Learning and Instruction 21 (2011) 746–756

Learning and Instruction

www.elsevier.com/locate/learninstruc

From guided to self-regulated performance of domain-general skills: The role of peer monitoring during the fading of instructional scripts

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Received 1 October 2010; revised 29 April 2011; accepted 2 May 2011

Abstract

The fading of instructional scripts can be regarded as necessary for allowing learners to take over control of their cognitive activities during the acquisition of skills such as argumentation. There is, however, the danger that learners might relapse into novice strategies after script prompts are faded. One possible solution could be monitoring by a peer with respect to the performance of the strategy to be learned. We conducted a 2 × 2-factorial experiment with 126 participants with fading and peer monitoring as between-subjects factors to test the assumptions that (1) the combination of a faded script and peer monitoring has a positive effect on strategy knowledge compared to only one or none of the two types of support; and (2) this effect is due to a greater amount of self-regulated performance of the strategy after the fading of the script when peer monitoring takes place. The findings support these assumptions.

Keywords: Collaboration scripts; Skill acquisition; Argumentation; Fading; Peer monitoring

1. Introduction

During learning through guided performance, a learner in some way performs the activities to be learned. However, typically the control of these activities is taken over by a more capable person (Wood, Bruner, & Ross, 1976, p. 98; Wood & Wood, 1996, pp. 391–392) who thereby creates a "zone of proximal development". In computer-supported collaborative learning, such a zone of proximal development may be created by means of the entire learning environment, including learning partners as well as technology-based instructional support. In order to acquire domain-general skills, such as argumentation, learners need to take over control of their activities. For this purpose, support may be gradually reduced or *faded* (e.g., Pea, 2004, p. 431 f.). In the following we will argue, however, that fading alone may be insufficient for taking over control, and learners may need further support of a different kind during fading.

2. Theoretical background

2.1. Components of cognitive skills and their acquisition

The literature on cognitive skill acquisition typically regards a skill as a system of knowledge components (cf., e.g., Anderson & Lebiere, 1998, p. 6–8). Each single knowledge component can fulfil at least one of two functions: (1) it can be used to regulate the execution of the skill by setting subgoals, or (2) it can directly contribute to performance by helping accomplish these subgoals (see Anderson, 1987, p. 198). The first kind of knowledge is critical for any skill because it embodies the overall strategy for tasks within the scope of the skill, such as the strategy for solving subtraction problems. In contrast, the second kind of knowledge is necessary to solve specific tasks and therefore varies among tasks, for example, the "number facts" required for solving a specific subtraction problem (see VanLehn, 1990, p. 14). Accordingly, a skill can later be extended by acquiring more knowledge of the second type, once sufficient knowledge of the first type concerning a strategy has been acquired. Therefore, we focus on the first

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0959-4752/$ - see front matter
doi:10.1016/j.learninstruc.2011.05.001

kind of knowledge and refer to it by using the term "strategy knowledge". One crucial prerequisite of acquiring a unit of knowledge of both types is repeated application of that knowledge (Anderson & Lebiere, 1998, p. 107 f.; 133). In the case of strategy knowledge, application means using that knowledge for setting subgoals during the execution of a skill by the learner.

For the purposes of this study, we selected the ability to generate a counterargument against the relevance of someone else's argument for a claim as a representative of domain-general skills. Based on the distinction of "tenability" and "relevance" as quality criteria for argumentation (Naess, 1966, pp. 108–109; see also Voss & Means, 1991, p. 339) and a taxonomy of argument schemata (e.g., Walton, Reed, & Macagno, 2008, ch. 9–11), a strategy underlying this skill can be characterized by the following series of subgoals:

(1) *identification of a claim* in someone else's utterance (for example, "Lisa should receive attributional retraining to learn to attribute failure to external causes …");
(2) *identification of an argument* put forward to support the claim (for example, "… because her actual attribution of failure to internal stable causes is detrimental for her subsequent achievement motivation.");
(3) *identification of the type of the claim* (in this example: recommendation of an intervention);
(4) *identification of the type of the argument* (in this example: negative prediction in case of the omission of the intervention);
(5) *check of the fulfilment of the conditions for the argument to be relevant to the claim;* these conditions depend on the types of the claim and the argument; hereafter, they are called "conditions of relevance" (in this example: the possibility of a positive prediction in the case of the execution of the intervention – which is not fulfilled); and
(6) *formulation of a counterargument* on the basis of the results of the analysis conducted in steps 1–5.

Strategy knowledge is constituted by the knowledge of this sequence of subgoals. As described above, theories of cognitive skill acquisition assume that this knowledge is acquired if learners repeatedly use it to set subgoals during the *performance of the strategy.*

2.2. Instructional scripts as a means to foster strategy knowledge

To guide learners to apply a new strategy, in computer-supported collaborative learning settings there is the opportunity to support learners by means of an instructional script (e.g., De Wever, Van Keer, Schellens, & Valcke, 2007; Kollar, Fischer, & Slotta, 2007; Rummel & Spada, 2005; Rummel, Spada, & Hauser, 2009; Stegmann, Weinberger, & Fischer, 2007). A script is a kind of instructional support that provides learners with guidance about how to interact (Kollar, Fischer, & Hesse, 2006, p. 162 ff.). If learners are supposed to also internalize the strategy suggested by the script to acquire the corresponding skill, the way learners process these scripts needs to be considered. From the perspective of cognitive skill acquisition, script prompts are processed by means of general, so-called "interpretive" procedures (cf. Taatgen, Lebiere, & Anderson, 2006, p. 46). For example, after a claim and an argument in a learning partner's contribution have been identified, the learner may not know how to move on. Therefore he or she may consult a prompt offered by a script and use it to set the subgoal to identify the type of the claim. It is important to note that the control of a learner's activities is exerted by the script and not by the learner in such situations.

The internalization of a strategy suggested by a script can be explained by means of compilation (Taatgen et al., 2006, p. 47): By replacing the general reference in the interpretive procedures to instructions in the environment by the activities specified in these instructions, skill-specific procedures can be built. From situations such as the example above, learners may acquire a rule to set the subgoal to identify the type of the claim when they have identified claim and argument. This piece of strategy knowledge is strengthened if learners repeatedly apply it autonomously to set this subgoal in similar situations without relying on the script (Anderson & Lebiere, 1998, p. 133). This may be unlikely, however, if the script is permanently available. Accordingly, for the internalization of the strategy, it might be necessary to gradually withdraw the script (fading, see, e.g., Pea, 2004, p. 431 f.; Rummel et al., 2009, p. 88).

2.3. Problems associated with the fading of instructional scripts

Diverse kinds of instructional support can be faded, ranging from stimuli and prompts (Riley, 1995) to steps in worked examples (Renkl & Atkinson, 2003). In most of these cases, fading has proved effective for learning (e.g., Renkl, Atkinson, & Groβe, 2004; Schunk & Rice, 1993). The findings about the fading of steps in worked examples in particular, however, have limited pertinence for fading scripts because examples are studied *before* performance. In contrast, scripts are employed *during* performance and control of the performance.

Actually, instructional scripts can be regarded as a kind of socio-cognitive scaffolding (Carmien, Fischer, Fischer, & Kollar, 2007, p. 305). Fading has always been regarded as an integral part of scaffolding (Pea, 2004, p. 431 f.; Wood et al., 1976, p. 92; Wood & Wood, 1996, pp. 395–396); hence it seems natural to fade scripts as well. So far, only a couple of studies on the effects of the fading of scaffolds have been conducted, with mixed and partly disappointing results. Leutner (2000) conducted two experiments on the effects of fading on the acquisition of software skills. One provided evidence for the beneficial effects of fading (p. 351), and the other indicated decreased performance during fading (p. 354). McNeill, Lizotte, Krajcik, and Marx (2006) found that learners acquired more knowledge about the principles of scientific explanations with fading than without. However, this difference failed to reach significance (McNeill et al., 2006, p. 175).