the content scheme would have appeared if learning outcomes had been tested again at a later time. Unfortunately, this was not possible for organizational reasons.

In contrast to the content scheme the cooperation script showed significant effects on learning outcomes. However, advantages of the scripted groups only occurred concerning the cued recall measure of the "Theory of Genotype-Environment Effects". One reason for the advantages of the cooperation script only in one theory might be that the effectiveness of the cooperation script is tied to the level of difficulty of the studied theory. A comparison of the outcomes of the two cued recall tests shows that the score of the "Theory of Genotype-Environment Effects" is lower than the score of the "Attribution Theory". This lower score indicates a higher degree of difficulty of the first theory. Therefore, the conclusion can be drawn that the cooperation script only shows effects with more complex learning material.

At present we can only present results concerning learning outcomes. In order to gain deeper insight in mechanisms of the varied treatments additional analyses of learning processes are needed. Therefore we are currently working on a category system for discourse analysis. According to the assumptions described in the theoretical framework, the categories include content-related and process-related aspects. The content-related aspects refer to activities concerning the coordination of the collaboration activities, the discussion of text material and the elaboration on information of the text. Process-related aspects comprise activities concerning elicitation, externalization, and conflict- or consensus-oriented negotiation of on-task contents as well as the distribution of task-related activities among learners (such as writing down information in the shared document). We assume that such a detailed analysis of discourse will enable us to reveal critical factors correlated with recall performance.

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