Chapter 2

SCRIPTING COLLABORATIVE LEARNING PROCESSES: A COGNITIVE PERSPECTIVE

Alison King
California State University San Marcos

Abstract: Scripting collaborative learning is an effective approach to promoting learning in both face-to-face and on-line computer learning contexts. Although the term *script* originated in cognitive psychology, it is used in educational contexts to describe ways of structuring interaction and scaffolding collaborative learning through the use of roles, activities, and sequencing of activities. There are several specific types of learning activities that numerous lines of research have shown enhance learning during interaction, however, these activities rarely occur spontaneously during naturally-occurring group collaboration. Also, it is not always clear what individuals learn during collaboration, how they learn it, and the underlying cognitive mechanisms that account for learning collaboratively. Four illustrative approaches to scripting face-to-face collaboration are presented. Each approach is examined to reveal how roles, activities, and sequence of activities, are used to structure collaborative learning and what particular cognitive, metacognitive, and socio-cognitive processes their scripts are intended to induce in learners. The expectation for some scripts is that over time learners will internalize the roles, activities, and sequence; and, once learners can play all of the roles of a script on their own, they will self-regulate their learning without the aid of an external script. However, the wide range of differences in both the complexity and goals of scripts affects their potential for internalization, and some external scripts are not intended to be discontinued even if roles are internalized.

A large body of research has shown that collaborative approaches to learning can be effective in producing achievement gains, promoting critical thinking, and enhancing problem solving in both face-to-face learning contexts (e.g., Cobb, 1988; King, 1989; Webb, 1989; Webb & Palincsar, 1996) and more recently in computer-supported learning environments (e.g., Weinberger, Fischer, & Mandl, 2002).

From a cognitive perspective, learning is defined as cognitive change or conceptual change; that is, some form of reorganization and reconstruction of the learner's own knowledge. This change occurs as connections are made between the new material and prior knowledge and are integrated into the learner's existing knowledge base. From a *socio*-cognitive perspective (e.g., Mugny & Doise, 1978, Vygotsky, 1978), these cognitive changes are strongly influenced by interaction and activity with others.

Any interaction with another provides opportunities for learning to occur; however, some forms of interaction and activity have been found to be more effective in facilitating learning than others. For example, giving explanations is more effective than receiving them (Webb, 1989). And helping behavior that supports others' problem solving by offering cues and hints that guide them to achieve a solution on their own is more effective in promoting learning than helping by simply providing the right solution. Moreover, it appears that different levels of *verbal* interaction promote different kinds of learning (e.g., Chan, Burtis, Scardamalia, & Bereiter, 1992; King, 1994; Webb & Palincsar, 1996) and are therefore conducive to different kinds of learning tasks. For example, factual questioning and responding tend to be effective for knowledge retelling tasks because fact questions tend to elicit facts. However, fact questions are less effective for complex learning tasks which involve analyzing and integrating ideas, constructing new knowledge, and solving ill-structured problems, as they seldom elicit the required thoughtful responses (Cohen, 1994; King, 1994).

Unfortunately it is rare for collaborating learners to spontaneously use effective interaction procedures and match them to the task at hand without some form of explicit prompting or other guidance (Bell, 2004; Britton, Van Dusen, Glynn, & Hemphill, 1990; Cohen, 1994; King, 1994; King & Rosenshine, 1993; Kuhn, 1991). Indeed, even when given instructions to work collaboratively on a task, learners generally tend to interact with each other at a very basic level (Vedder, 1985; Webb, Ender, & Lewis, 1986) and do not even consistently activate and use their relevant prior knowledge (see Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987). For this reason, numerous attempts have been made to promote learning by structuring and regulating the interaction within collaborating groups so that learners are required to interact in ways that induce cognitive processes appropriate to their learning task. Such structures compel learners to assume designated roles, follow a prescribed sequence of activities, and sometimes even engage in a particular pattern of dialogue (e.g., Dansereau, 1988; King, 1997; Palincsar & Brown, 1984; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988; Webb & Farivar, 1994).

These methods of structuring interaction have generally been referred to variously as "scaffolding learning", "prompting thinking", "using problem solving supports", "guiding cognitive performance", and "strategy instruction". However, recently the term *scripting collaboration* has appeared in the literature to describe these and other ways of structuring and regulating interaction during collaborative learning. Even more recently, *scripting collaboration* has been used to describe computer-supported collaborative learning (CSCL) environments (e.g., Weinberger, et al., 2002) where collaboration is partly or totally mediated by computer (see also, Lauer & Trahasch, this volume; and Ertl, Kopp, & Mandl, this volume). Thus, *scripted collaboration* is a term currently used to refer to externally structured collaborative learning in both on-line and face-to-face learning contexts.

This chapter presents a cognitive perspective on scripting collaborative learning. The following section presents different meanings of the term *script* as it is used in cognitive psychology and in collaborative learning contexts. The section after that deals with specific cognitively-oriented activities that several lines of research have shown enhance learning during interaction. Next, four illustrative scripted collaboration approaches that use some or all of these activities are examined to reveal the cognitive, metacognitive, and socio-cognitive processes their scripts are designed to induce in learners; the use each script makes of roles, activities, and sequence of activities in structuring collaborative learning is also analyzed. The issue of what individuals learn during collaboration and how they learn it is a thread that runs throughout the chapter. A final discussion of the potential for learners to self-regulate their collaborative learning revolves around differences in approaches to scripting collaboration and the related question of when (or even if) use of a script can be discontinued once roles and scripts are internalized.

1. SCRIPTS AND SCRIPTING

1.1 Scripts in cognitive psychology

According to Schank and Abelson's (1977) seminal work on the topic, a script is an internal memory structure of a "sequence of actions that define a well-known situation" (p. 41) where there is a socially shared understanding of the roles and procedures to be followed (for example, in the frequently cited "going to a restaurant" script: getting seated, looking at the menu, ordering food, eating, and then paying). Thus, a script is a guide to the roles and steps people follow for what to do and how to do it in a specific social situation. An individual develops a particular script from repeated participation in several specific instances of a social situation and by abstracting common features from those instances (Schank & Abelson, 1977). Simply put, a script involves a sequence of actions where each actor has a specific part to play and pre-specified actions to take, somewhat like the script of a play where action and stage directions are prescribed by the playwright. Once stored in memory, a script can be activated when cued by a similar situation and can guide the individual in how to act in that situation.

There are several ways in which scripts facilitate information processing. Because a script involves expectations about the order as well as the occurrence of events, having a script for a situation can help an individual to understand that particular situation, remember procedures to be followed, and predict roles and actions of those involved (Schank & Abelson, 1977). Furthermore, scripts play a useful role in reducing cognitive load for individuals so they can focus their attention on what is important in an interaction and its context (Dansereau, 1988); with *procedure* scripted, attention can be focused on *content* of an interaction.

1.2 Scripts and scripting in educational contexts

Although in cognitive psychology the term "script" refers to the Schank and Abelson definition, the term *scripting* has also begun to be used in educational settings (particularly in computer-supported learning), where the meaning it has taken on is somewhat different. In contrast to the Schank and Abelson (1977) view of script 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 (Dansereau, 1988). 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, actions engaged in, and the sequence of events, prompt specific cognitive, socio-cognitive, and metacognitive processes, thus ensuring that the intended learning takes place.

Whereas in the Schank and Abelson cognitive psychology view, a *script* is an internal memory structure with a narrow application, in the educational view scripts are externally imposed, are more flexible, and have broader application. They also differ in terms of their location, their point of origin, and their purpose.

The purpose of a script in cognitive psychology is to guide the individual in the social roles and actions expected in a specific social situation; whereas in educational settings a script's purpose is to prompt collaborating learners to focus on, remain engaged in, and regulate specific roles and actions which are expected to promote learning. While both kinds of scripts emphasize roles and actions to be taken, those roles and actions originate from different sources and are created by different agents. In cognitive psychology a script is seen as a memory structure, residing internally to the individual but created by that individual by means of abstracting the essence of a social situation from repeated external experiences. In contrast, in educational settings a script is designed externally by *others* and explicitly imposed on learners (by a teacher or other learning facilitator) as a guiding structure to prompt them in how to act. Initially the script is external to the individual but the expectation is that, over time, it will become internalized through practice (e.g., in the Vygotskian, 1978, sense) and the timely fading of external prompts.

Thus, the term *internal* collaboration script often refers to an internalized version of an external script; of course, at the same time, it may also refer to prior socially/culturally-derived rules for cooperating as in the Schank and Abelson "script" (see also Carmien, et al., this volume). For example, every learner by the age of three has already developed an internal Schank and Abelson kind of cooperation script (perhaps only a rudimentary one that specifies roles such as turn-taking and rules such as sharing).

2. COGNITIVE, METACOGNITIVE, AND SOCIO-COGNITIVE ASPECTS OF LEARNING THROUGH INTERACTION

Cognitive processes of thinking and learning take place within the individual, as do metcognitive processes (monitoring, regulating and evaluating one's own thinking and learning). In contrast, according to theories of the social construction of knowledge (e.g., Bearison, 1982; Damon, 1983; Mugny & Doise, 1978; Perret-Clermont, 1980; Vygotsky, 1978), socio-cognitive processes are induced by joint activity where learners scaffold their collaborative thinking and learning in a shared construction of knowledge. As such, partners' actions are interdependent, each triggering the other's cognitive and metacognitive processes; in such mutual cognition learners contribute jointly to development of the learning outcomes. By necessity then, socio-cognitive processes always arise in some kind of social context, real or virtual. In this view, cognitive and metacognitive processes are individual cognitions (occurring internally "in the head" of the individual) while socio-cognitive processes are social (occurring outside the individuals – in the interaction per se). Cognitive, metacognitive, and socio-cognitive processes involve thinking; whereas cognitively-oriented *activities* are experiences, behaviors, and interactions, that often (but not always) induce cognitive, metacognitive, and socio-cognitive processes in the learners engaged in those activities.

Socio-cognitive, cognitive, and metacognitive processes come together during collaborative learning. Ideally, during interaction and activity individual learners are continually using each other's ideas, reasoning, explanations, and argumentation to modify their own thinking and restructure their own knowledge (individual cognitive processes). At the same time they are jointly constructing knowledge and negotiating meaning with each other (socio-cognitive processes). The products of that socio-cognitive process (the jointly-constructed knowledge and meanings) are (to a greater or lesser extent) internalized by both learners individually; and the procedures, skills, and strategies used are also internalized by both (Rogoff, 1990). For example, when summarizing occurs during collaboration it usually is in response to another's question or in the context of engaging in a pre-specified role (e.g., the summarizer role) of a collaboration script; in such a case, where the summary is created jointly by learners mutually building on each other's contributions in a coordinated interdependent effort, summarization is a socio-cognitive process. The learning product is the jointly-constructed summary; and when it is internalized, that summary, being far more coherent and complete than it would be if developed by each learner alone, can result in a richer knowledge base for both learners. Ideally, each learner's summarizing skills (identifying main idea, selecting and sequencing details, etc.) are enhanced because of the other's contributions; and these summarizing skills are also internalized to be applied in similar learning situations in the future. Thus both the new knowledge constructed during a collaboration and the cognitive skills which individuals learn, refine, and use during that collaboration are what is retained by the individual learner after the collaboration.

Metacognitive processes can play a major role in collaborative learning as learners mutually regulate their joint learning. Activities of monitoring and regulating learning during collaboration can induce corresponding metacognitive processes in individual learners. Again, cognitive and metacognitive processes are always individual, while socio-cognitive processes are induced in interaction with others.

Generally the term collaborative learning means that learners are engaged in activities that are intended to induce socio-cognitive processes. This meaning implies an important distinction between collaborative and cooperative learning. Cooperative learning often involves separate activities by individuals through the distribution of labor or task components, with little of the joint activity that induces socio-cognitive processes so characteristic of true collaborative learning.

2.1 Effective learning activities

Effective learning activities are ones that induce relevant cognitive, metacognitive and socio-cognitive processes in participants. Although repetition, rehearsal and retelling are effective activities for memorizing factual material, and summarizing and paraphrasing are effective for promoting understanding and demonstrating comprehension, research has revealed that when complex learning occurs during interaction it can be attributed primarily to activities that go beyond memorization and comprehension. Effective learning interactions induce complex cognitive processes such as analytical thinking, integration of ideas and reasoning. Activities that have been found to promote such higher-level cognitive processes include: elaborating on content (e.g., Webb, 1989); explaining ideas and concepts (e.g., Chi, deLeeuw, Chiu, & LaVancher, 1994); asking thought-provoking questions (e.g., King, 1994); argumentation (e.g., Kuhn, 1991); resolving conceptual discrepancies (e.g., Piaget, 1985) and modeling of cognition. Although these activities are learned and refined during interaction with others (Leont'ev, 1932; Luria, 1928; Vygotsky, 1978), they can be accomplished by an individual learner alone (see, for example, Chi's & VanLehn's, 1991, "self-explanation" and King's, 1989, "self-questioning") as well as in a social context such as a collaborative learning group.

Recently researchers have designed various collaborative learning approaches that structure or "script" group interaction so as to elicit and regulate these specific learning activities in the expectation that they will, in turn, induce high-level cognitive, metacognitive, and socio-cognitive processes in learners. The phenomenon of making thinking explicit through "thinking aloud" during interaction sets the stage for such higher-level learning to occur.

Thinking Aloud. Talking or writing about the task at hand is known as thinking aloud. The advantage of thinking aloud during collaboration is that it makes thinking explicit and available to the individual doing the thinking and also exposes that same thinking to the rest of the group. Such verbalization during collaboration promotes learning in and of itself because it forces those who are "thinking aloud" to clarify their own ideas, elaborate on them, evaluate their existing knowledge for accuracy and gaps, or in some other manner re-conceptualize the material (Bargh & Schul, 1980; Brown & Campione, 1986). As importantly, making thinking explicit allows others access to that thinking too; they may then respond by challenging, disagreeing, asking for proof, offering examples and other elaboration, justifying and so on. Making thinking explicit by thinking aloud in a group is a general phenomenon that can give rise to the powerful learning activities of explanation, questioning, elaboration, argumentation, resolution of conceptual discrepancies, and modeling of cognition.

Explaining. An effective explanation goes far beyond description; it tells the "why" and "how" about whatever is being explained (King, 1997), rather than just describing it (telling the "what" of it). Explaining must be in the learner's own words rather than simply repetition of already-memorized material (King, 1997) because accurate paraphrasing is an indication that the explainer understands. In addition to demonstrating true understanding, a useful explanation requires analytical thinking, as the explainer must make connections between the phenomenon being explained and prior knowledge.

Explaining something to someone else often requires the explainer to think about and present the material in new ways such as: relating it to the other's knowledge or experience, translating it into terms familiar to the other, or generating new examples. Thus, explaining expands understanding for the individual doing the explaining because it forces the explainer to clarify concepts and generally reorganize knowledge structures (Chi & VanLehn, 1991; Chi, et al., 1994; Vygotsky, 1978; Webb, 1989; Webb & Farivar, 1994). Receiving explanations often enhances learning also (Webb, 1989).

Two separate lines of research by Chi and Webb and their colleagues have shown the power of self-explanation in promoting learning for individuals (see the "self-explanation" effect, Chi & VanLehn, 1991). However, during collaborative learning, when one partner's explanation is enlarged upon or clarified by others and a fuller explanation is jointly constructed, explaining becomes a collaborative activity that induces socio-cognitive processes.

Asking thought-provoking questions. Factual questions and comprehension questions are important in learning contexts as their responses help determine whether certain information has been acquired (for factual questions) and the extent of understanding achieved (for comprehension questions). Both of these types of question are memory-based and require little cognitive effort; both ask for the recall of information from memory and the reproduction of that information, either verbatim retelling of it (for fact questions) or a reconstructed version that is paraphrased to show understanding (for comprehension questions). However, for inducing higher-level cognitive processes, asking questions that are thought-provoking is much more effective.

Thought-provoking questions require thinking. They ask learners to go beyond exact reproduction of material or reconstruction of it, to actually thinking *with* that material and *about* that material, making connections between elements of the material and between that material and what is already known. Thought-provoking questions call for higher-level cognitive processes such as integrating ideas into newly constructed knowledge to make inferences, generalizations, speculations, justifications, applications, alternative perspectives, problem solutions, and the like. In a collaborative learning context, thought-provoking questioning and the comparably thoughtful responses those questions elicit can be a valuable learning activity, and results of several programs of research have confirmed that asking and answering thought-provoking questions promotes high-level learning (e.g., Graesser, 1992; King, 1989, 1994; Lepper, Aspinwall, Mumme, & Chabey, 1990; Pressley, et al., 1992).

Simply posing thought-provoking questions on one's own is an activity that triggers higher-level cognitive processes in individuals (see King's, 1989, "self-questioning"). In generating such questions learners must identify the main ideas and think about how those ideas relate to each other and to the learners' own prior knowledge and experience. According to theories of information-processing, thinking about material in these ways establishes complex cognitive networks connecting the new ideas together and linking them to what the learner already knows. Such extensive cognitive representations of the material are more memorable.

Elaborating. Elaborating on an issue, topic, or idea involves adding details, giving examples, generating images, and in general relating the new material to what is already known. These elaborations are incorporated into learners' existing knowledge; and, as a consequence, their mental representations are reorganized and increased in complexity, thus improving understanding and recall (Dansereau, 1988; Webb & Farivar, 1994). A number of research programs have demonstrated the effectiveness of elaboration as a method for learning new material (e.g., O'Donnell & Dansereau, 1992; Pressley et al., 1987; Webb, 1989).

Explaining, questioning, and elaboration are activities that benefit an individual learner even without another's involvement. However, in a group-learning context these activities (and the cognitive processes they induce) are more likely to occur because they are triggered by others during interaction.

Argumentation. Reasoned argument involves giving adequate and convincing evidence or reasoning to support one's claims, statements and other assertions (Kuhn, Shaw, & Felton, 1997). Although one primary purpose of argument is to convince others of a belief or claim, argumentation can also be used to explore an issue and arrive at a deeper understanding of that issue (Wright, 1995). During collaboration when a learner makes an assertion, such as a conclusion arrived at, a statement of cause and effect, a hypothesis to account for some phenomenon, an explanation, a theory of how things are, that assertion elicits evidence-based thinking in others; that is, they ask for evidence or reasoning that supports the assertion (Kuhn, et al., 1997). Any collaborative activity provides a context for learners to develop and practice argumentation skills because it offers opportunities for them to generate, compare and evaluate multiple conclusions, theories, counter theories, counter arguments, and rebuttals along with any supporting evidence provided. In effect, during this verbal interaction, learners are not just exchanging theories and rebuttals, they are often negotiating meaning and arriving at re-conceptualized and deeper understanding about the topic or issue being argued. These jointly constructed meanings can be internalized by individuals as their own revised mental representations of the topic or issue. Engaging in such constructive argumentation usually promotes learning (Kuhn, et al., 1997). Like explanation, elaboration, and questioning, argumentation is a learning activity that can occur independently of others. In fact, individual deliberation about an issue often takes the form of an internal argument where the individual considers all sides of the issue – all possible challenges, counterarguments, justifications, and refutations. Thus, whether used by an individual or in interaction with others, argumentation can aid in clarifying thinking and promoting understanding.

Unfortunately, without specific prompting and scaffolding, even adults rarely engage in reasoned argumentation; for example, most adults have been found to make assertions and, even when prompted, are unable to support them with evidence or logical reasoning (Kuhn, 1991). Interaction during collaborative learning can be structured to guide and support learners' reasoned argumentation during complex learning tasks. Research (e.g., Hogan, Nastasi, & Pressley, 1999) shows that such activity can promote learners' skills of developing sound arguments and detecting faulty ones.

Reconciling cognitive discrepancies. During group interaction, differences between individuals' opinions and understandings about a topic are exposed. Individuals discover that their own understanding of an aspect of the content, their opinions about an issue, or even their basic background information about the material may not be shared by others in the group and may even differ to a great extent from others. When individuals are confronted with these conceptual discrepancies, they experience cognitive conflict within themselves (see Piaget, 1985; De Lisi & Golbeck, 1999) and they might feel the need to resolve it through further interaction with others.

Reconciling cognitive discrepancies can give rise to a number of other cognitive, metacognitive, and socio-cognitive processes. Individual group members may find they must clearly articulate their own position, explain their ideas, defend their views, verbalize their confusions, acknowledge gaps in knowledge, recognize any misconceptions, and generally present their thoughts in a reasoned manner. Other group members may do the same as the group experiences *socio-cognitive* conflict (Mugny & Doise, 1978). In attempting to understand each other's ideas and views and reconcile them with their own in this way, group members arrive at shared meaning (Roschelle, 1992). Thus, ideally, in the process of resolving those cognitive discrepancies, knowledge is jointly constructed, and the product of group interaction, the new jointly constructed knowledge, is individually internalized.

Modeling of cognition. A general phenomenon of learning through interaction is social modeling of cognition and metacognition. In collaborative learning contexts, when skilled peers demonstrate accurate use of questioning, explaining, and elaborating, they become ideal models for others to observe and imitate. When individual learners observe and imitate their peers' use of cognitive skills, they modify and refine their own use of those skills. They can even learn new cognitive strategies by modeling their own reasoning, argumentation style, questioning and problem-solving strategies on those of other group members. Similarly, sharing questions and responses with each other can help the group develop ideal standards of expert questioning and responding.

Although peer modeling of cognition is generally not intentional, it is a very powerful way of learning during interaction. However, individual cognition can be modeled during interaction only if it is exposed; and this is where thinking aloud contributes to modeling by making thinking explicit and available to all. Of course, before any of these higher-level cognitions can be modeled during interaction, they first have to occur, either spontaneously or through some form of prompting.

2.2 The need for structuring interaction

There may be several explanations for why learners generally do not interact in cognitively effective ways without some structured guidance. Learners may not know what it actually means to explain and argue and analyze ideas, they may not have been taught how to do so; or they may not be well practiced in the skills of explanation, argumentation, analysis and other aspects of high-level discourse in a collaborative setting. Perhaps for some learners, their internal scripts for collaborative learning (the script they have built up from their experiences in groups) may be limited to such cooperative action as taking turns, dividing labor, and getting the task completed. For learners with such a naïve conception of what constitutes group collaboration, their most frequently occurring verbal interaction may be no more than simply sharing information and checking for consensus.

Because giving explanations, asking thoughtful questions, elaborating on content, argumentation, and engaging in exposing and reconciling cognitive discrepancies are known to be effective in collaborative learning but do not generally occur spontaneously, scripted collaboration approaches focus on structuring group interaction so as to elicit these and other kinds of effective activity. Many of these scripting approaches also prompt the metacognitive processes needed to monitor and regulate those activities.

In the following section several examples of face-to-face scripted collaboration approaches are presented. Each script is analyzed to reveal the cognitively effective activities their scripts support and the cognitive, metacognitive and socio-cognitive processes those activities are intended to induce in participating learners.

3. EXAMPLES OF FACE-TO-FACE SCRIPTED COLLABORATION

Collaboration scripts run along a continuum from very basic to very sophisticated; and scripts can be designed for many kinds of learning tasks and objectives from ordinary factual learning, to text-based comprehension, to higher-level learning that involves knowledge building and problem solving. The scripted collaboration approaches presented here represent a variety of approaches to scripting and show how scripting can be used for a range of tasks from simple knowledge retelling to complex problem solving.

All of the scripts presented here are domain independent, and therefore all can be used with a variety of subject areas for learning from a range of materials. Because each script is designed to match a particular kind of learning task, some scripts focus more on inducing socio-cognitive processes than others; also, some scripts structure the task and its sequence, while others also explicitly scaffold group communication.

3.1 Scripted Cooperation

One of the earliest and simplest approaches to scripting collaboration in educational contexts is Pair Summarizing (Vaughan & Estes, 1986) in which one partner summarizes material read and the other checks for errors and omissions. Pair Summarizing is commonly used to promote recall and understanding of definitions, procedures, and similar conceptual material (see also U. S. Department of Education, 1986). A somewhat more sophisticated version of Pair Summarizing, and the first use of the term *scripting* in an educational context is Dansereau's Scripted Cooperation (Dansereau, 1988; Larson, Dansereau, Goetz, & Young, 1985; Spurlin, Dansereau, Larson, & Brooks, 1984). In this approach to collaborative learning, partners each have specific roles and activities to carry out and the script is used to direct the performance and sequence of those roles and activities. The script consists of the roles of *recaller* and *listener* (cf. the listener and explainer roles in Johnson & Johnson's, 1993, Academic Controversy) and a specific sequence of activity (summarizing, feedback, and joint elaboration, usually followed by exchanging roles for the next portion of content). First, both partners read material (or listen to a lecture) and take notes; then the one designated as recaller summarizes the main ideas of the material orally while the partner listens and checks for errors and omissions (using the notes if needed). When the recaller has finished summarizing, the listener provides feedback on errors, distortions, and material omitted. Then both partners together elaborate on the material read by adding details, generating examples, developing images, and in general relating the new material to what they already know.

The sequence of summarizing, error detection and feedback, then elaboration, is repeated on the next section of text with partners alternating the listener and recaller roles.

Cognitive, metacognitive and socio-cognitive processes underlying Scripted Cooperation. Based on an extensive program of research, Dansereau and his colleagues (Dansereau, 1988; Larson, et al., 1985; Spurlin, et al. 1984) have found this strategy to be effective in enhancing learning for both the recaller and listener. Learning in Scripted Cooperation can be accounted for by the cognitive and socio-cognitive processes induced by the script. First, summarizing helps the summarizer to reformulate and consolidate material into the memory structure already developed during the initial reading of the material. This makes the information more stable in memory and therefore more readily recalled. Summarizing also involves metacognitive processes; during summarizing the recaller is monitoring or self-checking on how well the material is understood. For the recaller, inability to summarize signals a lack of understanding, and errors or omissions suggest inaccurate or incomplete comprehension. During error detection the listener also engages in metacognitive processes to constantly compare what is being orally recalled to the actual content of the material read. The listener's role of monitoring the accuracy of the other's recall also provides the listener with an additional pass through the material thus promoting further consolidation of the new material into memory structures and facilitating future recall. Both partners get further exposure to the material during feedback.

The activities of note-taking and elaboration induce additional cognitive, metacognitive and socio-cognitive processes. Note-taking provides not only another opportunity for further encoding of the material (see Kiewra, 1989), but also for encoding it in a different mode – writing. As a result, both recaller and listener encode the material through reading it in the initial text format, writing notes on it, and hearing it in the oral summary. Encoding through three different modes can result in a richer memory structure with numerous cues for subsequent recall. Through elaboration, the recaller and listener create additional and varied links to their existing knowledge. Elaboration not only extends understanding by adding additional links, it also provides a variety of *different* recall cues (the details added, examples generated, and images developed). The elaboration phase of Scripted Cooperation induces socio-cognitive processes as the elaboration is jointly accomplished by the partners; and products of that elaboration (the details, examples, and images generated) are available for encoding by both. Neither partner alone would generate the same details, examples, and images as they do by engaging in joint elaboration. Such thoroughly encoded and jointly-elaborated material will not soon be forgotten.

This whole procedure, with its set of roles and activities, benefits both partners as neither partner would accomplish the same level of learning without the other's assistance. Because this procedure is intended to support only knowledge acquisition (not higher-level learning), the focus on information processing and encoding activity is both appropriate to the task as well as effective.

Dansereau (1988) found that the partner who summarizes the content presented learns more than the partner who listens and checks for errors. Possibly self-checking of understanding during summarization made the difference; presumably such metacognitive processes enhance learning over and above the cognitive and socio-cognitive processes.

Dansereau (1988) points out that modeling can enhance learning in Scripted Cooperation also. Partners have the opportunity to improve their cognitive skills of summarizing, error detection, and elaboration through observation and imitation of each other's behavior.

3.2 Reciprocal Teaching

Palincsar and Brown's (1984) Reciprocal Teaching is another form of scripted collaboration designed to enhance text comprehension. In this approach learners in small groups take turns assuming roles (questioner, summarizer, clarifier, predictor) and follow a sequence of activity beginning with making predictions about the content and topic of a text segment to be read, reading the segment, asking questions about the content, summarizing and clarifying the content, followed by making new predictions about the next segment of text (Palincsar & Herrenkohl, 1999). This sequence is repeated with additional passages until the complete text is covered. Over time, during subsequent sessions of Reciprocal Teaching, learners get practice in all four activities by assuming different roles during subsequent reading sessions.

A great deal of research on the use of Reciprocal Teaching has been conducted with somewhat mixed results. Although pre-post achievement measures generally show learning gains in text comprehension, it is not always clear that those gains can be attributed to the roles students play rather than simply to the additional processing of material (Rosenshine & Meister, 1994). Rosenshine and Meister suggested that often there was merely rote application of the procedure, as many groups tended to be more interested in following the roles and rules in a routine manner and getting the task done than in fully comprehending the text.

Cognitive, metacognitive and socio-cognitive processes underlying Reciprocal Teaching. Because the roles in Reciprocal Teaching are not clearly defined, their underlying cognitive processes will vary depending on how the roles are taught and modeled by teachers. Each of the roles of questioner, summarizer, clarifier, predictor, has the potential to prompt different cognitive and metacognitive processes in readers. The extent of cognition involved in the questioner role is dependent on the kinds of questions asked. If higher-level questions are asked, then higher-level cognitive processes (such as analysis, inferencing, and making connections to prior knowledge) may be activated; however, since Reciprocal Teaching is designed to promote understanding and remembering of text, the kind of questions asked are generally factual and comprehension ones. The cognitive processes induced by asking fact questions are simple retrieval, while asking comprehension questions may involve some extent of reformulation of content retrieved. Moreover, when those questions are answered, the cognitive processes activated in the responder are likely to be straight retrieval and retelling of content from memory (for both kinds of question); although comprehension questions might induce more extensive reconstruction processes, verbalized as paraphrased or summarized content.

Playing the role of clarifier can trigger several cognitive and metacognitive processes. Clarifiers must constantly monitor their own understanding by comparing what they know with what is being asked and stated by others in the group; this self-checking involves continuous revision of clarifiers' mental representations of the text passage, which results in richer memory structures with a variety of cues for recall.

As in Scripted Cooperation, the summarizer role induces reconstruction of material read and consolidation of it in memory. Here too, summarizing involves metacognitive processes of self-monitoring for comprehension of the material read.

The predictor is a role that can activate higher-level cognitive processes of analysis and reasoning to generate real predictions (as opposed to guesses) about what will happen next. Metacognition comes into play here as the predictor must self-monitor comprehension to avoid making improbable predications.

The mutual regulation of learning that occurs during Reciprocal Teaching is the activity at the heart of this procedure. Mutual monitoring is built in to the use of the roles in conjunction with each other. As questions are asked and answered, as material is clarified and summarized, learning is monitored for accuracy; as predictions are made they are evaluated for consistency with text events. In this way the whole group monitors their on-going comprehension.

The scripted collaboration procedures discussed so far focus on scripting the task and its sequence; however, some attempts have been made to guide both the task sequence and the content of group communication. In these kinds of scripted collaboration the interaction in collaborating groups is structured by guiding the actual dialogue learners engage in during the task. The rationale for this approach is: if explaining, questioning, elaborating, arguing, and reconciling cognitive discrepancies are such effective cognitive and socio-cognitive learning activities, why not use actual dialogue prompts to elicit these particular forms of discourse? Dialogue prompts used to guide the interaction of the group would presumably result in socio-cognitive processes conducive to higher-level learning. For example, when King (e.g., 1989, 1991, 1994; King & Rosenshine, 1993) trained students in collaborative learning groups to ask each other task-related thought-provoking questions, she found that, as expected, those questions elicited explanations, inferences, speculations, hypotheses, comparisons, analyses, conclusions, and other high-level responses. This high level of discourse, in turn, had a direct positive effect on learning. In effect, guiding group discourse in such ways can be a means of controlling discussion content or of keeping discussion focused on a particular procedure or at a high cognitive level.

Two of King's scripted collaborative learning procedures that guide both the task sequence and group communication are presented below. Both procedures provide structured scaffolding for group discourse. The first one guides the discourse of partners during problem solving; the other one prompts partners to initiate, maintain, and regulate high-level discourse during complex collaborative learning tasks.

3.3 Guided Strategic Problem Solving

King's (1991) Guided Strategic Problem Solving (GSPS) procedure was designed to scaffold student interaction when solving complex problems[1]. GSPS is based on a sequence of "strategic" questions that guide learners' problem-solving activity by controlling the content of their interaction while solving problems together. The questions are designed to guide students to be strategic (intentional and planful – rather than resorting to guessing and trial-and-error) during their problem solving.

Learners in small groups or pairs engage in asking and answering these questions with each other to prompt their partners and themselves to plan, monitor, and evaluate their problem solving process and problem solution in a strategic manner. There are no specified roles, and either partner can ask or answer the questions, specific activities are prompted by the strategic questions, and there is a general sequence to. Both the format of the particular questions and the sequence of questions is structured to guide learners through the typical stages of problem solving (e.g., problem-identification and representation, search for a solution path, implementation of a solution,

[1] Complex problems are problems that are ill-structured and/or have several possible solutions.

and evaluation; Gick, 1986) and help them to monitor their progress towards solution. The general strategic questions are designed to prompt learners to clarify the problem, think about the problem in new ways, access their existing knowledge and strategies, formulate plans and strategies for solving the problem, and evaluate alternatives. Examples of the general strategic questions include: "What do we know about the problem so far?", and "Do we need a different strategy?" In addition to being trained to use the questions, learners are coached in developing elaborated responses (ones that are solution-oriented or strategy-oriented) during problem solving. King (1991) found that GSPS was very effective in promoting problem-solving success, for fifth graders in terms of both the problem-solving process and solutions achieved.

Cognitive, metacognitive and socio-cognitive processes underlying GSPS. The learning effects of GSPS can be accounted for by the cognitive, metacognitive, and socio-cognitive processes induced by elements of the collaboration script used. First of all, the question sequence was provided on a hand-held card and this alone assisted learners' information-processing in two ways: it reduced their cognitive load (they didn't have to remember the questions or general problem-solving sequence) as some of the cognitive load was distributed to the question prompt card (see Salomon's, 1997, concept of distributed cognition); and the content of those problem solving questions (as well as the sequence) kept attention focused on the problem space and its solution.

Furthermore, the GSPS script prompted the activities of questioning, explanation, elaboration, and resolution of cognitive discrepancies, which in turn induced cognitive and socio-cognitive processes conducive to problem-solving success. Analysis of transcripts of recorded GSPS student interaction during problem solving revealed that, as expected, when students asked strategic questions, those questions elicited explanations, elaborated responses (e.g., detailed directions for how to execute a specific move, analysis of a situation, and rationales for actions suggested), and follow-up thought-provoking questions relevant to the problem (King, 1991, 1999). Engaging in this questioning-answering dialogue during problem solving allowed students to share information and perspectives, negotiate understanding, resolve cognitive discrepancies, and truly co-construct their problem solving plans, strategies, solution paths, as well as improve their pair's problem-solving performance.

In GSPS, metacognition is overtly built into the script. The general strategic questions are arranged into three categories: plan, monitor, evaluate; this structure in and of itself induces and supports the kind of metacognitive processes that promote success during problem solving. Also, the specific strategic questions students asked each other (e.g., reason for why an attempt was successful or unsuccessful) prompted self-monitoring and regulation of their particular problem solving process and decision-making during problem solving.

3.4 ASK to THINK – TEL WHY®©

King's (1997) ASK to THINK – TEL WHY®©[2] is also a question-based collaborative learning procedure. It can be used for scripting collaboration in several forms of high-level learning where one partner assumes the role of *teacher* and the other the *learner* and partners alternate roles (see King, Staffiri, & Adelgais, 1998, for use of this procedure in mutual peer tutoring). The focus of the script is on use of five different types of questions which learning partners carefully sequence to scaffold their learning from comprehension checking and consolidation of prior knowledge to building new knowledge and monitoring thinking.

The learning partner in the teaching role (the ASK to THINK role) is called the *questioner* and the learning partner in the TEL WHY role explains (tells why and how) and elaborates (makes connections) and is referred to as the *explainer* (note that this role combines the activities of explanation and elaboration). This clear differentiation of roles makes it easier for the teaching partner to focus on asking questions rather than "lecturing" to the partner, which is more likely to elicit explanations and elaboration from the explainer.

The particular questions provided are generic questions that learners use to generate specific questions on the text or other material to be learned. A question-asking sequence begins with review questions and proceeds to more-sophisticated thought-provoking questions, with hint and probing questions as well as metacognitive questions interjected as needed. These questions, when posed, prompt partners to make corresponding responses. In this way learners continuously help each other build on their own and each other's previous contributions so as to "scaffold" knowledge construction to progressively higher levels (Vygotsky, 1978). During any learning session partners exchange roles. Collaborative learning with ASK to THINK – TEL WHY®© has been successful for students as young as fourth grade.

Cognitive, metacognitive and socio-cognitive processes underlying ASK to THINK – TEL WHY®©. To begin with, partners are provided with a

[2] ASK to THINK – TEL WHY®© is a registered trademark and the learning procedure itself is copyrighted by Alison King, 1994a, 1997, 1998 and 1999. Neither the names ASK to THINK – TEL WHY®© or ASK to THINK nor the particular learning procedure known by that name and described herin may be used for any commercial, teaching, or training purpose whatsoever or any other purpose without prior written permission from Alison King.

prompt card containing the questions and sequence as well as the TEL WHY role, and this serves as an external representation of the script to support cognitive activity. As with the GSPS procedure, use of a prompt card is meant to reduce learners' cognitive load by distributing some of the cognition to the external cards; at the same time the content of those questions (as well as their sequence) should keep learners' attention focused on the learning task at hand. For a fuller account of distributed cognition in ASK to THINK – TELWHY®©, see King (1998), where a description can be found of *what is being distributed* during the procedure and *how cognitions are distributed* across the learning pair and various aspects of their learning environment.

All of the cognitively effective activities of explanation, elaboration, asking thought-provoking questions, argumentation, and reconciling cognitive discrepancies are incorporated into the ASK to THINK – TEL WHY®© script. And the script is designed so that these activities induce a variety of cognitive, metacognitive, and socio-cognitive processes in learners. For example, when questioners begin the procedure by asking review questions (e.g., "What does ... mean?"); in so doing, they are not only assessing their partners' memory for the material and their understanding of it, they are also monitoring their own comprehension and repairing the knowledge base. Those review questions activate whatever knowledge partners have on the topic and elicit their definitions, descriptions, explanations, and elaborations. If an answer to a review question is incomplete, the questioner asks probing questions (e.g., "Tell me more about ...") to prompt the explainer to expand on an idea, clarify a point, be more explicit, or in some other way elaborate. When responses are incorrect or partial, hint questions (e.g., "Have you thought about ...?") are asked. Hint questions provide clues or partially-framed answers so as to guide explainers to repair any knowledge deficits or errors in reasoning and integrate the modification into their mental representations of the material. With a shared knowledge base firmly in place, learners proceed to construct new knowledge onto that base by asking and answering thinking questions (with hint and probing questions as needed). Examples of thinking questions and the specific cognitive processes they are intended to induce include: "What are the implications of ... for ...?" (analysis and inferencing), "What disadvantage might there be to using ...?" (speculation), "What is the difference between ... and ... in terms of ... ?" (analysis, comparison, and application of criteria), "What evidence is there to support the contention that ...?" (evaluation and evidence-based reasoning), and "What might be a counter-argument for ...?" (inferencing and logical reasoning). Such questions are designed to require going beyond the text material to induce higher-level thinking and learning. Thinking questions scaffold learners in creating links between ideas and between the new material and prior knowledge. Asking and answering thinking questions can not only increase the number of connections in learners' knowledge structures, it can also create a variety of different kinds of connections (such as comparison connections and evaluation connections), and therefore numerous and varied cues for retrieval and additional knowledge building.

Question sequencing from review questions through thinking and metacognitive questioning and responding serves to both control the progression of learning and monitor its extensiveness. The sequence also keeps the cognitive and socio-cognitive processing focused on the mutual scaffolding of learning to increasingly higher levels. Asking and answering metacognitive ("thinking-about-thinking") questions such as "How did you figure that out?" can function as a way for partners to monitor their own and their partner's thinking; they also serve to consolidate learning and make it more readily retrieved by generating additional cues for recall.

This questioning and answering is a socio-cognitive process characterized by mutuality and interdependence of roles. The question asked generally determines the response made which in turn dictates the next question, both its form (review, probing, hint or thinking) and its content (as the questioner builds on the explainer's response). Because of the interdependence and mutuality inherent in the activity of asking and answering thinking questions and hint and probing questions, partners' socio-cognitive processes can be induced, meaning is negotiated, and knowledge jointly constructed. The frequent exchange of roles required in this script also reinforces interdependence.

4. THE QUESTION OF SELF-REGULATION OF COLLABORATION SCRIPTS

For some face-to-face scripted collaboration approaches there is the expectation that the script itself will be internalized so that learners can become self-regulated in their use of it. According to Vygotskian thinking, the actions of the roles and any verbal prompts can be internalized as inner speech and then used by the learner to self-prompt actions in similar situations (Rogoff, 1990; Vygotsky, 1978).

However, because scripts vary in their complexity and goals, some lend themselves better than others to learners' appropriation (see Rogoff, 1990) through internalization. Some scripts simply label roles, activities or strategies, and sequence of activities and depend heavily on extensive teacher modeling and coaching in how those roles and activities are to be "played out" during interaction (e.g., Herrenkohl & Guerra's Cognitive Tools and Intellectual Roles [CTIR], 1998; Palincsar & Brown's Reciprocal Teaching, 1984). Other scripts (e.g., GSPS & ASKto THINK – TEL WHY®©)provide more specific guidance for interaction through use of explicit scaffolds that prompt specific kinds of dialogue that can, in turn, induce the intended cognitive and socio-cognitive processes. With some scripts the focus is on structuring the form of learner interaction, other scripts focus more on influencing the level of thinking and activity during that interaction. Some scripts must be rigidly adhered to and learners cannot modify the externally-provided roles, actions, or sequence (e.g., Scripted Cooperation) and this is necessary and appropriate (who can imagine checking the summary before summarizing?); while other scripts provide learners with a great deal of flexibility within the script's basic parameters. Some scripts are designed to be used in each and every instance of the collaborative activity (e.g., Scripted Cooperation, as well as essentially all computer-supported on-line scripts); in other scripted collaboration procedures, use of the script is less rigid and can be eventually faded because learners have internalized the basic script or have adapted it to fit their unique uses and internalized the modified script (e.g., Reciprocal Teaching; King's GSPS & ASK to THINK – TEL WHY®©).

Reciprocal Teaching is readily internalized by learners because of the separation of roles and simplicity of script. Indeed the goal of Reciprocal Teaching is for the procedures and roles to be learned and practiced in a group context with the intention that the procedure will eventually be used independently by learners to promote their reading comprehension. Because the roles are alternated during Reciprocal Teaching, learners get experience playing all four roles in the script so that over time those roles are internalized. Teacher and peer modeling of each role helps to make the roles easier to remember and assume later on. Over time roles are internalized to the extent that they can be played with self-prompting rather than external guidance. Presumably this can lead to learners being self-regulated in their reading comprehension when they are able to prompt their own execution of the entire script as they read independently.

Similarly, when GSPS is used over time external prompts can be faded as learners internalize the script and no longer need their question cards. It is expected that individuals will use their internalized GSPS guiding questions to self-regulate their problem solving either on their own or in collaboration with others.

Even some complex scripts can be appropriated by learners for later use. For example, ASK to THINK – TELWHY®© appears to be very complex because of its explicit dialogue prompts and sequencing; however several features of this procedure promote internalization. For example, role exchange provides opportunities for partners to play both roles and internalize them. Modeling supports this role appropriation. Also, the dialogue prompts (the questions) can be appropriated. An advantage of scripting dialogue is that aspects of the dialogue used during scripted collaboration, particularly the scaffolding prompts, are readily internalized as what Vygotsky (1978) refers to as *inner speech*. Appropriating the actual dialogue as inner speech can allow learners to engage in *self talk* (e.g., posing the questions to themselves) to prompt their own cognitive processes in subsequent similar situations (Rogoff, 1990; Vygotsky, 1978). Taking over the prompting role themselves facilitates learners' moving from being script-regulated to being self-regulated in many face-to-face collaborative learning contexts.

For designers of scripted collaborative learning and researchers assessing the effectiveness of these approaches it is important to be aware of what cognitive, metacognitive, and socio-cognitive processes their scripts are likely to induce in learners. Knowing more precisely what is learned and how it is learned through scripting can improve script design to facilitate collaborative learning and perhaps also promote eventual self-regulation of learning with those scripts.

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