Chapter 3

CAN PEOPLE LEARN COMPUTER-MEDIATED COLLABORATION BY FOLLOWING A SCRIPT?

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Abstract: Our central hypothesis is that partners who jointly work on a task in a computer-mediated setting following a collaboration script, can acquire collaborative skills that will help to improve the collaboration in subsequent tasks as well as their outcome. In an experimental study, a collaboration script was provided for a first computer-mediated collaboration in one experimental condition. Meantime, in a different experimental condition, the collaborators observed a model-collaboration. Learning effects of script and model were expected to become evident in the process and outcome of a second, unscripted computer-mediated collaboration. Compared to two control conditions (a condition with unsupported collaboration during the learning phase and a condition without a learning phase) both the script condition and the model condition showed positive effects on process and outcome during the application phase. This leads to the conclusion that collaboration scripts can indeed constitute a promising instructional method to promote collaborative competences and to improve subsequent computer-mediated collaboration.

1. BACKGROUND

As outlined in the introductory chapter of this book and illustrated by the individual chapters, collaboration scripts have proven to be powerful strategies for supporting collaboration in learning and problem-solving contexts. Moreover, they have shown such beneficial effects on collaborations in a variety of face-to-face settings ranging from collaborative learning of science texts in college settings (e.g., O'Donnell, 1999; O'Donnell & Dansereau, 1992) to collaborative problem-solving and learning in mathematics in a school setting (Berg, 1993). Also in a variety of computer-mediated collaboration settings empirical evidence has been established that scripts can provide effective support for collaboration (for examples refer to the chapters of this volume).

However, Dillenbourg (2002) expressed concern that there may be a danger to "overscript" collaborative interaction. Scripting collaboration might prevent the independent, exploratory thinking required for generative learning or problem-solving. This, Dillenbourg argues, is especially true for highly coercive scripts which dictate interaction in a very detailed and inflexible way. A high degree of coercion might also decrease student motivation. We have argued along similar lines (see Rummel & Spada, 2005b) that the motivation theory of Deci and Ryan (1985) indicates that collaboration scripts may cause motivational problems and reactance towards the script as this theory regards self-determination as central for motivation. Observations pointing in the same direction have also been made by researchers who have successfully applied scripts to enhance computer-mediated collaboration in their own research (Bruhn, 2000; Kollar, 2001). Negative motivational effects can be expected in particular if collaboration is scripted over an extended period of time and over many collaborative sessions (Hron, Hesse, Reinhard, & Picard, 1997).

Against this background, an important question is, whether central elements of a collaboration script can be learned from a scripted session, and then serve to promote subsequent unscripted collaboration (in the following called *learning-from-script hypothesis*). Such learning effect of a collaboration script would make it unnecessary to continue the scripting and risk motivational drawbacks, but collaborators could themselves maintain a fruitful collaboration following their internalized script rules.

In the following paragraphs, we first discuss approaches to scripting collaboration in the literature that are relevant for our own approach. We characterize our collaboration script within a classification framework proposed by Dillenbourg (2002) and introduce the experimental paradigm it has been investigated with. We provide empirical support for our hypothesis from a recent study (see Rummel & Spada, 2005b). In the final section, the central results gained from our experimental study are evaluated in the light of the key question of this chapter: Can people learn computer-mediated collaboration by following a script?

2. SCRIPT APPROACHES RELEVANT TO THE LEARNING-FROM-SCRIPT HYPOTHESIS

The central idea of collaboration scripts is to foster fruitful collaboration by externally structuring the interaction process. The script guides the collaborating partners through a defined sequence of interaction phases. For each phase specific activities are prescribed like roles in a theater or movie script. By enforcing specific kinds of activities among the collaborators, the script is expected to prompt cognitive, metacognitive and social processes by participants that might otherwise not occur (see chapter by King, this volume). This description holds true for collaboration scripts at a very general level even though there are great differences in the specific ways collaboration scripts have been realized. In this section we present some illustrative examples of collaboration scripts relevant to our script approach.

2.1 Collaboration scripts in traditional collaboration research

Several of the classical script approaches have originated from the idea to improve individual learning by including collaborative elements in the instruction. As it had become obvious that collaboration would in many cases not facilitate learning just by itself (e.g., Azmitia, 1988; Cohen, 1994; Dillenbourg, Baker, Blaye, & O'Malley, 1995; Slavin, 1983), scripting approaches were developed with the goal to design collaboration in a way to make it fruitful for learning.

One of the most well-known approaches to scripting is the so-called MURDER script developed by Dansereau and colleagues (Dansereau, 1988; O'Donnell & Dansereau, 1992; for an overview see O'Donnell, 1999). This script is directed at helping two college students in learning collaboratively from text material in science. The script includes detailed instruction on how to proceed in jointly processing the text at hand. At the outset, the text is broken into sections. Then students first read a section individually. Next, they take turns in the role of the recaller (summarizing the major ideas of the passage) and the listener (monitoring the explanation: detecting errors, identifying omissions and asking for clarifications). Together, the partners elaborate on the contents of the section and try to make it more memorable by connecting it to previous knowledge and to mnemonic illustrations like images or analogies. This cycle is repeated for each section of the text. Finally, the students review the text once more. In sum, the central activities prompted by the script are (see O'Donnell, 1999): the overt verbalization of thinking about the text, the metacognitive activities involved in active listening (e.g., error detection), and the emphasis on continuous elaboration. Further, cross-modeling among the two peers is an important element.

In a similar way, the script developed by Palincsar & Brown (1984; see also chapter by King, this volume) provides support for the collaborative processing of text. The main difference to the scripting approach by Dansereau and O'Donnell is that the reciprocal teaching technique was developed for the classroom. The teacher and several students take turns in performing the different steps of the script. Thus, the teacher provides an *expert model*, particularly in the beginning. As the students become more proficient, the teacher retreats and the cross-modeling among peers becomes more and more important. The reciprocal teaching script involves four main activities: formulating questions on the text, summarizing, clarifying difficulties with the text, and making predictions about how the text will continue. These steps are repeated for the different passages of the text.

Many of the classical script approaches that were developed to facilitate collaborative learning are built on the assumption that through extended practice with the script, the learners would little by little internalize relevant elements of the the script so that the external scaffolding provided by the script could be faded out over time (e.g., Palincsar & Brown, 1984). In other words, similar to the hypothesis we pose in this chapter, the classical script approaches comprised the notion that good collaboration would be learned from scripted interaction. However, they did not assess this assumption directly, for example by analyzing subsequent, unscripted collaborations for script elements, but the internalization of the fruitful script was inferred from learning gains.

2.2 Collaboration scripts in CSCL research

In computer-mediated collaboration settings, scripts can be incorporated in the structure of the technical environment. Many computer-mediated settings include shared workspaces that may be prestructured by embedding script information that can guide the collaborators and enhance content-specific negotiation (Bruhn, Fischer, Gräsel, & Mandl, 2000; Suthers, 2001; see also Ertl, Kopp, & Mandl, this volume; Weinberger, Ertl, Fischer, & Mandl, 2005; Weinberger, Stegmann, Fischer, & Mandl, this volume). Thus, in order to support computer-mediated collaboration, interaction design by means of scripts can be combined with interface design to provide an optimal environment for productive collaboration (Hesse, Garsoffsky, & Hron, 1997).

For example, the collaboration script implemented by Hron et al. (1997) regulated the interaction of two people in a text-based computer-mediated setting. Collaborative task of the dyad was to perform corrections on a diagram depicting some biological structure. The script dictated a dialog cycle, prompting each step that had to be performed in the interface of the collaborative environment. First, one partner was asked to propose a correction; then, the other partner was requested to express his approval or disapproval of the proposition. If disapproving, he was asked to give an explanation, which the first partner had to concur with in turn. This cycle went on until they had agreed on a correction. Only then would the system allow them to actually perform the correction in the graphical tool of the interface.

Pfister and Mühlpfordt (2002; see also Haake & Pfister, this volume) have developed a collaboration script structuring the discourse among learners in different knowledge domains in a similar way as the script by Hron et al. (1997). They call their script approach a *learning protocol*. In their computer-mediated collaboration setting, the interface requires participants to choose from a predefined menu of contribution types (e.g., question, explanation) before typing their specific contribution. Also, participants are asked to indicate which previous contribution in the discourse their contribution is relating to. When the message is then added to the dialog history, the chosen contribution type and the reference are indicated. In addition, the system assigns alternating roles to participants (e.g., tutor), which then again have an impact on the contribution types available to that person.

It is obvious that this kind of scripting exerts a high degree of coercion (Dillenbourg, 2002) on the collaborators as the script is enforced by the collaborative environment. In consequence, stronger negative motivational reactions to the scripting would be expected as compared to the traditional script approaches presented above. In further contrast to the above approaches, the script approaches in computer-mediated settings have concentrated exclusively on providing online support during a particular ongoing collaboration. The expectation that the script would be internalized or learned by the collaborating partners and would thus also affect subsequent collaborations has not been in the focal point.

3. A SCRIPT FOR LEARNING TO COLLABORATE

As we have pointed out above, the hypothesis that scripted collaboration should lead to an internalization of relevant aspects of the script is not new. Script approaches developed in research on collaborative learning (e.g., O'Donnell & Dansereau, 1992; Palincsar & Brown, 1984) assumed that the scaffolding provided by the script could be faded out because learners would internalize the script over time. However, this hypothesis was not tested systematically. And in the context of computer-mediated collaboration, collaboration scripts have so far been applied as *online* support measures for ongoing collaboration. Dillenbourg (2002, p. 81) has presented some initial thoughts on the idea that the cognitive processes instructed by a collaboration script in computer-mediated collaboration may be internalized by the collaborators. However, he also acknowledged that empirical evidence for this consideration has yet to be provided.

Our hypothesis is that scripts structuring computer-mediated collaboration online can also trigger *learning about collaboration*. We think that partners who follow a collaboration script while jointly working on a problem-solving task can acquire collaborative skills, which will then improve the collaborative process and outcome in a subsequent unscripted collaboration. Some evidence in support of our hypothesis can be found in the literature on the problem-based learning approach in medicine (e.g., Barrows, 1986; Cameron, Barrows, & Crooks, 1999). The central goal of this approach is to involve the students in constructive knowledge-building activities while solving authentic problems. In addition to the acquisition of contextualized domain knowledge, learners are expected to develop *procedural knowledge of the clinical reasoning process* (Barrows, 1986). It is this emphasis on the acquisition of procedural skills in addition to domain knowledge where the problem-based learning approach shares ground with our hypothesis that scripted collaboration may promote collaborative process skills. Moreover, the situated learning approach (Greeno and MMAP, 1998; Lave & Wenger, 1991) provides support for our learning-from-script hypothesis from a different angle: it supports our notion that meaningful collaborative activities guided by a script should yield much better learning effects (including better transferability to new collaborations) than direct instructions of the relevant script contents could.

3.1 Testing the learning-from-script hypothesis: The experimental framework of our collaboration script

The *collaborative scenario* we chose for our research was the computer-mediated solving of complicated psychiatric cases that required both medical and psychological expertise. Dyads of advanced medical and psychology students were asked to make use of their complementary expertise and jointly develop a diagnosis and sketch a suitable therapy plan for the cases. The two partners collaborated computer-mediated via a desktop-videoconference including personal text editors and a shared text editor.

Why choosing to investigate the interdisplinary collaboration among dyads of medical and psychology students, and why using a desktop video conference system for the collaboration?

The collaboration of psychologists and medical doctors (or of medical doctors with different specialization) is increasingly regarded to be of importance for the well-being of patients. A successful treatment is only possible if a correct diagnosis has been deduced from the symptoms of a patient. However, some symptoms can indicate both a physical as well as a mental diagnosis. Moreover, there is a high comorbidity of mental and physical disorders. While the interdisciplinary collaboration on the treatment of in-patients in hospitals is one topic, the other relevant question is how to encourage and support collaboration among locally distributed medical and psychological practices. In this context video conference systems have been advocated as a particularly suitable solution (Köhler & Trimpop, 2004).

In a desktop videoconference, participants at different locations each sit at their individual computer and communicate with one another via an audio-video connection. On the computer screen they can see video pictures of the remote partners. Each video picture is captured by a small camera sitting on top of the computer screen or placed directly to the side of the screen. A continuous audio channel provides the possibility to talk to the remote partners. In addition, desktop videoconferences support application sharing, which adds the important chance to not only view, but also jointly edit text or visual material. Moreover, the possibility to combine a shared application (e.g., a text editor) with an individual one (e.g., an individual text editor for each partner) offers ideal conditions to include both joint and individual work phases in a remote collaboration. In sum, video-mediated communication systems support complex synchronous interactions with an exchange of both verbal as well as nonverbal information (Finn, Sellen, & Wilbur 1997). However, there are also particular challenges that collaborators in such a setting are likely to experience and that a collaboration script ought to help them overcome

Depending on the quality of the audio and video transmission, delays in the transmission of sound and picture cause specific communication problems such as breaks and overlaps in the dialogue structure (Angiolillo, Blanchard, Israelski, & Mané, 1997). But even with a very good technical quality, the expenditure of any form of collaborative activity in videoconferences is increased by an additional and more explicit effort (Anderson et al., 1997) concerning, for example, the processes of grounding (Clark & Brennan, 1991), turn-taking, or giving feedback. O'Conaill and Whittaker (1997) found that video-mediated communication is more "lecture-like", that is, handing over turns is done in a very formal way by using questions or naming the next speaker. One reason for this finding might be that the visual contact possible in desktop-videoconference settings is in most cases limited to seeing the face or upper body part of the partner; usually eye contact is not possible, neither is gaze awareness (Angiolillo et al., 1997; Joiner, Scanlon, O'Shea, Smith, & Blake, 2002). It has also be criticized that joint awareness of and attention towards objects in the environment are not supported by videoconference systems (Kato et al., 2002). This may lead to problems for example when jointly using shared applications. It can be concluded that in a desktop videoconference setting the collaborative process requires extra effort, and good and explicit coordination is necessary.

3.2 Testing the learning-from-script hypothesis: A script to teach collaboration

We have adopted a particular *experimental paradigm* (see Rummel & Spada, 2005b) to test our hypothesis that scripts can promote the acquisition of collaborative skills. The paradigm comprised two phases of computer-mediated collaborative problems-solving: one task was solved during the so-called *learning phase*; a second task was solved during the *application phase*. In the learning phase, a collaboration script was provided to structure the interaction and to build up collaborative competences, which were then expected to become evident in the process and outcome of the second – unscripted – collaboration during the application phase.

A detailed script prescribing specific phases for their interaction was provided to the partners during their first collaborative case (i.e., during the learning phase). Table 3-1 gives an overview of the phases instructed by the script. Participants received the script instructions in written format. The instructions in the script were given in the following way: "Please, use the following 5 minutes to ask your partner any questions you might have about the case. Make use of each other's knowledge to clarify information given to you about the patient in the case description before turning to the diagnosis."

With the classification framework proposed by Dillenbourg (2002) our collaboration script can be characterized as follows:

The script defines phases with specific *tasks/activities* for each phase. Completion criteria are particular results that have to be achieved in a given phase (for example, individual notes on the diagnosis ought to be taken in Phase 4, see Table 3-1), but also the time limits that are set for each phase. The criterion for *group formation* (or better *team formation* since we are looking at dyads here) is the complementarity of domain knowledge (psychology vs. medicine). This criterion is relevant to form the dyads at the outset of the collaboration. The *group size* varies between phases: the partners are instructed by the script to either work jointly or individually. The *distribution of input* is preset by the complementarity of expertise in the dyad and further increased experimentally by a domain-specific distribution of text material. The input distribution then induces the activity distribution (Dillenburg, 2002, p. 74). For example, the medical student is expected to know more about possible side effects of the current medication of the patient than the psychologist. Consequently, he is going to be the one to explain those to the psychologist. Also, he will have to make sure that the side effects are taken into account when diagnosing the patient. On the other hand, the psychologist has knowledge about psycho-therapeutic treatments. Hence, he is going to be in charge of planning the psychotherapy for the patient. A corresponding *distribution of activities* across the partners is facilitated by the division of labor prescribed by the script. The *mode of interaction* is synchronous. However, this does not preclude phases where the partners work individually. To the contrary, particularly in the given collaboration scenario with relevant knowledge distributed over the partners, taking time for individual reflection and work is of great importance (see Hermann, Rummel, & Spada, 2001). Given the distinction King (this volume) makes between cooperative and collaborative learning, one might thus argue that our script should be labeled a *cooperation script*. However, as we have discussed before (Rummel & Spada, 2005b) making this distinction on the basis of the task division is somewhat arbitrary (see also Dillenbourg, 1999), and it would be difficult to make for our script – and the given task – as it comprises both collaborative as well as cooperative elements. It is cooperative, because a division of labor and individual work on subtasks is inevitable at some points given the complementary expertise of the partners. On the other hand, one could also define the script as collaborative, because the partners will need to work jointly a great deal to integrate both the medical and the psychological perspective. And the script does provide instruction for socio-cognitive processes to occur during the collaboration. Overall, we would characterize our script as a *collaboration script* rather than a cooperation script. As already mentioned, *time management* is supported by the script by prescribing a particular time frame for each phase in addition to the task definition.

Table 3-1. The phases of the collaboration script in Rummel & Spada (2005b)

Phase		
1.	🧍🧍	short initial coordination: define objectives of task
2.	🧍	scan case description for potential problems with understanding, formulate questions to the partner
3.	🧍🧍	mutually answer questions, coordination: determine course of action (content, time, roles)
4.	🧍	individually work on **diagnosis**, take individual notes
5.	🧍🧍	exchange notes, discuss individual ideas
6.	🧍	revise individual solutions and formulate final solution for diagnosis
7.	🧍🧍	copy individual parts of solution (diagnosis) in shared editor, integrate
8.	🧍🧍	formulate goals for the **therapy**
9.	🧍	individually work on therapy plan (division of labor!), take individual notes
10.	🧍🧍	exchange notes, discuss individual ideas
11.	🧍	revise individual solutions and formulate final solution for therapy
12.	🧍🧍	copy individual parts of solution (therapy) in shared editor, integrate final check of entire joint solution

In addition to the above *syntactical* (i.e., structural) attributes of our script, it can also be characterized along the lines of four *semantic* dimensions (Dillenbourg, 2002).

The *design rationale* behind our collaboration script is based on assumptions of what aspects characterize a good collaboration in the given type of scenario. We integrated empirical findings from different strands of research and came up with three levels merging in a good collaboration (see Rummel & Spada, 2005a): a level concerning the coordination of the joint work; a level concerning aspects of the communication; and a level concerning domain-specific demands for a good joint solution. Above all, the *learning objective* of our script was to promote the acquisition of meta-cognitive knowledge: we aimed at improving our participants' knowledge and skills in collaborating by providing them with a script.

Our collaboration script exerts a medium to high *degree of coercion* on the collaborators as it gives very detailed instructions of who should do what and how much time is available for the activity. Thus it prescribes the interaction of the collaborating partners to a great extent. However it is not equally as coercive as, for example, the script by Hron et al. (1997) because the communication interface does not enforce the script. Our script was provided on paper which entailed the danger that the collaborators could simply not adhere to its instructions. Indeed it was sometimes the case that the experimenter had to intervene and reprove the collaborators to stick to the script. In other words, the *adoption* of the script was not a trivial issue (first level of *appropriation* according to Dillenbourg, 2002). Not so much because people had problems following the script instructions, but because sometimes they did not want to follow them. The second level of appropriation according to Dillenbourg (2002), the *internalization* of the script over (scripted) time is in the focus of our research. As has been stated above, we have developed an experimental paradigm to investigate precisely this question. We have tested the effects of our collaboration script on the application phase at different levels (see Table 3-2): the collaborative process, its outcome – the joint solution for Case 2 – as well as an individual posttest.

4. RESULTS IN SUPPORT OF THE LEARNING-FROM-SCRIPT HYPOTHESIS FROM AN EMPIRICAL STUDY

4.1 Method

In an *experimental study* (see Rummel & Spada, 2005b) we compared learning effects of scripted collaboration (script condition) to three other conditions (see Table 3-2): a condition in which the collaborators observerd a worked-out collaboration example during the learning phase (model condition), a condition with unscripted collaboration during the learning phase (unscripted condition), and a condition without a learning phase (control condition). The unscripted condition served as a second control condition testing the learning effects of our script against the potential learning effects of merely gaining experience in collaborating. The model condition on the other hand was testing the alternative hypothesis that learning to collaborate from observing a model collaboration might be more successful than learning from scripted interaction, because the observation of the model allows to dedicate more cognitive capacity to elaborative meta-cognitive activity on the rationale of the different phases in the collaborative process.

Table 3-2. Experimental design in Rummel & Spada (2005b)

	Experimental variation			
	Script condition	Model condition	Unscripted condition	Control condition
Learning phase (Case 1)	Learning from scripted computer-mediated collaboration	Observational learning from a worked-out example of collaboration	Learning from unscripted computer-mediated collaboration	No learning phase
	Assessment of effects of instruction provided in the learning phase			
Application phase (Case 2)	Computer-mediated collaborative problem-solving in all four conditions → Data on collaborative process → Data on outcome (joint solution)			
	Posttest	→ Data on individual knowledge		

As can also be seen from Table 3-2, the experimental variation was implemented during the first phase of the experiment, the learning phase. With exception of the control condition all dyads were engaged with the first psychiatric case during this phase – either solving it themselves or watching it being solved by the models. In the application phase, effects of the experimental intervention were assessed as dyads were collaboratively solving the second psychiatric case. Both the collaborative process itself and the joint solution were analyzed as dependent variables. In addition, an individual posttest was administered testing for the participants' knowledge on what makes a good collaboration in the present scenario on two subscales.

In all four conditions nine dyads were tested each consisting of a medical student and a student of psychology (a total of 72 participants). Students were recruited during university lectures and seminars, and received a financial compensation for their voluntary participation. All students were at an advanced level of proficiency in their studies at the time of participation.

4.2 Results

The overall comparison of all four conditions yielded the following results. In the application phase (i.e., test phase) dyads in the script and the model condition outperformed dyads in both the unscripted and the control condition at three levels (see Table 3-2): the collaborative process, its outcome (the joint solution of case 2), and an individual posttest administered after the application phase. The results are summarized in Table 3-3 (for a more detailed account of the results, see Rummel & Spada, 2005b).

Table 3-3. Summary of results*

	Script condition	Model condition	Unscripted condition	Control condition
Logfile analysis on individual time	+	+	-	-
Analysis of dialogs on time management and coordination	+	+	-	?
Quality of joint solution				
Diagnosis	-	+	-	-
Therapy plan	+	+	-	-
Posttest				
Scale A	+	+	-	-
Scale B	+	+	-	-

*The table summarizes the results on all dependent variables. In the table "+" denotes a positive result, "-"denotes a negative one, and "?" a result which is difficult to interpret.

With regard to the *collaborative process*, an analysis of the activity patterns gained from log-file data revealed that dyads in the script and model condition adhered to the proportions of individual and joint work instructed during the learning phase. They showed a substantial *amount of individual work*, which – as had been hypothesized (see Rummel & Spada, 2005b) – proved to be an important predictor of successful performance on the joint solution. The script and the model conditions did not differ substantially on this variable. A detailed analysis of the *dialog data* with a coding scheme assessing the frequencies of utterances on a number of categories pertaining to aspects of good collaboration, like coordination and time management, revealed that dyads in the script and model condition did engage more in such process management than did dyads in the unscripted condition.

With regard to the *joint solution* for Case 2, dyads in the script condition produced the best therapy plan, however, they were outperformed by the model condition with regard to the diagnosis. We will come back to this point in the discussion.

Participants in the script and model conditions further showed better performance on the two subscales of the individual *posttest* testing knowledge about aspects relevant for good collaboration and problem-solving: subscale A, asking for knowledge on what makes a good collaboration in the given type of scenario at a more general level, and subscale B, asking participants to describe elements of a good therapy plan. Again, the script and the model condition did not differ in their performances.

In sum, the results support our hypothesis that *collaboration scripts can trigger learning about collaboration* and thus improve subsequent collaboration. The results attained by the model condition were similar to those of the script condition. Thus, observing a worked-out collaboration example during the learning phase also proved to be an effective instructional measure to improve the subsequent collaboration in the application phase.

5. CONCLUSIONS: CAN PEOPLE LEARN COMPUTER-MEDIATED COLLABORATION BY FOLLOWING A SCRIPT?

In analogy to Salomon's distinction between effects *of* technology and effects *with* technology (Salomon, 1993), we propose that one could differentiate between effects *of* the script versus effects *with* the script (A. Ertelt, personal communication, September 29, 2004). Salomon (1993) has argued that particularly in education improved performance while a tool is used should not be the primary goal. Rather, tool use should be aimed at improving the learners' abilities independent of continued tool use. In a similar way we have argued in this chapter, that we believe that the ultimate goal of supporting collaboration with a script should not lie in the improved, scripted performance, but in an improved ability to collaborate in fruitful ways, of course, leading to a good performance.

The promising results of the above study lead us to the conclusion that in future research the learning effects of collaboration scripts on the acquisition of collaborative skills should be investigated more systematically. We further propose that if collaboration scripts foster learning about collaboration, they can constitute a means to improve computer-mediated collaboration in the long term. Of course, in the study reported here we have only provided evidence of the learning effects on one delayed collaboration and, therefore, potential long-term effects cannot be claimed yet, but require further research on a greater number of more delayed collaborations.

An area that demands further consideration and empirical investigation is the question of how to design collaboration scripts from an instructional point of view to yield the best learning effects.

Guiding the collaborating partners to reflect on the relevant features of the script might be a promising measure to promote its internalization and acquisition as a standard of subsequent collaboration. Some indication that reflection of the scripted activities could improve learning is provided by the cognitive apprenticeship approach (e.g., Collins, Brown, & Newman, 1989). In this research, open verbalization and reflection accompanying the own behavior have proven to be important scaffolding strategies to support the acquisition of complex cognitive skills. It is our assumption that to foster the reflection of a scripted cooperation could provide such *procedural facilitation* (Scardamalia & Bereiter, 1985) while learning to collaborate from the script. More support for the beneficial effects of reflection and elaboration can be found in research on worked-out examples, where self-explanations (Renkl, Stark, Gruber, & Mandl, 1998) and instructional explanations (Renkl, 2002) have shown to improve the processing of worked-out examples and in consequence learning of the demonstrated problem-solving strategies.

Moreover, reference to the literature of learning from worked-out examples gives important indications for how to design the transition from scripted collaboration to independent unscripted problem-solving in order to achieve the best learning effects. The collaboration could initially be guided by a script like the one implemented in the present study. The scripting should then be faded out giving way to increasingly independent problem-solving. However, this transition should not happen abruptly from one task to the next as in the study described above, but in a supported step-by-step procedure similar to the transition from studying worked-out examples to solving problems proposed by Renkl, Atkinson, Maier and Staley (2002). Such a transition from collaborating with script to collaborating without script support is particularly interesting with regard to a potential long-term intervention with collaboration scripts

One issue that has to be addressed, particularly when aiming at script-learning, are motivational problems that collaboration scripts may cause and that may impede the adoption and, consequently, the internalization of the script. Although we did not directly assess motivational effects as part of our study, we think that negative motivational effects of the scripting in the learning phase became evident in the initial phase of the collaboration in the application phase. These negative effects are reflected in the performance of dyads in this condition on the diagnosis, which was poor compared to the outstanding performance they then showed on the therapy plan. However, the fact that dyads in the script condition then yielded very good results with regard to their therapy plans, and also showed high performances in the posttest, supports the conclusion that collaboration scripts can constitute a powerful method to promote collaborative skills. Yet, precautions have to be taken to avoid motivational problems arising from the scripting during the learning phase. The above proposal to guide the collaborating partners to reflect on the relevant features of the script might also be a promising measure to prevent negative motivational effects of scripting. If reflection on the script is promoted, the collaborating partners might gain a better understanding of the relevance of the scripted activities. This might then improve their openness towards the script and promote its internalization.

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