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One click away is too far! How the presentation of cognitive learning aids influences their use in multimedia learning environments

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ABSTRACT

In an experimental study, we investigated how the presentation of cognitive learning aids, as well as the availability of self-monitoring questions affect the frequency of use of cognitive learning aids in a multimedia learning environment. The learning aids were presented either dynamically, statically, or they were initially collapsed and the students had to activate them by clicking on a button. The comparability of all three versions of the multimedia learning environment was assured by means of repeated usability testing. Self-monitoring questions were either presented to the learners or not. A total of 60 undergraduate students participated in the study. Their activities in the learning environment, together with their eye movements were recorded. The students took advantage of the learning aids most when they were dynamically presented, less when they were statically presented, and least when they were presented in a collapsed form. The differences in use of the learning aids were statistically significant with large effect sizes. The availability of self-monitoring questions had no significant effect on the use of learning aids.

1. Introduction

Multimedia learning environments often place high demands on the learners. There is a growing body of evidence which shows that many learners struggle to appropriately process the information included in different representations such as text and pictures (for an overview see Mayer, 2005). In order to facilitate learning within multimedia learning environments, cognitive learning aids are often made available to the learners. These aim at helping learners to engage in cognitive processes that are relevant to the learning task such as the selection, the organization, and the integration of information encoded in the different representations (cf. Clarebout & Elen, 2006; Jonassen, 1999; Mayer, 2009).

In past research, it has been repeatedly demonstrated that the use of learning aids can significantly improve learning from multimedia. For instance, Renkl (2002) investigated learning from worked examples in a computerized learning environment about probability calculations. He found that students learn more successfully not only when they self-explain but also when they take advantage of instructional explanations offered by means of an online help system. In an experimental study on learning from hypertext, Gerjets, Scheiter, and Schuh (2005) demonstrated that prompting students to produce self-explanations improves learning. Schworm and Renkl (2006) obtained similar results when they investigated learning from a multimedia environment. Bartholomé, Stahl, Pieschl, and Bromme (2006) examined learning from a multimedia environment about the biology of plants. They found that students who took advantage of instructional hints performed better than students who did not so. Clarebout and Elen (2009a, 2009b) observed more successful learning in computerized learning environments when the students made use of learning aids such as dictionaries, descriptions of learning goals, sample questions, and help for interpreting text and images that were presented in the environments. In experimental studies conducted by Kombartzky, Ploetzner, Schlag, and Metz (2010) as well as by Ploetzner and Schlag (2013), learning from narrated animations was significantly improved by means of cognitive learning aids that were designed on the basis of Mayer's (2009) Cognitive Theory of Multimedia Learning. Schlag and Ploetzner (2011) obtained comparable results with respect to learning from combinations of texts and static images.

Although many empirical studies demonstrate that learning aids can improve learning from multimedia, several studies also report a severe problem: In many cases it was observed that learners do not use learning aids spontaneously, and often they are completely ignored (cf. Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Clarebout & Elen, 2006; Heiß, Eckhardt, & Schnotz, 2003; Horz, Winter, & Fries, 2009; Narciss, Proske, & Koerndle, 2007;

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Roll, Aleven, McLaren, & Koedinger, 2011). This raises the question of how the use of learning aids can be encouraged.

Previous research on the use of learning aids in computerized learning environments primarily investigated how learner related variables such as prior knowledge, self-regulatory skills, motivation, and epistemological beliefs affect the use of cognitive learning aids. Only a few studies examined the influence that the characteristics of the learning environment have on the use of learning aids, such as the content of learning aids, the usability of learning aids, or the presentation of supplementary metacognitive cues to encourage the use of learning aids (for an overview see Aleven et al., 2003; Clarebout & Elen, 2006). Up until now, these studies provided little evidence that could guide the design of cognitive learning aids in such a way that learners would actually take advantage of them.

In this paper, we present an experimental study that was conducted to investigate how the design of a multimedia learning environment can increase the frequency of use of cognitive learning aids, irrespective of the learning aids' educational effectiveness. We first describe a process model of help-seeking in multimedia learning environments. We also report empirical findings concerning the influence of various factors on the process of help-seeking. On the basis of the model, we suggest two design features of multimedia learning environments that could foster the use of cognitive learning aids. The first feature concerns the presentation of learning aids; the second feature is concerned with the availability of self-monitoring questions. We then describe a multimedia learning environment in which the suggested design features have been implemented. The usability of the learning environment was repeatedly tested and systematically improved during the development phase. Thereafter, we report an experimental study that was conducted to investigate how the implemented design features affect the use of cognitive learning aids. A discussion of the observed results concludes the paper.

2. Theoretical background

The use of learning aids is a complex process that comprises metacognitive reasoning as well as decision making (for an overview see Aleven et al., 2003). Current conceptualizations of this process rely for the most part on Nelson-Le Gall's (1981) model. It was formulated to describe help-seeking processes in social contexts and consists of five steps:

1. Learners must become aware of their need for help, i.e., they must realize that they cannot accomplish the learning task exclusively by means of their own resources.
2. Learners can decide to seek help from others. This decision is based on an analysis of the costs and benefits associated with seeking help. Costs may be the loss of perceived competence, for instance, or the fear of getting less credit for a successful accomplishment.
3. Learners need to identify potential helpers, i.e., persons who can provide the required support.
4. Learners have to apply strategies for receiving help from others. For example, learners may attempt to receive help by expressing their need in an adequate way.
5. Learners evaluate the help-seeking episode, i.e., they assess the success or failure of their attempt to receive help. This evaluation may influence future help-seeking activities.

Aleven et al. (2003) adopted this model to describe the process of using help in computerized learning environments. According to those authors, however, the steps of Nelson-Le Gall's (1981) model take on a different character within computer-based learning:

1. Learners must become aware of their need for help. In this case, the computerized learning environment itself might support learner self-monitoring.
2. Learners can decide to seek help. In computerized learning environments, the anticipated costs and benefits may be different from those in social contexts. For instance, the use of the learning aids may demand specific efforts.
3. Learners need to identify potential sources of help. For example, computerized learning environments may offer different kinds of learning aids. The learners not only need to be able to locate them within the environment, but must also decide which learning aids best meet their needs.
4. Learners have to apply strategies for receiving help. In computerized learning environments, learners have less flexibility to express their requests for help. Furthermore, learning aids commonly offer a specific functionality to the learners. As a consequence, the learners have to take advantage of this functionality in such way that their need for help is met.
5. Learners evaluate the help-seeking episode. Again, the learning environment may aid this evaluation process by supporting learner self-monitoring.

To our knowledge, the model of Aleven et al. (2003), respectively Nelson-Le Gall (1981), is up until now the only generic process model concerning the use of learning aids in computerized learning environments. Mercier and Frederiksen (2008) customized this model to problem-based learning environments with focus on various cognitive aspects of using help. Aleven, McLaren, Roll, and Koedinger (2006) developed a process model specific to intelligent tutorial systems based on the model of Aleven et al. (2003).

The research presented in this paper is also based on the model of Aleven et al. (2003). However, we suppose that the identification of potential sources for help needs to take place before the decision to make use of them. In computerized learning environments, learners might not even be aware of the availability of learning aids. Even if the learners are aware when they start to learn, they might lose track during learning. Therefore, to make an informed decision, the learners need to be aware of existing learning aids, their functionality, as well as the effort it takes to use them. Thus, we propose to modify the model of Aleven et al. (2003) as follows:

1. Learners must become aware of their need for help.
2. Learners need to identify potential sources of help, i.e., the learning aids available in the learning environment.
3. Learners can decide to seek help.
4. Learners have to apply strategies for receiving help, i.e., to take advantage of the provided functionality in a goal-oriented way.
5. Learners evaluate the help-seeking episode.

Each step in this process can be influenced by a number of factors. For instance, learners may not properly identify their need for help because they lack prior knowledge or only have limited metacognitive ability. The learners may not be aware of available learning aids because they are presented in an unapparent way. Furthermore, the learners may reject using learning aids because they are difficult or laborious to use.

Despite two decades of research, it is still unclear under which conditions learners make use of learning aids. One line of research primarily investigated how learner characteristics such as prior knowledge, self-regulatory skills, motivation, and epistemological beliefs influence the use of learning aids. The main result from this line of research revealed that learners with low prior knowledge utilize learning aids more frequently than learners with high prior knowledge (Babin, Tricot, & Mariné, 2009; Bartholomé et al., 2006; Horz et al., 2009; Renkl, 2002; Wood & Wood, 1999). It was also