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Abstract

Studies have shown that videoconferences are an effective medium for facilitating communication between parties who are separated by distance. Furthermore, studies reveal that videoconferences are effective when used for distance learning, particularly due to their ability to facilitate complex collaborative learning tasks. However, as in face-to-face communication, learners benefit when they receive additional support for such learning tasks. This article provides an overview of two empirical studies to illustrate more general insights regarding some effective and less effective ways to support collaborative learning with videoconferencing. The focus is on content schemes as content-specific support and task-specific support as collaboration scripts. Based on the results of the two studies, conclusions can be drawn about support measures that promote learning. Conclusions can also be reached about the need for employing both content schemes and collaboration scripts to provide learners with the most benefit.

Keywords: computer-supported cooperative learning, videoconferences, collaboration scripts, content schemes.

Zusammenfassung

Studien haben gezeigt, dass Videokonferenzen ein effektives Medium für die verteilte Kommunikation sind. Ebenso zeigten erste Studien, dass sich Videokonferenzen auch in Telelernumgebungen einsetzen lassen, insbesondere weil sie komplexe kooperative Lernaufgaben ermöglichen. Lernende profitieren jedoch in solchen Lernaufgaben – ähnlich wie face to face – von zusätzlicher Unterstützung. In diesem Beitrag werden zwei empirische Studien dargestellt, die weiterführende Erkenntnisse hinsichtlich effektiver und weniger effektiver Arten der Unterstützung kollaborativen Lernens in Videokonferenzen erbringen sollen. Der Schwerpunkt liegt dabei auf Wissensschemata als Methode inhaltlicher Unterstützung, und aufgabenspezifischer Unterstützung in Form von Kooperationsskripts. Ausgehend von den Ergebnissen dieser zwei Studien werden Folgerungen über lernförderliche Merkmale der Unterstützungsmaßnahmen formuliert. Befunde weisen auf die Notwendigkeit Wissensschemata und Kooperationsskripts kombiniert anzuwenden hin, um für die Lernenden den größtmöglichen Nutzen zu erreichen.

Schlüsselwörter: computerunterstütztes kooperatives Lernen, Videokonferenzen, Kooperationsskripts, Wissensschemata.

SUPPORTING COLLABORATIVE LEARNING IN VIDEOCONFERENCING USING COLLABORATION SCRIPTS AND CONTENT SCHEMES

Videoconferences are regarded as highly beneficial mechanisms for facilitating collaborative distance learning. In contrast to text-based communication, videoconferencing enables learners to interact more frequently and thus supports learners in solving complex tasks (cf. Anderson et al., 1997; Pächter, 2003). Furthermore, the use of shared applications allows learners to work collaboratively on a written solution to a problem *while* discussing important aspects of that solution.

However, as collaborative problem solving is a complex task in itself, learners need support when performing such tasks. When employing support measures that are widely used in face-to-face and text-based learning scenarios, the following question arises: To what degree are these measures applicable for learning in videoconferencing? On the one hand, trainings (cf. O'Donnell & Dansereau, 2000; Rummel & Spada, in this book) that are widely used in face-to-face situations may be difficult to realize when learners are spatially separated. On the other hand, cues, such as sentence openers that are often used in text-based learning environments (cf. Weinberger, Fischer & Mandl, in this book), may fail in spoken communication as they may be neglected in the natural flow of spoken communication.

Thus, it seems necessary to develop new methods of support for collaborative learning in videoconferencing. A key support feature may be the shared application, which is central to computer-mediated communication (cf. Baker & Lund, 1997; Dillenbourg & Traum, 1999). Shared applications are made available on the screen of every videoconference participant and learners can easily manipulate the contents of these shared applications. Furthermore, the shared application may be pre-structured to provide instructional support and thereby function as a representational context for the learners (cf. Baker & Lund, 1997; Fischer, Bruhn, Gräsel & Mandl, 2000; Suthers & Hundhausen, 2001). This context may change the learner's perception of the task and thus guide them to a better solution.

This paper discusses ways to support collaborative learning in videoconferencing and compares two different support measures. The first support measure is a collaboration script that pre-structures the learning task. This method is widely used in scripted collaboration research. The second support measure is a content scheme that focuses learners' attention on

important aspects of the subject matter and is realized through a pre-structured shared application. In two empirical studies, the effects of both support measures were compared with respect to collaborative learning outcomes and individual learning outcomes.

Collaborative learning

Collaborative learning in small groups means that groups act relatively independent of a teacher with the goal of acquiring knowledge or skills (cf. Cohen, 1994; Dillenbourg, 1999). One major goal of collaborative learning is to support social interaction and encourage the learner's cognitive processes. In this context, learners' elaborations are seen to play a crucial role (cf. Webb, 1989; Webb & Palincsar, 1996) for expressing their knowledge, ideas and beliefs to their partners (cf. O'Donnell & King, 1999; Palincsar & Brown, 1984; Rosenshine & Meister, 1994). There are three specific mechanisms in collaborative learning that should be emphasized: the tendency for cognitive conflicts to arise (Doise & Mugny, 1984; Nastasi & Clements, 1992; Piaget, 1932), the need for elaborated explanations and negotiations (Webb, 1989; Webb & Palincsar, 1996) and the co-construction of knowledge (Bruhn, 2000; Fischer et al., 2000; Roschelle & Teasley, 1995). These socially mediated learning processes should foster individual cognitive engagement with the learning material and consequently benefit learning outcomes.

In the context of collaborative learning, it is also necessary to consider the conceptualization of learning outcomes. There are two main ways to assess the benefits of a collaborative learning scenario, either individually on the learner level or collaboratively on a group level.

The *collaborative learning outcome* is the success all learning partners achieve together. Since the group task is interdependent and requires the various contributions of every group member to solve it, learning success can be measured through the quality of the group product. This can be recorded through a case solution learners developed during collaboration (cf. Hertz-Lazarowitz, Kirkus, & Miller, 1992) or through a test the learners complete collaboratively after collaboration (Salomon, 1998).

The *individual learning outcome* is based on the knowledge or skills the individual learns through interaction with others. The main objective is to discover how much of the knowledge that is co-constructed in the collaboration can be transferred to the individual situation. There are many different potential learning measurements: tests (Jeong & Chi, 1999; Lambiotte, Dansereau, O'Donnell, Young, Skaggs & Hall, 1988) to measure factual knowledge

acquisition are one possibility as well as case solutions to measure applied knowledge acquisition (Bruhn, 2000).

However, there are differences in the interpretation of such learning outcomes (cf. Anderson, Reder & Simon, 1996; Greeno, 1997; Hertz-Lazarowitz, Kirkus & Miller, 1992; Salomon & Perkins, 1998; Slavin, 1995; Webb, 1989). These involve the degree to which individual knowledge assessment can evaluate effects of collaborative knowledge construction and the degree to which a group assessment can provide indications about individuals' learning progress.

Characteristics of collaborative learning in videoconferencing

In videoconferencing, collaboration processes may change depending on the various media being used, which can also affect learning outcomes. During videoconferencing, the synchronous interaction of the learners can be guided by the transmission of audio, video, and data. Studies on the influence of videoconference systems in small groups show the importance of the quality of the audio transmission (O'Connaill, Whittaker & Wilbur, 1993): The collaboration scenario will only work if the audio transmission is reliable, specifically if sound bytes are not lost and audio delays are not more than 500ms (cf. Finn, Sellen & Wilbur, 1997; O'Connaill et al., 1993). Another important component is video. A connection via video can modify the perception of the learning partners. Some communication cues such as facial expressions and gestures may not fully be transmitted (cf. Bruce, 1996). In videoconferences, it is also not possible for participants to make eye contact. Eye contact is particularly important for the control of communication in groups (cf. Anderson et al., 1997; Isaacs & Tang, 1997; Joiner, O'Shea, Smith & Blake, 2002). Therefore, communication in videoconferencing scenarios can differ from face-to-face settings. In spite of these differences in learning discourse, results from previous research suggest that learning outcomes are not affected by videoconferencing (cf. Anderson et al., 1997; Bruhn, 2000; Fischer et al., 2000; Pächter, 2003).

Moreover, videoconferencing offers new methods for supporting collaboration and learning processes. One key feature of videoconferencing systems that provides this assistance is application sharing when it is used to transmit data. Using application sharing, learning partners in videoconference settings are able to access and modify the same content on their individual screens (Dillenbourg & Traum, 1999). When sharing an application, learners have the ability to work on the same document simultaneously and to find a written problem solution collaboratively from different locations. Learners are able to disseminate their knowledge with the help of the shared application. In short, shared applications can support the interaction and the exchange of knowledge through discourse. Furthermore, the interaction between the learners is

simplified because they can refer to the shared information without providing further explanations to their collaboration partners (Roschelle & Teasley, 1995). Another important aspect of shared applications is the *salience* of their contents (Suthers, 2001). This salience of this permanent joint knowledge representation influences the co-construction of knowledge (Dillenbourg & Traum, 1999) and makes modifications and improvements possible. Furthermore, the concept of salience can be useful and important for the specific support of collaborative learning in videoconferencing. Important aspects of the collaborative task can be made salient and therefore foster collaborative learning in videoconferencing.

Fostering collaborative learning in videoconferencing

As collaborative learning can be deficient in certain areas, e.g. due to differences in expertise (Slavin, 1995), differences in status (Cohen & Lotan, 1995) or dysfunctional group phenomena (cf. Salomon & Globerson, 1989), collaborative learning may impede the results of collaborative and individual learning outcomes. Therefore, it is necessary to provide support for the learners. Such support strategies focus mainly on improving collaborative learning processes, either by offering collaboration strategies as collaboration scripts or by presenting content processing strategies as content schemes. However, strategies directed at the collaboration process cannot be independent of the learners' task. Strategies that encourage learners to focus their attention on content may affect collaboration processes. Both approaches will be characterized in the following sections.

Collaboration scripts

There has already been a large amount of research on strategies for improving the collaboration process that are widely used in scripted cooperation (cf. O'Donnell & King, 1999) or cooperative teaching (O'Donnell & Dansereau, 2000) research. These scripts mainly structure collaborative learning by assigning specific activities to the learners. Such activities are virtually content independent; however, they are tailored to the task at hand, e.g. theory learning or problem solving. In many studies, beneficial effects of collaboration scripts were found in face-to-face scenarios (cf. O'Donnell & Dansereau, 1992; O'Donnell & King, 1999; Palincsar & Brown, 1984; Rosenshine & Meister, 1994). Recently, collaboration scripts have been increasingly used in text-based learning environments (see Weinberger, Fischer & Mandl, in this book) and in videoconferencing (see Rummel & Spada, in this book). The main results of

these studies show that collaboration scripts can have a beneficial influence on learning processes. However, there are no consistent results regarding learning outcomes.

Scripts may vary in many aspects. In the context of this article, we will focus on the aspect of *sequencing collaboration* and the aspect of *strategy application*. The aspect of sequencing collaboration is based on the script definition of Schank and Abelson (1977) stating that internalizing routine procedures as a fixed script in memory has advantages when performing such procedures. In the context of collaborative learning, this implicates that once learners have internalized the script for performing a particular learning task (e.g. problem solving), they will be able to perform this task better in future situations. Furthermore, this kind of sequencing can provide a model for learners to perform the task like an expert (cf. Collins, Brown & Newman, 1989). The second aspect of strategy application means that learners are encouraged to apply beneficial learning activities when working collaboratively. In a meta-review, Rosenshine, Meister and Chapman (1996) found out that particularly the strategies of summarizing and questioning provide beneficial learning activities for the learners.

Content schemes

In contrast to collaboration scripts, there are specific strategies for encouraging learners to focus their attention on specific contents. Brooks and Dansereau (1983) call them content schemes. Such schemata provide the representational context for a task by providing placeholders for important dimensions of content. Providing external schemata can modify the representational context of a task. According to Zhang and Norman (1994), such modified representational context of a task may also change learners' subjective representation of this task and thereby influence learners' ability to solve the task. The modified representational context of a task may not only affect the learners' task solution when using this external schema, but may also have an effect without the schema.

Using content schemes in collaboration means that no specific activities are assigned to the learners, but that learners gain an increased awareness of important concepts and categories of the subject matter. The awareness of particular contents focuses the learning process on these contents and ensures that these contents receive increased attention. Usually, the specific contents are displayed permanently during the learning session; either on a style sheet (cf. Brooks & Dansereau, 1983) or on the user interface on the computer (cf. Fischer, Bruhn, Gräsel & Mandl, 2002; Slotta & Linn, 2000; Suthers & Hundhausen, 2001). In this context, Suthers and Hundhausen (2001) refer to

the concept of salience: Through permanent display, these contents remain salient during collaboration. Due to this salience, Suthers and Hundhausen (2001) postulate a "representational guidance" that states that the representation of these concepts can guide and focus learners. This representational guidance can be an important mechanism for supporting the collaborative learning process. However, representational guidance also implies that the representation must be present to have an effect. For this reason, representational guidance and salience may be adequate support mechanisms *during* collaboration, but their effects *after* collaboration remain unclear (cf. also Salomon, 1992).

However, until recently, the effects of content schemes were mainly studied within the context of individual learning (cf. Brooks & Dansereau, 1983; Kotovsky & Fallside, 1989; Kotovsky, Hayes & Simon, 1985; Larkin, 1989; Zhang & Norman, 1994; Zhang, 1997) and only little was known about such mechanisms in collaborative problem solving (cf. Fischer et al., 2002; Suthers & Hundhausen, 2001). Results of the Fischer et al. (2002) study, investigating the effects of structural visualization similar to mapping, indicate beneficial effects of the content scheme on the learning process and on collaborative learning outcomes. Suthers (2001) also reported similar results with respect to tabular schemes. There is little information regarding the influence of content schemes on collaborative learning in videoconferencing. Fischer et al. (2000) and Bruhn (2000) discovered that content schemes modified collaborative learning processes in videoconferencing; however, content schemes did not seem to affect collaborative or individual learning outcomes. Yet, as shared applications play a very prominent role in videoconferencing, one could assume that interventions implemented through a shared application could be quite beneficial for collaborative learning scenarios.

Research questions

Our basic research question examines the degree to which support measures implemented in the shared application – such as content schemes – affect collaborative and individual learning outcomes during collaborative learning in videoconferencing. Then the objective is to discover the degree to which these effects differ from the effects of well-known support measures such as collaboration scripts. For this reason, we will compare two collaboration scripts with two content schemes that have been specifically designed for learning in videoconferencing. A further focus lies in the potential interactions between the collaboration script and the content scheme. We then present results concerning individual and collaborative learning outcomes.

The studies were conducted during the last few years. Study 1 analyzed the effects of a collaboration script and a content scheme on collaborative teaching (Ertl, Reiserer & Mandl, 2002). Study 2 was centered around the effects of a collaboration script and a content scheme on a collaborative problem-solving scenario (Kopp, Ertl & Mandl, 2004).

Table 1: Participants, task and subject matter of the 2 studies.

	Participants	Task	Subject matter
Study 1	86 (43 Dyads)	Collaborative Teaching	Theory of Genotype Environment Effects
Study 2	159 (53 Triads)	Problem-Solving	Attribution Theory

In the following sections, we will first describe each individual study answering following research questions:

- To what extent do collaboration scripts affect collaborative and individual learning outcomes in videoconferencing?
- To what extent do content schemes affect collaborative and individual learning outcomes in videoconferencing?

Then we will compare the results of the two studies regarding the influence of the different types of support within the two studies.

Study 1

The particular aim of study 1 was to discover the degree to which a collaboration script and a content scheme used within a dyadic collaborative teaching scenario could foster learners' collaborative and individual knowledge acquisition in videoconferencing.

Method of study 1

The learning environment was made up of an individual and a collaborative learning unit. One person from each dyad worked on the individual learning unit. This was comprised of a text on the theory of Genotype Environment Effects (cf. Scarr, 1984), which contained both theoretical concepts and evidence. During collaborative learning unit, the person learning from the text functioned as the teacher, while the second person assumed the role of learner. Both learners were given the task (1) to study the most important contents of the theory text,

both theoretical concepts and evidence and (2) to discuss their own reflections, ideas and comments on the subject. To achieve this, the teacher had to explain the contents of the theory text to the learner. Using a shared application (text editor), the learners had the opportunity to collaboratively create shared representations of theoretical concepts, evidence and personal elaborations, such as the consequences of the theory or their personal opinion. Following the collaborative learning unit, domain-specific knowledge was assessed on an individual basis.

During the collaborative learning unit, both the factors of collaboration script for collaborative teaching and content scheme for collaborative teaching were used. In a further condition, collaboration script and content scheme were combined while learners in the control condition had no additional support.

Collaboration script for collaborative teaching

The collaboration script structured the collaborative learning unit in two different respects. Firstly, it provided the learner with different phases in which to communicate the contents of the text. Furthermore, it provided specific activities for each phase to be undertaken by the learners in both the teacher and learner role. The *first* phase of the script served to promote the communication of the text by the teacher. The task of the learner in the teacher role was to explain the contents of the text. The partner in the learner role was asked to listen and to query the information as soon as anything was unclear. In the *second* phase, the learners deepened their comprehension of the text. To this end, they worked together on a shared representation of the main contents of the text in the shared application. The partner in the learner role had the task of summarizing the contents and important points in the text editor; the teacher was given the task of supporting the learners' activity. In the *third* phase of the script, both learning partners reflected individually about the contents of the text and about any unanswered questions. In the *fourth* phase, the learners discussed the text and individual reflection took place. Then the partner in the learner role had the task of capturing important notes from the discussion as a shared representation.

Content scheme for collaborative teaching

In the condition using the content scheme, the scheme structured the shared application during the collaborative learning unit. Using this scheme, both partners had to consider the following categories: *theoretical concepts*, *evidence*, *consequences* and *personal opinion*. However, it was not specified explicitly in which sequence these topics had to be dealt with and which of the partners should fill in the scheme. Both partnerswere asked to describe basic theoretical concepts in the category entitled *theoretical concepts* and to present

studies that supported the theory in the category entitled *evidence*. They used the category entitled consequences to capture *personal elaborations* on the usefulness and limitations of the theory. The category entitled personal opinion was used to present a personal evaluation of the theory and to provide an assessment. The scheme helped both partners to differentiate between theoretical concepts and evidence and supported them in personal elaborations. The abstract categories were made more concrete by the questions contained in each category (see table 2).

Table 2: Structure of the content scheme.

Theoretical concepts	**Evidence**
What are the core concepts of the theory?	How was the theory examined?
What are the most important statements of the theory?	Which findings support the theory?
Consequences	**Personal opinion**
Which pedagogical interventions can be derived from the theory?	What do we like about the theory? What do we not like?
Which limitations of pedagogical interventions are set by the theory?	Which of our own experiences confirm the theory? Which of our own experiences contradict the theory?

Instruments

In order to measure the collaborative learning outcome, the concepts that were written down in the shared application were analyzed with respect to the areas of theoretical concepts, evidence and personal elaborations. These units of meaning were either summed together into a score for theoretical concepts or for evidence. For the evaluation of the personal elaborations, a similar method was employed. The sum was made of all comprehensibly elaborated units of meaning in the document. The individual learning outcome was measured by free recall; learners were asked to write down the most important contents of the theory text from memory. This test was also analyzed with respect to theoretical concepts and evidence.

Results of study 1

The *collaborative learning outcome* reflected the areas of theoretical concepts, evidence and personal elaborations. There were significant effects of both independent variables on the area of theoretical concepts. On the one hand, an effect of the collaboration script for collaborative teaching showed that the learners with this script captured more thought units in this area. On the other hand, an effect of the content scheme for collaborative teaching showed that this factor led learners to capture significantly less thought units in the area of theoretical concepts. Regarding evidence, there were no significant differences. With respect to personal elaborations, results indicate a clear effect of the content scheme for collaborative teaching: learners with the scheme externalized significantly more elaborations than learners without the scheme. In addition, there was a significant interaction effect between scheme and script indicating that the combination of both support methods resulted in the most adequate solution of the task by drawing attention to theoretical concepts, evidence and personal elaborations. Regarding absolute values of all categories, learners in the control group captured the least number of units of meaning while learners with content scheme and collaboration script performed best.

In summary, the collaboration script and content scheme had different effects on the collaborative learning outcome – i.e. the group product both learners built together. Learners with the script worked more on theory concepts than other learners. In contrast, learners with the content scheme worked less on theory concepts but slightly more on evidence and much more on personal elaborations. When both support measures were combined, these effects even out and learners with both support measures achieved the most adequate task solution.

With respect to *individual learning outcomes*, the results of the learners in the learner role are described, because they show only the effects of the collaborative learning unit. In the area of theoretical concepts, there were no significant effects of the collaboration script or of the content scheme. Regarding evidence, there also was no significant effect of the factors of collaboration script or content scheme. Descriptively, learners in all groups recalled nearly the same amount of theory concepts in absolute terms, while learners with content scheme scored lower in the area of evidence.

Discussion of study 1

The results of Study 1 show effects of both the collaboration script for collaborative teaching and the content scheme for collaborative teaching with respect to the collaborative learning outcome. The collaboration script was shown to be especially effective in the area of theoretical concepts. This result may be attributed to the structure of the collaboration script, encouraging learners to deal with the core of the theory twice: once in the first phase, when the learner in the learner role explained the text material, and again in the second phase, when the learner in the learner role had to recall and note them. This learning by teaching (cf. Renkl, Mandl & Gruber, 1996) may have led to a higher activity level of the learner in the learner role (cf. Reiserer, 2003) who had to document the collaborative learning outcome. The content scheme mainly influenced the area of personal elaborations. Learners with the content scheme benefited from the mechanisms of representational guidance (cf. Suthers & Hundhausen, 2003) and focused on elaborations. For this reason, they tended to neglect theoretical concepts.

There were no apparent effects on individual learning outcomes. Thus, the question arises as to why the strong effects of the interventions on the collaborative learning outcomes were not evident in the individual learning outcomes. This may be, on one hand, related to the support of collaborative teaching and differences in the concepts of collaborative and individual learning outcomes (cf. Hertz-Lazarowitz et al., 1992; Salomon & Perkins, 1998). The category of empirical evidence may function as an example. In this category, learners with the content scheme performed best during the process but performed poorly with respect to individual learning outcomes. As the support measure was aimed at the teaching process, it may not have been helpful for individual learning transfer (cf. Ertl, Fischer & Mandl, in press). On the other hand, the results relating to the content scheme can be explained with the mechanisms of representational guidance (Suthers & Hundhausen, 2001). Important concepts were salient during the process but not during the individual posttest. From this point of view, the content scheme was not able to change the learners' perception of the task according to Zhang to Norman (1994).

Consequently, we used another task, collaborative problem solving, for the learners in Study 2. We expected that strategies which were seen as helpful during collaborative problem solving would also be applied in the individual problem solving process after collaboration. Furthermore, we anticipated that we could design a content scheme that would change learners' perception of the task and thus have a lasting effect. In the context of problem solving, we decided to work with triads for a more stimulating discussion process.

Study 2

The aim of Study 2 was to investigate the effects of a collaboration script and a content scheme on collaborative problem solving in videoconferencing triads.

Method of study 2

The learning environment consisted of an individual and a collaborative learning unit. At the beginning of the exercise, learners worked individually on a text about attribution theory with core concepts according to Heider (1958) and Kelley (1973). In the collaborative learning unit, all three learners worked together on the solution of a learning case. They were given case material, which contained somewhat different information for each learner. The learners' task was to discuss the case according to the attribution theory and to find evidence from the case material and relate it to theoretical concepts. At the end of discussion, learners were asked to document a case solution in the shared application (text editor). A collaboration script and a content scheme were used as support measures during the collaborative learning unit. In a further condition, the collaboration script and the content scheme were combined while learners in the control condition had no additional support.

Collaboration script for collaborative problem solving

The collaboration script structured the collaborative unit in four phases. In the *first* phase, learners were asked to read case material and to work individually to extract information important for the case solution. In the *second* phase, the learners had to exchange information and to resolve comprehension questions collaboratively. They used a shared application for writing down concepts that were important for the case solution. In the *third* phase, learners had to reflect individually about the comprehensiveness of the information collected and in the *fourth* phase, the learners had to collaboratively develop the case solution.

Content scheme for collaborative problem solving

The participants using the content scheme received a pre-structured shared application (text editor). Learners followed the structure of the table, which was divided into three main categories (cf. Table 3): *Cause,* for collecting the causes for the problem described in the case, *Information* for finding case information, giving evidence for the cause and *Attribution* for making the correct attribution of the cause. The categories *Information* and *Attribution each* contained two subcategories: *Information* was divided into columns for *Consensus* and *Consistency* for making these two aspects of the attribution theory salient. *Attribution* was split into *Kelley* and *Heider* for guiding learners to attribute according to both theories. Using this scheme, learners would be able to record

complete attributions according to Kelley and Heider with causes and case information about consensus and consistency.

Table 3: Structure of the content scheme.

Cause	Information		Attribution according to	
	Consensus	Consistency	Kelley	Heider

Instruments

In order to measure the collaborative learning outcome, the contents of the shared application were analyzed. A coding system was developed in accordance with the different categories of the Attribution Theory, in which all causes, information and attributions were listed in an identifiable way without any overlap. Case information and theory concepts were assessed and each category summed up into a single score. A short case was used to measure individual learning outcome. The analysis of this case was similar to the collaboratively solved case: Scores were given for case information and theoretical concepts. Points for each category were then summed up as a single score.

Results of study 2

The content scheme had a strong effect on the *collaborative learning outcome*. Learners with the scheme externalized nearly the double the amount of theory concepts than learners without the scheme. Regarding the collaboration script and regarding case information, there were no significant effects. Descriptively, learners with content scheme and collaboration script scored the highest while learners using only the collaboration script scored the lowest.

Regarding *individual learning outcomes*, the content scheme also proved to be highly influential. In the category of theory concepts, the learners with the content scheme achieved a higher score. The collaboration script had a positive effect on the learners' ability to apply case information. However, regarding all outcome measures, learners who were given both the collaboration script and the content scheme descriptively scored highest.

Discussion of study 2

In summary, we can conclude that the content scheme highly influenced collaborative and individual knowledge acquisition, particularly in the category of theoretical concepts. The effect during the process may be attributed to the salience of the relevant categories. Learners who used the content scheme may have experienced representational guidance (cf. Suthers & Hundhausen, 2001). However, learners internalized these categories and applied them individually. Therefore, one can assume that the content scheme was able to modify the learners' perception of the task (cf. Zhang & Norman, 1994). They perceived the task of performing an attribution differently; in particular to find causes, evaluate consistency and consensus of the causes and decide on an attribution based on these evaluations (cf. Ertl, Fischer & Mandl, in press).

The collaboration script only had little effect. The reason for this may lie in the quite general structure of the collaboration script. These general activities do not appear to be very helpful when used in isolation. According to the script conceptualization of Schank and Abelson (1977), learners might also have to use this script more often to internalize it and benefit from it. However, results revealed that the collaboration script was able to further improve effects of the content scheme. Thus, both support measures should be implemented together to foster the acquisition of knowledge.

General Discussion

The aim of this paper was to analyze the effects of collaboration scripts and content schemes on collaborative learning in videoconferencing. Furthermore, the collaboration script was compared with the content scheme to examine which would best support collaborative learning in videoconferencing.

The *collaboration scripts* used in both studies were of a similar structure to the scripts known from scripted cooperation (cf. O'Donnell & Dansereau, 1992) or reciprocal teaching (cf. O'Donnell & Dansereau, 2000). However, due to the nature of videoconferencing, these scripts were used only as a guideline without the specific training that is given when these scripts are utilized in face-to-face scenarios. Therefore, the collaboration scripts as they were used in videoconferencing may have not been as beneficial as would be expected in face-to-face scenarios (cf. O'Donnell & Dansereau, 1992, 2000; O'Donnell & King, 1999; Palincsar & Brown, 1984; Rosenshine & Meister, 1994). On the other hand, this may also be one limitation of videoconferencing. When using videoconferencing, it is not possible to conduct training in the same manner as in face-to-face settings. This raises the question of how relevant the scripts are

for videoconferencing. However, using the same guideline several times in videoconferencing scenarios may encourage learners to internalize it as a script. After a time, this internalized script may be able to support learners (cf. Schank & Abelson, 1977).

The *content schemes* proved to be highly effective, in study 1 as well as in study 2. In study 1, the scheme worked mainly to benefit collaborative learning outcomes. In study 2, the scheme had a positive effect on both collaborative and individual learning outcomes. These differences may be attributed to the different tasks in the studies (cf. Ertl, Fischer & Mandl, in press). In study 2, learners received a scheme for problem solving. Using the scheme, they were provided with a strategy for performing a complete attribution, which was independent of whether they used it individually or collaboratively. The scheme used in study 1, however, was aimed directly at the collaborative-teaching process and particularly focused learners' attention on empirical studies and elaborations. Learners may not have found this focus to be helpful for individual theory recall. When analyzing the mechanisms of content schemes, we could assume, that some kind of "representational guidance" (Suthers, 2001) took place during the collaboration. Due to this representational guidance, learners were able to successfully focus on particular aspects of the task. In Study 2, we also can assume that the modified representational context also modified the learners' perception of the problem-solving task for the learners using the content scheme (cf. Zhang & Norman, 1994). Thus, the different perception of the task affected the learners collaboratively as well as individually in the post-test. In conclusion, one can assert that content schemes using the mechanisms of representational guidance (cf. Suthers & Hundhausen, 2003) have a significant effect when learners are working *with* them (cf. Salomon, 1992). After collaboration, content schemes may also have an effect, when the scheme is able to change learners' perception of the task (cf. Zhang & Norman, 1994).

In both studies, we gathered evidence that supported the notion that the collaboration script could enhance the effects of the content scheme. In Study 1, we observed an interaction that led learners to a more adequate collaborative learning outcome. In study 2, learners who were using both support measures scored highest regarding all outcome measures. Our conclusion is that collaboration-specific support needs a content-specific basis to be effective.

Further analyses showed that both interventions influenced the spoken discourse of the learners (cf. Dengler, 2004; Reiserer, 2003, Seidel, 2004). However, further investigation is required to examine how this modified learning discourse is related to learning process and outcomes.

Conclusions

Based on these results, three main conclusions can be drawn. First of all, interventions which are very effective during the collaboration process may fail to benefit individual learning outcomes. This may occur when it is difficult to assess the goals of the collaboration following the collaboration. An improved teaching process, for example, may simply improve the teaching process itself, but not result in better outcomes concerning the material taught (cf. Ertl, Fischer & Mandl, in press; Salomon, 1992). Thus, it is necessary to develop an approach for process evaluation which describes helpful activities in the learning process that are independent from learning outcomes. Such helpful skills may be, that learners are better able to differentiate between theory concepts and empirical evidence (cf. Ertl, 2003; Kuhn, Weinstock & Flaton, 1994; Sodian, Zaitchik & Carey, 1991), that they use better, more scientific argumentation (cf. Leitão, 2000) or that they collaborate with less social conflicts (cf. Bales, 1950). These effects, which can be viewed as “side effects” of collaborative learning, should be considered for future investigations.

Secondly, combined support measures centered on collaboration and content-specific strategies should be applied to support learners. For the purpose of empirical research, it may be necessary to split these factors to avoid confounding them. However, focusing solely on content or on collaboration strategies may not appropriately meet the support needs of computer supported collaborative learning environments.

Thirdly, further research should be conducted on the degree to which interventions applied in collaborative learning can prompt sustainable learning strategies. Fostering learning outcomes *once* is certainly important for collaborative learning. However, thoughtfully designed interventions should also have a lasting effect to benefit learners when solving similar tasks in the future.

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