Perspectives on Collaboration Scripts

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Chapter 1 – Introduction

PERSPECTIVES ON COLLABORATION SCRIPTS

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Collaborative learning is widely regarded as an effective instructional approach. It has been shown that by having learners collaborate with peers, they may come to externalize their knowledge, monitor each others' learning, and jointly negotiate meaning. These activities may trigger significant individual cognitive processes that ultimately lead to individual knowledge construction (see Webb & Palincsar, 1996). On a theoretical level, the benefits of collaborative learning are often described in Piagetian and Vygotskyan terms: in collaborative learning, it is argued, that "socio-cognitive conflicts" (Doise & Mugny, 1984) may arise. When learners then try to resolve these conflicts, individual learning is stimulated. In addition, researchers claim that collaborators can provide one another with a "zone of proximal development" (Vygotsky, 1978). This is achieved by mutually scaffolding their activity such that they can perform slightly above their current level of competence.

However, a rich body of research has demonstrated that learners often do not collaborate well if left to their own devices. For example, they often do not sufficiently reference each others' contributions (e.g., Hewitt, 2005), do not build well-grounded arguments (e.g., Sandoval & Millwood, 2005), have problems in effectively coordinating their joint efforts (e.g., Gräsel, Fischer, Bruhn, & Mandl, 2001), and engage in quick and superficial consensus-building (e.g., Weinberger, 2003). Some of these problems may even be further augmented when collaboration is mediated by computers. This is because learners may be overstrained by dealing with the computer interface, may have less communication channels available than in natural face-to-face settings, or could adopt a social loafing behavior more easily (see Bromme, Hesse, & Spada, 2005). In other words, to be successful, collaborative

learning – be it a face-to-face experience or mediated by a computer – needs to be supported by adequate scaffolds.

In this book, all contributions center around one scaffolding approach that has repeatedly been demonstrated as successful in improving both collaborative learning processes and the individual learning outcomes mediated by these processes: the collaboration script approach. At a fundamental level, collaboration scripts are an instructional means that aim to make collaboration processes more productive (see Dillenbourg & Jermann, this volume). However, different researchers have different notions concerning what specific aspects of collaboration should be subject to scripting. In general, two major focuses of collaboration script research and design can be distinguished. Firstly, collaboration scripts may focus on what may be termed the "macro level" of collaboration (see Ayala, this volume; Haake & Pfister, this volume; Dillenbourg & Jermann, this volume). This involves the organizational issues of collaborative learning concerned with questions such as "Who collaborates with whom?", "What is the group's task?", or "What roles are distributed among the learners?". Secondly, other researchers are more concerned with the micro level of collaboration, designing scripts that provide support for specific activities. In this approach important questions are, for example, "What specific collaboration processes are the learners supposed to engage in?" or "How should learners specifically conduct these activities?".

Especially when looking at collaboration script approaches that provide support at the micro level of collaboration, one critical issue is the question of how coercive the script should be. Indeed, critics of overly coercive collaboration scripts often express their concern that learners are given too little freedom for productive collaboration to take place ("over-scripting"; Dillenbourg, 2002). On the other hand, it often seems necessary to provide learners with scripts that impose some structure to enable them to engage in productive interaction. However, striking a balance between taking the "freedom from" and providing the "freedom to" learners is a delicate issue. This topic is important for the design of collaboration scripts for both face-to-face and computer-mediated script approaches.

Although collaboration scripts were introduced long before the development of computer technologies as ubiquitous educational tools (see King, this volume), they have become a major topic in the research community on computer-supported collaborative learning (CSCL; e.g., Dillenbourg, 2002; Kollar, Fischer, & Slotta, 2005). One main reason for this seems to be that the script concept has a unique potential as a "boundary concept" among the different disciplines that intersect in CSCL: cognitive psychology, computer science, and education. Because the script concept plays a specific role in all three disciplines, it can serve as an anchor in multidisciplinary and interdisciplinary discourse. Furthermore, the script context may contribute to the development of a scientific community with a clear focus on knowledge ac-

cumulation. As the collection of chapters in this book illustrates, all three disciplines can make significant contributions towards the design, theoretical rationales, and practical implementations of collaboration scripts. However, the different connotations of the term script in cognitive psychology (e.g., Schank & Abelson, 1977), computer science (Hoppe, Gassner, Mühlenbrock, & Tewissen, 2000), and education (e.g., O'Donnell & Dansereau, 1992) also provide a challenge for discourse between disciplines. Cognitive psychology uses the term script primarily to describe individual memory structures that guide learners in their understanding and behavior in particular event sequences such as a restaurant visit (e.g., Schank & Abelson, 1977). Computer science tries to develop formal language and devices that support designers and practitioners (i.e., teachers) in easily setting up collaboration scripts for computer-mediated learning. Education is interested in the design of collaboration scripts that can be implemented in formal or informal learning settings and effectively guide and improve collaboration processes and subsequent individual learning. Thus, interdisciplinary discourse often faces challenges because the different meanings of the script concept need to be negotiated. This negotiation is necessary so that a joint understanding of what scripts are and what they are not can ultimately emerge. Therefore, this book also provides interdisciplinary approaches to scripting that can lay the groundwork for future interdisciplinary discourse about scripting.

In summary, this book aims to bring these different disciplinary approaches on scripting closer together. We have collected advanced script approaches from (1) cognitive psychology, (2) computer science, and (3) education. Moreover, to demonstrate the opportunities for using synergy to apply the script concept between perspectives, we have included recent (4) interdisciplinary CSCL approaches to scripting. In the following paragraphs, we briefly introduce each of the perspectives and then provide a brief summary of the approaches that are included in the respective sections of this book.

(1) From a *cognitive psychology perspective*, scripts are culturally shared as well as personal knowledge and memory structures that help people act and understand actions and action sequences in specific every-day situations (Schank & Abelson, 1977). An example is the "restaurant script", which specifies how an individual should act when going for dinner in a restaurant (entering the restaurant, waiting for the waiter, following the waiter to a table, waiting for the menu, choosing a meal, placing an order, etc.). When applied to collaborative learning, the question is, how collaboration scripts can support the acquisition or the activation of appropriate cognitive scripts on how to collaborate. When applied to novel knowledge communication situations in the Web, questions arise such as: What scripts do collaborators apply in novel communication and collaboration contexts? What scripts are

effective in overcoming barriers and biases in novel communication situations? How do new scripts for these novel situations evolve over time?

In the first chapter, *King* emphasizes that collaboration is not effective as such for learning but is mediated by specific cognitive and metacognitive activities of the individual. These activities, however, can be triggered by specific collaborative activities (e.g., explaining, argumentation). Since research has shown that these activities rarely occur spontaneously, King identifies scripts that have proven to be effective in structuring interaction to improve the individual's learning in a group. In analyzing four script examples for collaborative learning, King describes how these beneficial collaborative activities can be guided, clustered to roles, and sequenced to optimally activate and guide cognitive and metacognitive processes.

The chapter by *Rummel and Spada* addresses the question of whether collaboration scripts can be internalized. Do learners really learn to collaborate when supported by a script? In an interdisciplinary problem-solving scenario in a videoconferencing environment, learners first collaborated using an external script and afterwards were also able to demonstrate important aspects of the collaborative behavior without the script. In their contribution, Rummel and Spada point to important conditions that must be met in order for script internalization to take place (e.g., guiding reflection, fading out, motivation).

The chapter by *Runde, Bromme, and Jucks* also emphasizes scripting as a way to support communicating individuals with largely differing knowledge structures, namely medical experts and patients in an online counseling scenario. In contrast to many of the other chapters in the book that use explicit collaboration scripts, Runde et al. focus on the effects of implicit scripting that was realized by external representations shared by the doctor and the patient. In their study, they found evidence for representational guidance by implicit scripting. This evidence was indicated by positive effects of the external representation on the content of the expert-layperson communication.

Nückles, Ertelt, Wittwer, and Renkl draw our attention to a highly promising function of collaboration scripts: Supporting the communication between individuals with large differences in prior knowledge. Nückles et al. investigated the effects of a collaboration script that supported the online communication between laypersons and experts in a computer helpdesk scenario. Findings of their experimental study show that providing the laypersons with successive prompts to better formulate their query substantially improved the effectiveness of communication by yielding the best expert reconstruction of the problem.

In his discussion, *Hesse* points to possible drawbacks of the collaboration script approach. One disadvantage may be that the designer of a collaboration script forces learners who may already possess effective collaboration strategies to adopt a strategy that interferes with their personal, possibly

highly functional collaboration approach. As an alternative to the scripting approach, Hesse therefore introduces what he calls the "awareness approach". The aim of this is to provide collaborators with information about the group members, the history of the group, or the group's situation instead of instructions (of varying detail) concerning how to structure their collaboration.

(2) From a *computer science perspective*, the prescription of activities and their sequences is an important issue. In the research areas of computer-supported collaborative work, collaborative learning and Artificial Intelligence (AI), scripts have been used to support developers in defining, configuring and adapting system behavior (such as in Hypercard, 1987). Scripts have also been used to guide users through complex work or learning processes (cf. Haake & Schümmer, 2003; Hoppe, et al., 2000; Hron, Hesse, Cress, & Giovis, 2000; Wessner & Pfister, in press). While approaches such as Workflow Management Systems (http://www.wfmc.org; http://www.e-workflow.org) focus on organizational processes (macro level), process modeling and execution languages (Dowson & Fernström, 1994) focus on supporting detailed work processes (micro level). Important issues involve the representation and computational semantics of scripts. For example, these include how scripts can be efficiently constructed and executed, and how their presentation and interaction mechanisms at the user interface should be designed to facilitate process execution and learning. Connecting macro and micro level approaches is still an open issue.

Ayala addresses the question of how software agents can contribute to scripting collaboration. He identifies a potential for agent-based procedural collaboration support both on the macro-level of collaborative learning (e.g., supporting the formation of appropriate groups) as well as on the micro-level (e.g., by supporting coordination). Illustrating his approach with two examples of agent-based environments, Ayala suggests different approaches for agent-supported collaboration scripts used with domains, which are pedagogically structured than for those, which are not. For both cases, Ayala examines the types of support possible on the macro and micro levels.

Miao, Harrer, Hoeksema, and Hoppe analyze the extent to which IMS LD appropriately addresses crucial aspects of scripting collaborative learning. They identify five major shortcomings of current approaches, e.g., the problem of modeling groups and the complexity of modeling dynamically changing artifacts that are produced and modified by collaborators in the learning groups during runtime. Miao et al. propose a CSCL scripting language aimed at overcoming these issues, e.g., by explicitly introducing the group and the artifact as entities and by extending the space of actions and expressions. By analyzing a typical CSCL script, they exemplify their approach together with the modeling environment they developed.

The chapter by *Lauer and Trahasch* is devoted to facilitating learning from multimedia lecture recordings through annotations and scripted discus-

sions. They introduce the concept of scripted anchored discussions that combine the approaches of scripted and annotation-based discussion. They define scripted anchored discussion as an activity in which several learners exchange structured comments. These comments are connected to certain spatial and temporal positions in digital documents. Lauer and Trahasch propose a formal model using a finite state machine formalism and provide examples to illustrate their approach. Using this model, they propose different strategies for increasing the script's adaptivity by fading components out.

Haake and Pfister suggest that the main function of CSCL scripts is providing support for coordinating learners by constraining their potential activities. They identify the inflexibility of collaboration scripts as a shortcoming of current approaches. These scripts are mostly built-in components of the CSCL environments and cannot be adapted quickly to specific contexts of use. They propose a formal model of CSCL scripts as extended finite state automatons as an important step in the direction of more flexible scripts, which can easily be changed by designers and teachers. For learners in specific roles and states, the script defines what they are allowed to do and what user interface they see. Moreover, the chapter presents a tool based on this model that supports the editing of scripts on varying levels of granularity.

In his comments, *Suthers* distinguishes two roles of computational scripts. Scripts can be a means of decreasing the cognitive load of learners and may help create effective learning situations. Scripts can also be a means of making the design of learning situations more explicit and accessible for discussions among educators and learners. Suthers discusses the ambivalences of computational scripts: they may provide guidance but may also remove "out of context" interaction. Scripts may support successful collaboration episodes, but may also serve as a potential resource for learners.

(3) From an *educational perspective*, scripts are primarily interesting for their potential to improve collaboration processes and individual learning outcomes in formal and informal educational settings like schools, university courses, or museums. Educational approaches are typically based on the constructivist assumption of active learners in a zone of proximal development (Vygotsky, 1978). In this zone of proximal development, learners collaboratively use technological tools and/or participate in a knowledge community. A collaboration script then provides such a zone of proximal development. The script should increasingly be replaced by the individual's self-regulation. Important research questions are: What kinds of activities and roles and which kind of sequencing are beneficial for collaborative learning and should therefore be used in the design of collaboration scripts? How do collaboration scripts compare to other forms of facilitating collaborative learning? How can collaboration scripts be effectively integrated into different computer-supported collaboration scenarios?

Weinberger, Stegmann, Fischer, and Mandl introduce collaboration scripts as an instructional approach for facilitating argumentation in a problem-oriented and distributed learning environment. They analyze the written discourse of distributed groups of students who were supported by different script components. The script components address different dimensions of argumentative knowledge construction (e.g., the epistemic and the social dimension). Their findings show that the script components improved argumentation with respect to the dimension they focused on. Moreover, they identify script components, which – in addition to improving collaboration – facilitate individual transfer from collaboration.

Ertl, Kopp, and Mandl explore the effects of collaboration scripts in videoconference-based tutoring environments. Their scripts specifically aim to support the interaction of learners separated by distance. They report on two experimental studies that consider the effects of such scripts on collaboration and learning outcomes. Their results show that scripts can have rather different effects on collaboration processes and individual outcomes. Their findings further point to the importance of analyzing the effects of scripts in the broader instructional context. Their collaboration scripts that aim to improve interaction proved to be effective for individual learning outcomes only when additional conceptual support was provided in the form of a content scheme.

Kolodner's chapter introduces the Learning by Design approach as a way to help learners acquire and refine (cognitive) scripts for successful participation in science-related discourse practices. Kolodner couples the script concept as presented by Schank and Abelson (1977) and Schank (1999) with stances taken in Lave and Wenger's (1991) conception of communities of practice. The Learning by Design approach focuses on the activity structures (or instructional scripts) that require learners to present the results of their work to the class (poster session, pin-up session, gallery walk). Kolodner explores how these can help to form stable cognitive scripts for participation in scientific practices.

In their discussion of educational approaches to scripting, *Häkkinen and Mäkitalo-Siegl* suggest considering scripts as contextual and situated resources in collaborative learning environments. An educational challenge connected to such a perspective is the integration of CSCL into the classroom. More specifically, they identify a current deficit with respect to theory-based instructional strategies for teachers to better integrate CSCL scripts into the overall classroom activity. They identify a further challenge for future research as exploring how external scripts can be gradually replaced by individual self-regulation. Methodologically, the authors conclude that these challenges can be addressed more appropriately when longer-term follow-up studies are included in research programs.

(4) Interdisciplinary perspectives. Although scripts can be regarded as a boundary concept for CSCL, cognitive psychology, computer science and

educational approaches have just started to collaborate in designing better representations and user interfaces for collaboration scripts. This has been achieved by exploring how the cognitive scripts of collaborators interact with the externally represented scripts provided by different instructional and computational approaches. In this context, two chapters aim to describe perspectives for promising interdisciplinary research on collaboration scripts.

Dillenbourg and Jermann introduce their SWISH model for the design of integrative scripts. They basically suggest splitting the task so that collaborators have to interact in a way that makes learning processes more likely to happen. From this cognitive design rationale, they then head in two directions. First, they describe collaboration scripts as part of a larger didactic activity in the classroom. They provide a systematization of script families that can be specified for different contexts and learning goals, thus connecting their approach to educational theory building. Second, they take a step towards computational approaches in generalizing their scripts and in presenting a generic modeling scheme.

Building on Perkins' (1993) Person-Plus-Surround approach, *Carmien, Kollar, G. Fischer, and F. Fischer* propose a conceptual framework. In their framework, three main components are proposed to describe the complex interplay between internal (cognitive) and external scripts in accomplishing collaboration tasks. These components are the activity, the underlying knowledge, and the executive function. Two script approaches from computer science and from educational psychology are analyzed and compared with the conceptual framework. One represents a script for living (supporting people with cognitive disabilities) and the other represents a script for learning (facilitating argumentation in biology classes in high school).

Stahl's comment highlights an aspect not prominently addressed in both of the approaches of this interdisciplinary section, but one which is of great importance for research on CSCL: the aspect of scripting group cognition. To align theory building on collaboration scripts with current socio-cultural thought, he argues for re-conceptualizing scripts as situated resources rather than prescriptions for acting in collaborative situations.

This volume should be seen as a reference on collaborative learning that brings together scripting approaches from cognitive psychology, computer science, and education. We believe that research on collaboration scripts has an extraordinary potential for advancing the multidisciplinary endeavor of CSCL research. It is our hope that this book can provide a rich basis for further exploring and realizing this potential.

REFERENCES

Bromme, R., Hesse, F. W., & Spada, H. (Eds.) (2005). *Barriers and biases in computer-mediated knowledge communication – and how they may be overcome.* New York, NY: Springer.

Chinn, C. A., & Brewer, W. F. (1993). The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. *Review of Educational Research, 63*, 1-49.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL. Can we support CSCL* (pp. 61-91). Heerlen: Open Universiteit Nederland.

Doise, W., & Mugny, G. (1984). *The social development of the intellect.* Oxford: Pergamon Press.

Dowson M., & Fernström, C. (1994). Towards Requirements for Enactment Mechanisms. In B. Warboys (Ed.), *Software Process Technology. Third European Workshop, EWSPT '94, Villard de Lans, France, February 1994. LNCS 772.* Heidelberg: Springer.

Gräsel, C., Fischer, F., Bruhn, J., & Mandl, H. (2001). Let me tell you something you do know. A pilot study on discourse in cooperative learning with computer networks. In H. Jonassen, S. Dijkstra, & D. Sembill (Eds.), *Learning with multimedia – results and perspectives* (pp. 111-137). Frankfurt a. M.: Lang.

Haake, J. M., & Schümmer, T. (2003). Supporting collaborative exercises for distance learning. In B. Wasson, S. Ludvigsen, & U. Hoppe (Eds.), *Designing for Change in Networked Learning Environments* (pp. 125-134). Dordrecht: Kluwer.

Hewitt, J. (2005). Toward an understanding of how threads die in asynchronous computer conferences. *The Journal of the Learning Sciences, 14*(4), 567-589.

Hoppe, H. U., Gassner, K., Mühlenbrock, M., & Tewissen, F. (2000). Distributed visual language environments for cooperation and learning - applications and intelligent support. *Group Decision & Negotiation, 9*, 205-220.

Hron, A., Hesse, F. W., Cress, U., & Giovis, C. (2000). Implicit and explicit dialogue structuring in virtual learning groups. *British Journal of Educational Psychology, 70*, 53-64.

King, A. (1998). Transactive peer tutoring: distributing cognition and metacognition. *Educational Psychology Review, 10*, 57-74.

Kollar, I., Fischer, F., & Hesse, F. W. (in press). Collaboration scripts – a conceptual analysis. *Educational Psychology Review.*

Kollar, I., Fischer, F., & Slotta, J. D. (2005). Internal and external collaboration scripts in web-based science learning at schools. In T. Koschman, D. Suthers, & T.W. Chan (Eds.), *Computer Supported Collaborative Learning 2005: The Next 10 Years!* (pp. 331-340). Mahwah, NJ: Lawrence Erlbaum Associates.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambrigde, UK: Cambrige University Press.

O'Donnell, A. M., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups. The theoretical anatomy of group learning* (pp. 120-141). New York: Cambridge University Press.

Perkins, D. N. (1993). Person-plus: a distributed view of thinking and learning. In G. Salomon (Ed.), *Distributed cognitions: psychological and educational considerations* (pp. 88-110). Cambridge, UK: Cambridge University Press.

Sandoval, W. A., & Millwood, K. A. (2005). The quality of students' use of evidence in written scientific explanations. *Cognition and Instruction, 23*(1), 23-55.

Schank, R. C. (1999). *Dynamic Memory Revisited.* New York: Cambridge University Press.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals and understanding*. Hillsdale, NJ: Erlbaum.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Webb, N. M., & Palincsar, A. S. (1996). Group processes in the classroom. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp.841-873). New York, NY: Simon and Schuster MacMillan.

Weinberger, A. (2003). *Scripts for computer-supported collaborative learning. Effects of social and epistemic cooperation scripts on collaborative construction.* Doctoral dissertation, Ludwig-Maximilians-University, Munich, Germany. Available at: http://edoc. ub.uni-muenchen.de/archive/00001120/01/Weinberger_Armin.pdf.

Wessner, M., & Pfister, H.-R. (in press). Points of cooperation: Integrating cooperative learning into web-based courses. In H. U. Hoppe, M. Ikeda, & H. Ogata (Eds.), *New technologies for collaborative learning*. Dordrecht: Kluwer.