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Instructional Support for Collaborative Activities in Distance Education

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INTRODUCTION

Distance education is facing many challenges nowadays. One of them relates to a different perspective on knowledge: Current policies and economies emphasize the need for lifelong learning and the learners' ability to apply their knowledge in working contexts. Furthermore, knowledge is nowadays one of the motors of economy and several of the world's most valuable companies merely sell goods based on knowledge (like software) rather than physical products. Authors reflect this impact of knowledge by the usage of terms like knowledge society (e.g. Nonaka, 1994) or knowledge age (e. g. Bereiter, 2002). Even if information and communication technologies allow access to an indefinite amount of information, it is up to the learners to develop key skills to information processing and exchange to transform the information to personal and shared knowledge. According to the European Commission (2007), such kind of digital literacy is therefore the key skill of the current century. But knowledge society does not only require learners to develop digital literacy, it also requires individuals as well as the whole society to engage permanently in keeping their knowledge up to date—a process of continuous knowledge generation (see Nonaka, 1994). Thereby, it is not more sufficient to just acquire knowledge; learners also have to get familiar with skills regarding knowledge construction, exchange, and rebuilding. This has also consequences for distance education because it has to overcome traditional teacher-student scenarios in which a teacher passes "knowledge" to learners who try to memorize and rehearse. To meet the requirements of knowledge society, distance education needs a new perspective on learning and teaching (see Ertl, Winkler, & Mandl, 2007).

Moderate constructivist approaches provide such perspective and focus on particular learner activities that are necessary for learners' individual and collaborative knowledge construction. They build on learners' active knowledge construction and postulate that learning requires learners' active participation. Approaches like situated learning (Lave & Wenger, 1991) or cognitive apprenticeship (Collins, Brown, & Newman, 1989) describe this new kind of relation between learners and the learning environment. This is in contrast to traditional approaches, which set learners in a receptive role. According to constructivist approaches, learning is mediated by learners' individual prior knowledge, their motivation and other individual learning prerequisites. Reinmann-Rothmeier and Mandl (2001) describe several key-elements for construction of knowledge according to this philosophy (see also Ertl et al., 2007). They state that a learning process is

- Active, because only active involvement enables learning.
- Self-directed and learners have to take active control and responsibility for their learning activities.
- Constructivist, which means that learners have to embed new knowledge in their existing knowledge structures.
- Social and knowledge acquisition requires a social context.
- Situated because knowledge acquisition happens in a specific context and is linked to this context.
- Emotional; the emotional component is particularly important for the motivation of the learners.

Besides these constructivist aspects, learning environments require a certain amount of instruction (Ertl et al., 2007; Kirschner, Sweller, & Clark, 2006; Reinmann-Rothmeier & Mandl, 2001). Consequently, learning environments need to find a balance between

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construction and instruction. This balance can be realized by the design of problem-oriented learning environments (see Mandl, Gräsel, & Fischer, 1998) and case-based learning scenarios (Kolodner et al., 2003). Such learning environments can benefit from new technologies; they can provide tools for supporting the active construction of knowledge (Roschelle & Teasley, 1995), provide an authentic situational context by the display of video-cases (CTGV, 1997), enable the social context for spatially divided learners (Mandl, Ertl, & Kopp, 2006), and motivate learners by the provision of gimmicks and animations (Mayer, Hegarty, & Mayer, 2005). However, none of these benefits are caused by the technology itself—they are introduced by the instructional design of the learning environment including the use of the new technologies.

This article focuses on two particular aspects how the instructional design can apply new technologies for the improvement of learning environments: on collaboration-specific methods structuring learners' collaboration, and, on content-specific methods that are supporting learners' active construction of knowledge.

BACKGROUND

To enable learners' collaborative knowledge construction, particularly in distance education scenarios, they need environments that support collaborative activities. This means, that learners need an environment not only for exchange, but also for specific processes of collaborative knowledge construction. According to Fischer, Bruhn, Gräsel, and Mandl (2002), core processes of collaborative knowledge construction relate to learners *externalization* of knowledge, to the *elicitation* of knowledge from their learning partners and to processes for resolving socio-cognitive conflicts. The negotiation with these conflicts is of particular importance, because these processes go beyond the mere exchange of information but support the synthesis of different perspectives. Fischer et al. (2002) call these processes *conflict-oriented negotiation* and *consensus-oriented integration*. Yet, such processes only can happen when learners have the chance for differentiate elaborations. Therefore the environment has to support learners in elaborating as well as in an interaction frequency high enough to allow these discursive processes (a meta-study on this topic is presented by Jeong and Hmelo-Silver (2010)). During collaborative knowledge construction, learners build a shared knowledge base that can be seen as a joint product or mental artifact (see Bereiter, 2002). This can be a goal of a learning scenario, e.g. in the collaboration of interdisciplinary teams (see Rummel & Spada, 2005), as well as the base for further collaboration as it happens in learning communities (see e.g. Winkler, 2004). Studies have shown that such kind of collaborative knowledge construction can evoke beneficial learning activities (see e.g. Ertl, Fischer, & Mandl, 2006; Lou, Abrami, & d'Apollonia, 2001; Roschelle & Teasley, 1995). Modern technologies can support e-collaborative knowledge construction (see Ertl, 2008, 2010a, 2010b) for distance education settings. Yet, hereby the learning environment has to provide more than just materials and means for collaboration. Kirschner et al. (2006) emphasize the need for instructional design and a shared motivation as a prerequisite for beneficial learning. One aspect of the instructional design is the provision of specific instructional methods as support for learners' e-collaborative knowledge construction. Mayer (1994), e.g., shows the impact of visualization aids, Fischer, Kollar, Mandl, and Haake (2007) show different structures for collaboration, and Pata, Sarapuu, and Lehrinen (2005) discuss the role of tutoring. Diziol and Rummel (2010), provide a framework for such support methods.

COLLABORATION-SPECIFIC METHODS

Methods for facilitating learners' collaboration may be associated with several tools, particularly software products that aim at enabling collaborative work or at supporting particular collaborative tasks (e.g. collaborative drawing or text editing). These tools can support collaboration between learning partners, yet the fact remains that collaborative skills often do not come naturally to the individual learner and must therefore be acquired (see Salomon & Globerson, 1989). Instructional approaches focusing on the improvement of collaboration often refer to methods such as *scripted cooperation* (O'Donnell & King, 1999). Such scripts sequence learners' work on the task. Furthermore, they may provide roles for the learners and encourage them to apply beneficial strategies for solving a task.

As an example, the MURDER-script (Dansereau et al., 1979; O'Donnell & Dansereau, 1992) is comprised of several different aspects, and will therefore demonstrate the potential elements of scripts and their combination. This script relates to a collaboration process in which learners work collaboratively on text comprehension. It divides the collaborative learning process into six phases that focus on individual as well as on collaborative activities. The first phase relates to learners personal motivation for the task ahead (*M*ood). The second phase focuses on individual text comprehension (*U*nderstand). In the third phase, one partner repeats contents of the text from his memory (*R*epeat) while the other partners try to find difficulties and give feedback (4th phase; *D*etect). In the following, learners reflect and elaborate about the content to link the learning material with their prior knowledge (5th phase; *E*laborate). Finally, they check their work against the original text material (*R*eview, 6th phase). Learners may repeat these 6 phases for several text paragraphs and for each cycle, a different learning partner takes the role to repeat the text contents.

Technologies can integrate such scripts into collaborative learning environments. They may structure the collaboration process or the proceeding in the work on the task. Baker and Lund (1997), for example, report a script, which specifically directed the collaboration process. Their learning environment provided a shared graphics editor for working on a collaborative product and the instructional design added several *speech act buttons* to this editor. Each time a learner had made changes to the collaborative product, the learning environment required both partners to agree on these changes before continuing. They were required to demonstrate this by pressing the respective speech act buttons. The intention of this mechanism was that both learning partners increased their grounding (Dillenbourg & Traum, 2006) and their collaborative commitment to the joint product (Baker & Lund, 1997).

Ertl, Reiserer, and Mandl (2005) showed a different example for scripting in distance education using a videoconferencing scenario. The aim of this script was to facilitate learners during the task of collaborative teaching. This script structured the collaborative proceeding on the task, the roles of the learners and the application of beneficial strategies regarding the collaborative negotiation. Therefore, the script assigned two different roles to the learners, the role of a teacher and the role of a learner. Furthermore, it divided the collaboration process into four different phases. Learners worked with a shared application in this scenario and this application offered learners a space for written externalizations. Furthermore, the application was pre-structured with instructional elements that guided learners according to the script. In the first phase, the participant in the teacher role explained the text material while the partner in the learner role asked comprehension questions. In the second phase, the learner rehearsed the concepts acquired and fixed important aspects in the shared application. The teacher supported the partner and clarified misinterpretations. In the third phase, both partners reflected individually and in the fourth phase, they discussed the learning material. In this phase, the learner also noted important aspects in the shared application. After these four phases, learners switched their roles and continued with another text.

Results of the study showed that the learning environment with the script was able to facilitate learners' negotiation with theoretical concepts during collaboration. With respect to the individuals' learning outcomes, the script particularly facilitated learners in the learner role. They acquired more knowledge during collaboration than learners without a script (see Ertl et al., 2005). Other studies also report beneficial effects of scripts in distance education courses. These were related to the learning processes (Baker & Lund, 1997; Weinberger, Ertl, Fischer, & Mandl, 2005) as well as to the individuals' outcomes (Rummel & Spada, 2005). Scripts may improve general processes of collaboration (Baker & Lund, 1997), lead to a more homogeneous work on the task (see Weinberger, 2003) and to the acquisition of beneficial collaboration strategies (Rummel & Spada, 2005).

CONTENT-SPECIFIC METHODS

Content-specific methods rely on particular affordances of the course's content domain. They may provide domain categories or ontologies for the learners (see e.g. Ertl et al., 2006), facilitate the visualization of conceptual relations (see Fischer et al., 2002) or provide simulations or visualizations which help learners to understand particular mechanisms (see Roschelle & Teasley, 1995). Content-specific methods aim for support at a conceptual level and try to facilitate learners' understanding of particular conceptual aspects, relations or mechanisms of the content domain (see Table 1).

Table 1. Taxonomy of support methods with different goals

Goal of Support	Collaboration-Specific Methods	Content-Specific Methods
Improving collaborative processes	Scripts	
Understanding impact factors		Simulations
Understanding structures		Templates
Understanding relations		Conceptualization tools

Content-specific methods often rely on a particular representation of important content structures. Zhang and Norman (1994) postulate that this representation of content has an influence on learners' ability to deal with the content. If a method changes the representation of the content then it might be that learners perceive this content in a different manner. This may facilitate as well as impede learning-depending on the match between the representation and the learners' cognitive structure (see Zhang & Norman, 1994). This means that the content structure remains the same (it is isomorph) but the way in which it is presented changes. A rather simple example for this mechanism would be to provide a diagrammatic representation instead of a textual description (see e.g. Larkin & Simon, 1987). The representation can make important task characteristics salient and function as a representational guide for the learners (see Suthers & Hundhausen, 2003). There is a broad variety of methods and tools for this kind of facilitation (see Löhner & van Joulingen, 2001). They offer different amounts of facilitation to the learners and they vary with respect to the degrees of freedom the learners have when working with them.

In distance education, one has to distinguish between tools, which enable content-specific facilitation, and the instructional design, which applies the tools to a particular context and provides the facilitation. Powerful tools may offer many possibilities and much freedom to the learners. However, this may be too complex for the learners, who may not have the cognitive ability to apply it correctly and thereby suffer from cognitive overload (see Sweller, van Merrienboer, & Paas, 1998). Consequently, it may be too complex for beneficial activities (see Dobson, 1999) and negate the potential facilitation effect. The instructional design of a distance education course should therefore consider the skills and the prior knowledge of the learners (see Mandl et al., 2006; Shapiro, 2004) and aim for a balance between learners' experiences and the demands of the tools.

In the following, we will describe briefly different forms of content-specific support:

- Tools for simulations (see Roschelle & Teasley, 1995; Liu & Hmelo-Silver, 2010) allow learners to *simulate* scientific processes. The instructional design of these tools is such that the learner can simulate a process according to various parameters. The particular tools for simulations are modeled specifically for this one purpose and might also include visualizations or animations of these processes. Learners can modify the parameters of the simulation and observe the results of this change in the simulation. Thus, simulations aim at understanding the influence of particular factors on a whole (simulated) system.
- Templates are different from simulations in that they *pre-structure* a content domain (see Brooks & Dansereau, 1983; Ertl et al., 2006; Ertl, Kopp, & Mandl, 2008; Suthers & Hundhausen, 2003). In this case, the tool provides the features to create templates and the instructional design specifies the contents of these templates. It provides categories that are particularly important for content-specific negotiation and often uses tables for their representation. These tables provide empty spaces for the learners which help them to focus on the important categories. However, learners cannot change the structure of the tables and model new relations. Consequently, templates aim at internalizing the structure of a content area.

- Conceptualization tools allow the visualization of connections between different concepts within a subject matter. They enable learners to illustrate connections between concepts and theories by creating a mind map or a similar diagram. The tool provides the concepts and various types of connecting lines that are then sorted and put together to demonstrate the connections. Learners may thereby create their own representation, but the process is supported by the pre-existing elements used (see Fischer et al., 2002; Suthers & Hundhausen, 2003). Consequently, conceptualization tools are intended to facilitate a deeper understanding of the relationships within a particular content area.

Ertl et al. (2005) present an example for a content-specific method in a distance education course in the style of a template. This template aimed at facilitating learners' learning of text material. It focused learners on important aspects of theories, particularly on the categories of theory concepts, evidence and personal elaborations with respect to consequences and learners' individual opinion. They used a shared application for providing the template to the learners. The instructional design provided a table with 4 cells headed by the respective category names. Furthermore, it anchored the rather broad categories by different prompts in each table cell.

Results of the study show that this template provided several benefits for the learners. They reached a higher score in the category of evidence and they provided more personal elaborations (see Ertl et al., 2005). Thus, the template was able to direct the learning process not only to the memorization of facts, but also on the personal contextualization of these facts. Moreover, several other studies have shown beneficial effects of content-specific methods in the context of distance education (see Ertl et al., 2006; Ertl et al., 2008; Fischer et al., 2002; Roschelle & Teasley, 1995; Suthers & Hundhausen, 2003). Roschelle and Teasley (1995) report beneficial effects of simulations for transactive discourse and knowledge co-construction. Ertl et al. (2006) present a template, which provided benefits for learners' collaborative learning process as well as for their individual knowledge acquisition. Suthers and Hundhausen (2003) reported that a template had facilitated the learners to draw relations between theoretical concepts and evidence. Furthermore, Fischer, Bruhn, Gräsel, and Mandl (2000) found that conceptualization tools homogenized collaborative learning processes.

FUTURE RESEARCH DIRECTIONS

Studies which compared learning environments with a sound instructional design and traditional courses report an increased quality of education, a more active role of the learners and more motivated learners if they were working in the well-designed learning environment (see e.g. Dochy, Segers, van den Bosche, & Gijbels, 2003; Hiltz, 1997; Lehtinen, 2003). In contrast, studies which just compared different technologies were hardly able to find any beneficial effects of the technologies for learning (e.g. Clark, 1994; Salomon, 1984; Schweizer, Pächter, & Weidenmann, 2001; Storck & Sproull, 1995). This means that distance education courses can provide "powerful learning environments" (see e.g. Bettoni, 2010; Clark et al., 2010; Oehl & Pfister, 2010). One of the current trends relates to the provision of MOOCs (massive open online courses) or BOOCs (big open online courses, see Gaebel, 2013). They promise education (and certification) to many learners in different regions across the world. Yet, the more users a course has, the better instructional design is necessary to provide beneficial learning. Learners need appropriate support (e.g. Häkkinen, Arvaja, Hämäläinen, & Pöysä, 2010; Pächter, Kreisler, & Maier 2010), but also a certain amount of tutoring (see Kopp, Germ, & Mandl, 2010). Assuming that several learners of each course need some kind of support, a MOOC with 500 participants may exceed the capability of the offering institution. Therefore, new approaches of help seeking (see Schworm & Heckner, 2010) may be crucial to reduce drop out rates. The future of e-learning will evoke some kind of consolidation in the field. Distance education courses will be more and more subject to evaluation (see Ertl, Ebner, & Kikis-Papadakis, 2010). This will disclose how far a particular course or technology can provide benefits for the learners.

CONCLUSION

This article dealt with instructional support for distance education courses. This is of particular importance for distance education, because many distance education courses have a fairly simple instructional design. They provide either lectures without any opportunity for learners' individual knowledge construction or merely offer resources without any guidance for the learners. Courses for distance education should use well balanced aspects of construction and instruction to provide benefits for the learners. The instructional design of courses may be featured by several methods which apply information technology. Collaboration-specific methods structure collaboration tools to optimize collaborative learning processes. Content-specific methods use tools to facilitate learners' collaborative knowledge construction on a conceptual level. Both can enhance the instructional design and the outcomes of distance education courses.

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KEY TERMS AND DEFINITIONS

Collaboration: Tightly working together with a strong commitment of collaboration partners.

Collaborative Knowledge Construction: Learners' joint activities to acquire or create new knowledge.

Content Scheme: Tabular representation of domain-specific structure to facilitate learners.

Instructional Design: The didactical rationale for a learning scenario which includes instructional elements as well as the application of tools.

Knowledge Construction: Learners' work with their knowledge in a way that they link their new knowledge to their existing knowledge base instead of memorizing facts.

Learning Environment: Learners' context in distance education courses that is comprised of instructional, social and technical aspects.

Powerful Learning Environment: A learning environment which includes instructional elements that evoke learners' active construction of knowledge.

Script: Specification of learning processes which contains procedural aspects, the assignment of roles and the evocation of beneficial cognitive activities.