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Differential benefits of situated instructional prompts

Holger Horz [a,*], Claudia Winter [b], Stefan Fries [c]

[a] Department of General and Educational Psychology, University of Koblenz-Landau, Thomas-Nast-Strasse 44, D-76829 Landau, Germany
[b] Department of Educational Science 2, University of Mannheim, A 5, 6, B-Gebäude, D-68131 Mannheim, Germany
[c] Department of Educational Psychology, 6 c University of Karlsruhe, Hertzstraβe 16, D-76128 Karlsruhe, Germany

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ABSTRACT

Learners often neglect support (glossaries, help sites etc.) in computer-based learning environments since they experience it as an unrelated add-on. We assumed that prompts presenting situated instructional support would lead to an increased use of help sites and glossary. Further it was assumed that situated instructional support would lead to a higher cognitive load of learners, which causes differential learning outcomes depending on learners' general domain knowledge. To scrutinise the differential effect of situated instructional prompts we conducted an experiment with 69 students (undergraduates vs. graduates). Students learned either with a learning environment with or without prompts. As expected, learning with prompts resulted in an increased support usage. Furthermore, two interaction effects occurred. (1) Graduates learned slightly better with a program including prompts whereas undergraduates performed better without prompts. (2) Undergraduates stated a higher perceived cognitive load if they learned with a program with situated instructional prompts. In the group of graduates no differences occurred concerning the perceived cognitive load. The results are interpreted within the framework of cognitive load theory.

1. Introduction

Recent instructional theories focus on authentic learning environments that are based on real-life tasks as an incentive for learning (e.g., Martens, Gulikers, & Bastiaens, 2004; Merrill, 2002; van Merriënboer & Kirschner, 2001). The general assumption of these theories is that authentic learning environments offer the opportunity to apply acquired theoretical knowledge to real-life tasks and prevent inert knowledge (De Corte, Verschaffel, Entwistle, & van Merriënboer, 2003). Such authentic tasks can be realised especially in computer-based learning environments like computer-based trainings or simulations because of three reasons. (1) Computer-based learning environments allow the physical integration of different authentic media, (2) make adaptive interactive trainings better possible than other media, and (3) facilitate the simulation of realistic complex relations between different objects of a learning environment (i.e., by hypermedia design; Chuang & Tsai, 2005; de Jong & van Joolingen, 1998; Gulikers, Bastiaens, & Martens, 2005).

Successful learning within these complex authentic learning environments imposes high regulatory demands on the learner, which causes some self-regulation problems during learning and may complicate the learning process (Azevedo, 2005a; Azevedo & Hadwin, 2005). Consequently researchers investigated the effectiveness of support in order to optimize learning (Azevedo, 2005b; Bannert, 2004; Clarebout & Elen, 2009; Gerjets, Scheiter, & Catrambone, 2004). Despite instructional support presented by prompts or worked examples being physically integrated in the learning process as an embedded support device, learners often characterize them as 'additional' information and therefore as 'optional', resulting in non-sufficient usage of support. One solution for this problem would be the situated integration of support to form a unified learning environment (Meijer & Riemersma, 2002; van den Boom, Paas, van Merriënboer, & van Gog, 2004) in which support is no longer experienced as additional but as an integral part of the learning environment. Following the idea of integrating situated instructional support, we report an experiment about learning with a computer-based learning environment with or without situated instructional support presented via prompts in consideration of influences of learners' prior domain knowledge.

2. ATI-effects of situated instructional prompts

In computer-based learning environments, a common way to offer additional information to learners is to integrate supporting instructions (e.g., help sites, FAQ-lists, hypertext glossaries). The rationale behind these approaches is to offer optional assistance which can be used when needed (van Merriënboer, Kirschner, & Kester, 2003). This kind of support can be denoted as "just in time support".

* Corresponding author.
E-mail address: horz@uni-landau.de (H. Horz).

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Successful learning in a complex learning environment involves the use of adequate learning strategies (Azevedo, 2005a, b). These strategies include planning, monitoring and regulating the learning process in terms of the learning goals. Unlike studying in conventional learning environments, in authentic computer-based learning environments (i.e., simulations, role-plays) the learner has to face a multitude of decisions in most cases. For instance, learners often have to decide about their navigation behaviour, which information is relevant, which information most appropriately serves their needs, and how information can be added in the existing knowledge structure (Aleven & Koedinger, 2002; Bannert, 2003; Cuevas, Fiore, Bowers, & Salas, 2004; Teong, 2003). Therefore, learners often fail to gain a deeper understanding of the learning content because they lack sufficient self-regulation strategies (Leutner, 2000). Obviously, some learners have difficulties in assessing their comprehension and in adapting their learning strategy accordingly (Glenberg & Epstein, 1985, 1987; Pressley, Snyder, Levin, Murray, & Ghatala, 1987). As a consequence, learners will not reach the point of initiating an individual search for additional information, which in return could help them to organize the learning process or give them crucial hints. Especially learners with low domain and/or computer knowledge are overwhelmed by task and strategy complexity in complex computer-based learning environments and become uncertain how to deal with them. This often leads to disorientation problems ('lost in hyperspace'; see Dillon & Gabbard, 1998; Jonassen & Mandl, 1990) so that the learning achievement may be disrupted, resulting in worse outcomes (Chen & Rada, 1996).

One possibility to solve these problems is to integrate instructions in learning environments by the use of prompts. Prompts are instructions added in the learning context, which ask i.e., students to carry out specific activities (Bannert, 2003). Prompts are offered either after a certain study time or are depended on learning activities (e.g., at the beginning or end of a learning unit). In a study by Lin and Lehman (1999) students carrying out experiments in a biology simulation environment were prompted several times to give reasons for their actions (e.g., "What is your plan?", "How did you decide that ...?" etc.). Students learning with prompts showed significantly higher far-transfer performance compared with the control group learning without such prompts. In addition, Bannert (2003) argues that it is not sufficient to offer prompts alone but also to ensure adequate use of the instructions provided by forcing the use of prompts (i.e., via questions concerning actual activities), so that prompts can not be ignored easily.

2.1. Authentic support

Brown, Collins, and Duguid (1989) argue that learners "need to be exposed to the use of a domain's conceptual tools in authentic activity" (p. 34). Therefore, learning contents should be connected to the respective activity and environment to ensure deep involvement of learners. Following this approach, not only the learning content should be embedded in the learning context (Graesel, Fischer, & Mandl, 2001), additional instructions should be linked to the demands of the specific task in the learning situation as well.

Some studies report about an effective embedding of added instructions. Atkinson, Renkl, and Merrill (2003) successfully combined prompts with worked examples to improve students' performance on near and far-transfer tasks in a computer-based learning environment for probability word problems. Gerjets and colleagues showed a similar promising way to increase the learning success. Learners had to answer a given task in a learning environment by means of worked out examples (Gerjets, Scheiter, & Schuh, 2005; Gerjets et al., 2004). However, the learning environments of these studies are not as complex as most commercial and established authentic learning programs and were programed for purposes of the experimental study only.

The integration of situated instructional prompts in a learning environment may further raise the demands on the learner. Besides previously mentioned positive effects, it is also known that situating a learning environment means to increase its authenticity, which mostly leads to an increase of the learning environments' complexity (van Merriënboer et al., 2003). First, the added situated instructional prompts will enlarge the learning environment's cognitive costs because learners have more decisions concerning their own learning path and whether they follow the added instructions or not. Second, an integration of situated instructional prompts is realised by adding also some information which is not essential for the learning task. Hence,the positive effects of situated instructional prompts may be hampered by the limited processing capacity of the human mind, which allows only a limited number of cognitive operations during a specific time (van Merriënboer, Kester, & Paas, 2006; van Merriënboer et al., 2003). If learning time is limited, it is possible that a cognitive overload situation (see next section) will arise or learning effectivity diminishes because the total learning time increases and learners' endurance limits the learning success.

2.2. ATI-effects of situated instructional support

Because of learners' limited cognitive resources in the working memory, any evaluation of an authentic learning environment should also take into account potential aptitude–treatment-interactions (ATI). The proper cognitive resources allocation is critical to learning, because if a learner is required to devote mental resources to activities not directly linked to information processing and integration of knowledge (i.e., extraneous load), the learning process may be disturbed (Kalyuga, Chandler, & Sweller, 2001; Sweller, 1994).

In complex learning environments students with low prior knowledge show mostly a reduced learning success compared to students with high prior knowledge. Only in case of 'expertise reversal effects' (Kalyuga, Ayres, Chandler, & Sweller, 2003) learners with a high prior knowledge may have lowered learning outcomes compared to students with low prior knowledge. The mostly observed negative effects in the group of learners with low prior knowledge could be traced back – in terms of the Cognitive Load Theory (Chandler & Sweller, 1991; Sweller, 1994) – to the combination of content's higher intrinsic load due to a low prior knowledge and a high extraneous load because of the learning environment's complexity. This may result in a lack of additional learning activities because cognitive capacities are used by intraneous and external load related processes. As a result, no increase of germane load appears in the group of learners with low prior knowledge (e.g., Mayer, 1997; Mayer & Chandler, 2001; Mayer & Moreno, 2003).

Generally, learning environments' extraneous load, which is unrelated to adequate information processing and schema building like the intrinsic and germane cognitive load, should be decreased. Especially for inexperienced learners the extraneous load produced by the features of the environment itself should be minimized (van Merriënboer, Schuurman, de Croock, & Paas, 2002). The expertise level in the respective domain influences the extent to which schemas can be brought into working memory to organize incoming information (Kalyuga et al., 2003). Learners with a high amount of prior domain knowledge already possess cognitive schemas to which new information could be linked. Schemas allow experienced learners to process higher amounts of information. In contrast, when learners with a low amount of domain-specific prior knowledge start to build new schema learning success is more influenced by the design of the learning environment (Mayer &