

Chapter 2

Introduction to Collaboration Scripts

The recognition that not all learners are willing to execute the social and cognitive activities that lead to successful learning has long been recognized (McLoughlin 2002). Thus, supports are needed to assist the learners to develop competencies in self-regulated learning and social interaction. Based on constructivist models of learning, the term of *Scaffolding* is becoming increasingly popular in educational researches and practices. The term is mainly used by learning scientists to describe the help given to learners that assumed to promote deeper learning (Sawyer 2006). The term was first employed by Wood and colleagues to “adult controlling those elements of the task that are essentially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence” (Wood et al. 1976, p. 9). Consequently, a learner develops the skills necessary for completing such tasks independently (Bonk and Cunningham 1998; Rogoff 1990). Originating in the socio-cultural perspective of Vygotskian theory (1978), it is clear that the conception was derived from the notion of the Zone of Proximal Development, which characterizes the region of tasks within which learners would not be able to accomplish on their own but can successfully complete it with the assistance of a person competent in the task (Duffy and Cunningham 1996). In short, scaffolding enables the learner to bridge this gap between the actual and the potential depends on the resources or the kinds of support provided (Puntambekar and Hübscher 2005).

A number of scaffolding approaches have been developed based on empirical findings and socio-cognitive theories to directly facilitate specific processes of collaborative knowledge construction. Such instructional supports have been described and analyzed more systematically as *Collaboration Scripts* (Fischer et al. 2007). Collaboration scripts illustrate the convergence between instructional engineering and socio-constructivism (Dillenbourg and Jermann 2007). From this standpoint, collaboration scripts have been regarded as scaffolds that aim to improve collaboration through structuring the interactive processes between two or more learning partners (Kollar et al. 2006). In order to get an idea of why and how collaboration scripts are likely to be effective, let us first consider some of the

crucial features of what these scripts may look like. As with many such concepts that are felt to have useful power in theoretical and practical realms, it will be worthwhile to do some historical excavation by circumscribing the early uses and roots of the concept and then craft a conceptual map relating the term collaboration scripts.

2.1 Previous Works on Conceptualize Collaboration Scripts

As a ‘boundary concept’, the term scripting has been associated with various theoretical sources (Fischer et al. 2007) and it was introduced long before the development of computer technologies as ubiquitous educational tools (King 2007). Fischer and other pioneers (2007) in the multidisciplinary context of CSCL presented an extensive overview on recent researches with a special focus on collaboration scripts. Although the term ‘script’ refers to the notions originally used in computer science (Ayala 2007; Miao et al. 2007) and cognitive psychology (Schank and Abelson 1977), it has also begun to be used more often in educational settings, where the meaning it has taken on is somewhat different (King 2007). In educational settings, a script is designed externally (by a teacher or other learning facilitator) as a guiding structure to specify, sequence, and assign activities to collaborative learners (Weinberger 2003).

The first use of the term scripting in an educational context is the well-known MURDER script to facilitate text comprehension (O’Donnell and Dansereau 1992). The script includes detailed instructions on how to proceed in a text processing task, in which structured dyads take turns in the role of ‘recaller’ who recalls all the remembered information and ‘listener-detector’ who listens and then detects errors, identifies omissions and asks for clarifications in the recall.

Led by the initial work of O’Donnell and Dansereau (1992), several other instructional approaches have been subsumed as script approaches (Derry et al. 1998). King (1998, 1999, 2007) developed a peer-tutoring model for classrooms to support knowledge construction in dyads or in larger groups of learners. The guided ASK to THINK—TEL WHY model distributes structured reciprocal tutoring roles (questioner vs. explainer) among the learners and structures the activities on a rather detailed level by requiring learners to complete question prompts. Question sequencing from review questions through thinking and meta-cognitive questioning and responding serves to both control the progression of learning and monitor its extensiveness (King 2007).

Even more recently, collaboration scripts have become a major topic in research on computer-supported collaborative learning (Dillenbourg 2002; Kollar et al. 2007), where collaboration is partly or totally mediated by computer as opposed to consisting of face-to-face interaction (Dillenbourg and Jermain 2003; Ertl et al. 2007; Lauer and Trahasch 2007). The Argue Graph script (Dillenbourg and

Jermann 2003) was developed to trigger argumentation among pairs: First, each student is required to fill out an online questionnaire, that is related to the studied content domain (e.g., how to react to students' erroneous answers within educational software). The multiple-choice questions have no correct or incorrect answer. Questions measure opinions and students provide a short written argument for each of their choices. The system produces a graph in which students are positioned according to the collected answers. The system or the tutor forms student pairs by selecting students with the largest distance on the graph (i.e., with the most different opinions). And then pairs answer the same questionnaire together and provide arguments again. The system therefore aggregates the collected answers and the arguments that were given individually and collaboratively. The role of the tutor is to organize the students' arguments into theories, or, in other words, into the structured knowledge. Finally, each student individually writes a structured synthesis of the arguments collected for a specific question.

Another example is provided by the social and epistemic scripts (Weinberger et al. 2005) which consist of the following phases and interactions between the members of groups of three students: First, each student gets information about an (educational) case A and is required to write a report about the case. After that, each student gets the case B and the report of the student to his left and writes a comment about the report. Then, each student gets a case C and the report and the comment the student to his left produced, and write a second comment about the report. Finally, each student gets back his own report to case A together with the comments of the two other students and rewrites it taking the comments into account.

As shown in the preceding quick review, although the specific combination of procedures often varies from one collaboration script to the next, most researchers in the field have posited models that to some degree consist of shared conceptual components that are assumed to be important to ensure successful collaboration scripts. Despite a substantial number of empirical studies on the effects of collaboration scripts on processes and outcomes of learning, a 'coherent theoretical account' is still missing (Fischer et al. 2013). A few pioneering works (Dillenbourg and Jermann 2007; Kollar et al. 2007) made the first attempt to formalize some of the ideas of distinguishing internal/external and macro/micro collaboration scripts.

2.1.1 Internal Versus External Scripts

Schank and Abelson (1977) introduced the term (internal) scripts to describe the abstract mental structures that organize the processing of sequences of events. In short, they used scripts as personal knowledge and memory structures of a "sequence of actions that define a well-known situation" (Schank and Abelson 1977, p. 41) which determines how people act in specific every-day situations, such as in a restaurant. In a typical restaurant, for instance, individuals know that they first need to order a menu, subsequently wait to be served, and finally pay the bill after eating. Following Schank and Abelson's idea, Kollar et al. (2007) distinguished

internal scripts as cognitive structures from external scripts as instructional approaches. In contrast to the Schank and Abelson (1977) view of scripts as a fairly static internal memory structure with a narrowly constrained set of actions and roles, researchers in educational psychology talk about scripting the interaction of learning groups (O'Donnell and Dansereau 1992). From this perspective, collaboration scripts are normally represented in the learners' minds (internal representation) as a memory structure and on the other hand, scripts can be represented somewhere in the learning environment (external representation), with complex interplay between these two levels of representation (Carmien et al. 2007).

In this context, scripting is used more broadly to describe how collaborative learning can be externally structured or scaffolded for the purpose of prompting group interaction that promotes learning. Scripting of the interaction during collaboration is designed so that the roles of participants, the actions engaged in and the sequence of events, prompt specific cognitive, socio-cognitive, and meta-cognitive processes, thus ensuring that the intended learning takes place (King 2007). In short, as a working definition, external collaboration scripts provide a structure to collaborative knowledge construction by specifying, sequencing, and assigning roles or activities to learners (Kollar et al. 2006).

2.1.2 Macro Versus Micro Scripts

In a pioneering attempt to analyze collaboration scripts, Dillenbourg and Jermann (2007) made a distinction between macro- and micro-scripts. According to the distinction, micro-script scaffolds tend to directly influence the interactions of group members by giving more specific instructions, such as sentence starters or question prompts. Most examples described here are on the 'micro' side: in the work reported by O'Donnell and Dansereau (1992), King (2007), and Weinberger et al. (2005) that tends to provide more scaffoldings to students such as sentence starters, question prompts or descriptions (Kollar et al. 2007). Compared to micro-scripts, macro-scripting indirectly promotes productive interaction by arranging basic conditions like the group size, the group task or the communication media rather than specific support. Typically, macro-scripts describe longer time segments and are spread over more social planes compared to micro-scripts. The example presented by Dillenbourg and Jermann (2003) describe environments that articulate micro-scripts within phases of a macro-script.

Generally speaking, micro scripts reflect a psychological perspective, whereas macro-scripts are based on a pedagogical perspective that influences the process more indirectly (Häkkinen and Mäkitalo-Siegl 2007). For all apparent differences, micro and macro-scripts do not constitute clear-cut categories but only differentiate in the level of granularity (Kobbe et al. 2007). They share the same compositional structure and can therefore be described with the same set of components and mechanisms.

2.2 Script Theory of Guidance

Recently, Fischer et al. (2013) outlined a *Script Theory of Guidance* that is more systematic than works of other predecessors and takes a more analytic view of a few central components that are shared among different scaffolding approaches and several leading principles to explain a broad range of findings from the CSCL literature. Two main theoretical perspectives underpin the unified theory on collaboration scripts, namely, the schema theory (Schank 1999; Schank and Abelson 1977) and socio-cultural constructivism (Vygotsky 1978). We present a brief overview of our understanding of these perspectives and then describe the integration of these perspectives in the research motivation for the present study.

What is of great interest and expressed by constructivists is the dynamic process of knowledge construction that bridges the outside world and mind. As we have summarized earlier in the first chapter (i) collaborative learning is an active process of knowledge construction rather than knowledge transmission; (ii) learner plays a critical role to construct his/her own learning; and (iii) scaffolding is needed to adapt the dynamic process of knowledge construction. More like a ‘philosophy of learning’ (Kirschner et al. 2004), constructivism is thus criticized for the lack of guidelines to specify the critical role of learner, the dynamic feature of scaffolding and more important, the active process of knowledge construction triggered by the interplay between the internal side of learner and external side of scaffolds. As a solution to overcome the major problem, the *Script Theory of Guidance* bridges the gap between the philosophical constructivist thoughts on the one side and the research practice on computer-supported collaborative learning on the other.

2.2.1 Central Components

The *Script Theory of Guidance* started with the elaborated distinction between internal and external collaboration scripts. According to Fischer et al. (2013) an internal collaboration script is a configuration of knowledge components about a collaborative practice and its parts at different levels of complexity, while an external collaboration script is a configuration of representations to guide the collaborative practice.

First, four conceptual components were identified to constitute the internal configuration of knowledge (internal scripts): The *play* component is at the top level and includes knowledge of the sequence of *scenes* and of the *roles* involved in it. The *scene* components include knowledge about situations in a play and the *scriptlet* component refers to knowledge of sequences of single activities within particular scenes. Finally, the *role* components typically extend across several scenes and activities, which thereby constitute knowledge of taking part in several scenes and organizing specific scriptlets.

Since the purpose of external collaboration scripts is to guide CSCL practice by facilitating or inhibiting the internal collaboration script components (Fischer et al. 2013), the external collaboration scripts have a one-to-one correspondence between the structure of internal collaboration scripts and its four types of components: *Play scaffolds* guide the topmost level by presenting the main goal of the collaboration but no elaborating how to reach the goal. *Scene scaffolds* specify and sequence a set of scenes, which constitutes a comprehensive play. *Role scaffolds* assign specific roles to the participating learners. Assigning roles is meant to assure that learners are equally involved in establishing and maintaining shared conceptions and they can approach a problem from multiple perspectives. Typically, the equal participation and the diversity of perspectives can be achieved with role scaffolds that require learners to change roles transgressing the boundaries of scenes. Finally, *Scriptlet scaffolds* target the specific activities that constitute a scene.

This is an important advancement towards the direct comparison of various scaffolding approaches since the availability of the systematic framework provides the common language, basic structure, and general levels to be applied to interpret the differences. The comparison results of a few exemplifying collaboration scripts are summarized in Table 2.1.

2.2.2 Guiding Principles

Built on a recent version of schema theory and integrated constructivist perspectives, seven guiding principles were outlined in the *Script Theory of Guidance*.

2.2.2.1 Internal Script Guidance and Configuration Principle

The internal script is different from the notion proposed by Schank and Abelson (1977) in their early works in which script is an invariant structure that describes an appropriate sequence of events in a particular context. It seems clear that this initial version of the script is not subject to change, nor do they provide the apparatus for handling novel situations. Any structure proposed for memory must be capable of self-modification (Schank 1999). The notion of cognitive psychology was elaborated progressively by emphasizing the internal dynamism of scripts to explain the highly flexible configuration and reconfiguration of knowledge components according to a changing situation (Fischer et al. 2013).

According to the *Script Theory of Guidance*, prior experience and knowledge, connotated as internal collaboration scripts about collaborative practices play a crucial role for guiding the person's understanding of and actions in the collaboration (***Internal Script Guidance Principle***). The dynamic configuration and/or re-configuration of internal collaboration scripts are influenced by the learner's goal and the perceived situational characteristics (***Internal Script Configuration Principle***).

Table 2.1 Comparison external collaboration scripts

External scripts	Components			Scriptlet	Role
	Play	Scene			
MURDER	Text comprehension in pairs	<ul style="list-style-type: none">• Reading a set of text passages• Switching roles after completing one passage		Within each pair and for each passage of text: <ul style="list-style-type: none">• Both students set the Mood for studying• Both students read the text material for Understanding<ul style="list-style-type: none">• The recaller Recalls the material• The listener Detects errors/omissions and gives feedback• Both students Elaborate on the learning material• Both students Review the learning material and what they have learned	Recaller Listener
ASK to THINK-TEL WHY	Peer tutoring	<ul style="list-style-type: none">• Learning sessions• During any learning sessions, partners exchange roles		ASK to THINK: Questioner ask question in certain sequence <ul style="list-style-type: none">• Review questions• Thought-provoking questions• Hint questions• Probing questions• Metacognitive questions TEL WHY: Explainer answer those questions	Questioner Explainer
ArgueGraph	Argumentative dialogue	<ul style="list-style-type: none">• Individual question and argumentation• Group formation according to Argue Graph• Pair question and argumentation• Teacher organized debriefing• Synthesis			Individual/pairs

(continued)

Table 2.1 (continued)

External scripts	Components			Scriptlet	Role
	Play	Scene			
Social cooperation script (SCOS)	Case-based problems solving	<p>The SCOS-learners were guided through all three cases and were asked to alternately play the role of the analyst and that of the critic</p> <ul style="list-style-type: none">• First analysis• First constructive critique• Second constructive critique• Reply to first critique• Reply to second critique• Third constructive critique• Fourth constructive critique• New analysis of the case	<p>Prompts for the constructive critic</p> <ul style="list-style-type: none">• These aspects are not clear to me yet• We have not reached consensus concerning these aspects• My proposal for an adjustment of the analysis is <p>Prompts for the case analyst</p> <ul style="list-style-type: none">• Regarding the desire for clarity• Regarding our difference of opinions• Regarding the modification proposals	Analyst Critic	

2.2.2.2 Internal Script Induction, Re-configuration and Transactivity Principle

Learning is a process of internalizing external reality (Iran-Nejad 1990). Many of the classical script approaches that were developed to facilitate collaborative learning are built on the assumption that through extended practice with the external script, portions of the external script become more and more internalized by individuals in their internal scripts (Palinscar and Brown 1984). In this way, internal collaboration scripts can be consequently induced and continually modified.

As I have pointed out above, the grounding assumption that external scripted collaboration should lead to an internalization of relevant aspects of the script is not new: “Every function in the child’s development appears twice: first, on the social level, and later on the individual level; First, between people (inter-psychological) and then inside the child (intra-psychological)” (Vygotsky 1978, p. 57). Therefore, individual development could be referred to as a process from the internalisation through social interactions, restructuring conceptual system to new understanding (Liu and Robert 2005).

Before addressing the principles, a few essential assumptions need to be back-tracked. In Piagetian terms, individual knowledge construction stimulated by internal cognitive conflict as learners strive to resolve mental *Disequilibrium* via assimilation or accommodation to construct or alter internal structures (Piaget 1970). A more careful reading of Piaget indicates that he actually also emphasized the critical role of internalizing knowledge by making changes in the mental structure. According to cognitive constructivism, when new information is processed, it is considered by the extent to which it fits into an existing internal collaboration scripts. And most of the learning that occurs is either incorporated within internal scripts (*assimilation*) or modifies internal scripts (*accommodation*) if the discrepancies become too great. In this case, the learner has to either build new configuration to an existing internal scripts or alter the internal scripts to allow for what has been newly experienced in order to maintain a state of equilibrium (as we already know from the principles mentioned above).

Of key importance to the *Script Theory of Guidance* (Fischer et al. 2013) is the specification of the dynamic internalization process which refers to the generic link between the external and internal collaboration scripts. In order to address the essential issue of how to produce greater internalization and deeper understanding, three further principles were developed. That is, if a learner participates in an initially unfamiliar CSCL practice, then he or she builds a new configuration of already available internal script components and, through repeated application of this configuration of internal script components, develops new higher-level components (play, scene, or role) that organize the subordinate components (scenes, roles and scriptlets) for this CSCL practice (***Internal Script Induction Principle***). If a learner’s employed internal collaboration script does not lead to understanding or successful actions in a CSCL practice, the internal collaboration script configuration is likely to be modified (***Internal Script Re-configuration Principle***).

On the other hand, it is assumed that a cognitive conflict arises more often in a social situation and can cause active and reflective ways of solving the conflict which then can lead to deeper understanding and better learning (Hesse 2007). In Vygotskian terms, cognitive conflicts may arise through the dynamics of social exchange when the difference in the state of knowledge of an individual learner to that of a more advanced other person exists in collaborative learning (Dillenbourg and Schneider 1995). The difficulty of gaining consensus in the midst of conflict between perceptions and opinions can also contribute to learning and knowledge building cooperation through discussion and the nurturing of thought processes (Stahl et al. 2006). While Vygotsky never used the scaffolding metaphor (Stone 1998), it is widely accepted that the Zone of Proximal Development underpins the theoretical conceptualisation of scaffolding as the heart of that notion. From this perspective, the ZPD indicates the distance between a learner with and without scaffolding. In computer-supported collaborative learning, ZPD can be created by means of the entire learning environment, including learning partners as well as external collaboration scripts.

One major goal of collaborative learning is to support social interaction and hence encourage the learner's cognitive processes (Ertl et al. 2007). Socio-constructivist stated that the knowledge can be only built through discourse with others, that is, through social interaction (Pritchard and Woollard 2010). According to Vygotsky's idea, the learner develops as a result of active participation in social interaction with other individuals (Lave and Wenger 1991; Vygotsky 1978). Thus, development cannot be separated from its social and cultural context. Although Piaget's theory contends that development can proceed without social interaction, the social environment is nonetheless a key source for cognitive development (Schunk 2000). While the impetus for developmental change is internal, extrinsic environmental factor can still influence development (even not directly)—through activities that provide social interactions with the environments (Piaget 1977). Therefore, one more **Transactivity Principle** states that the more a given CSCL practice requires the transactive application of knowledge, the better this knowledge is learned through participation in this CSCL practice.

2.2.2.3 External Script Guidance and Optimal External Scripting Level Principle

Collaborative knowledge construction may be always more or less guided by external scripts, either as facilitators to select functional internal scripts, or as inhibitors to 'preclude' dysfunctional internal scripts (Fischer et al. 2013), but the effect of the facilitator or inhibitor is not guaranteed. The *Script Theory of Guidance* proposed the last set of principles to address the problem.

The *Scripts Theory of Guidance* acknowledges that effective external collaboration scripts enable learners to engage in collaborative practice at a level beyond what they can do without external collaboration scripts (**External Script Guidance Principle**). The most effective external collaboration scripts are at the highest

possible hierarchical level of available internal collaboration scripts (*Optimal External Scripting Level Principle*). The principles are capable of explaining the undesired effects of external collaboration scripts, either ‘Under-scripting’ or ‘Over-scripting’.

2.2.2.4 Under Scripting

Minimally guided instruction is likely to be ineffective (Kirschner et al. 2006). According to the *Script Theory of Guidance*, the prime purpose of external collaboration scripts is to prevent under-scripting effect. Specifically, it is more likely that an external script addresses scenes (e.g., ‘Please provide a counterargument!’) without sufficient information on the activity or addresses scripts that are not known (e.g., ‘Please engage in knowledge building by integrating pros and cons!’). As shown in Fig. 2.1, the level of external collaboration scripts far beyond the ZPD of learners is insufficient to support learning. This kind of interference between internal and external scripts might be called ‘under-scripting’.

2.2.2.5 Over Scripting

Although collaboration scripts show some potential for facilitating collaborative learning, this potential is not guaranteed. Recently, over-scripting is a widely cited

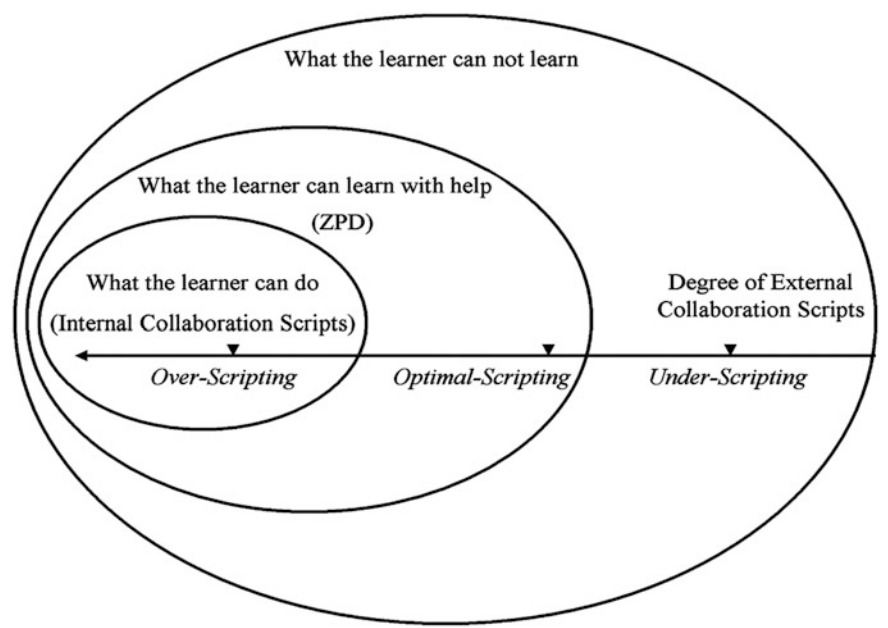


Fig. 2.1 The effects of external collaboration scripts

term, which is often connotated with negative and unexpected learning outcomes. This occurs when the collaboration is supported by ‘too much script’ (Dillenbourg 2002). Specifically, ‘*Over-scripting*’ occurs once external script provides scaffolds that guide procedures for which the corresponding internal scripts are already represented by the learner or even a learner might hold more effective or efficient internal script, the performance of the learner will decrease (Kollar et al. 2007). Therefore, an external collaboration script that includes unnecessary scaffolds at lower level (e.g., Scriptlets) is likely to impede learners to control the learning for them and hence hinder higher-order thinking (Cohen 1994; Fischer et al. 2013). In this case, learners just go through the motions rather than being reflective about what is required (Reiser 2004).

2.2.2.6 Optimal Scripting

Finding the balance between giving and withholding information or assistance is a fundamental challenge in designing effective instruction (Koedinger and Aleven 2007). To avoid the pitfalls of over- or under-scripting, the *optimal external scripting level principle* implies that it is essential for learner to get their chance to apply the newly developed script components—beyond available internal scripts but within the ZDP.

It is important to clear up the misunderstanding of recognizing that internal collaboration scripts are fixed and stable. In contrast, the *Script Theory of Guidance* proposed a new dynamic opinion inspired by cognitive and social constructivism. From this point of view, internal collaboration scripts can continually be induced and modified. Thus, the degree of scripting might be dynamic during the learning process to match the best balance between internal and external scripts. Against this background, the suboptimal fit between internal and external scripts may have negative effects on cognitive processes during collaboration. For instance, if collaboration lasts a certain amount of time, the originally perfect fit of internal and external script may become over-scripting, owing to an ongoing internalization of the external collaboration scripts (Wecker and Fischer 2010).

The *Script Theory of Guidance* yields substantial improvement in reframing the relationship between internal and external collaboration scripts, which allows the methodical differentiation between under-scripting, over-scripting, and optimal scripting when compared with preceding works.

Flexible Scripting to Facilitate Knowledge Construction
in Computer-supported Collaborative Learning

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