Available online at www.sciencedirect.com
SCIENCE DIRECT®
Computers in Human Behavior 21 (2005) 547–554
Computers in Human Behavior
www.elsevier.com/locate/comphumbeh

Editorial

Learning in innovative learning environments

1. Introduction

Modern day learning and accompanying learning environments are characterized by their place and time independence, their integrated presentation and communication facilities, and their opportunities for re-use of instructional materials in the form of learning objects. Many authors who claim that such learning yields a "technology push" that will higher the quality of education raise these arguments. But it is yet an open question if media will ever influence learning (Clark, 1994). A well-defendable viewpoint is that not the media used, but only instructional methods can improve the quality of education. Then, one should rephrase the question and ask if the current techn(olog)ical state-of-affairs in the field of innovative learning indeed enables the use of innovative instructional methods that are necessary to make learning more effective, efficient and appealing.

An educationalist with an open mind, who studies the overwhelming amount of modern learning applications currently available, can only come to one conclusion: from an educational perspective, the use of so-called innovative learning environments is often a step backward instead of forward. The central concept, for example of web-based environments, appears to be "content" and so-called content providers (publishers, universities, knowledge institutes etc.) "deliver" this content to their students over the Internet. This is also the case of many electronic learning environments that are proprietary in nature and are often nothing more than upgraded course management systems; the same old wine in a brand new bottle. Didactics and educational innovation are not at stake; instead, the most important questions typically relate to the costs, the necessary technical infrastructure, and the learning platform to use. A direct consequence of this approach is that many new learning applications bring us back to the early days of computer-based education with its programmed tutorials and electronic books. Student activities are limited to reading from the screen, filling out boxes and, at best, chatting with peer students about the content. The designers of these applications themselves sometimes acknowledge these shortcomings and refer to e-learning as computer supported page turning

doi:10.1016/j.chb.2004.10.022

(CSPT) or ''Simon says'' training (where the computer is demonstrating something that must be imitated by the learner).

In short, there is a sharp contrast between most current forms of innovative learning environments and the cognitive and/or social-constructivist ideas about learning that have emerged in the 1980s and 1990s. Forms of learning that stress the active engagement of learners in rich learning tasks and the active, social construction of knowledge and acquisition of skills are rare.

2. The road to a study environment

What then does an innovative study environment need? Fig. 1 (Kirschner, Vilsteren, van Hummel, & Wigman, 1997) sketches the contours of such a study environment for learning and the acquisition of competence. The three ovals represent sub-environments encircling each other, in which four main learning activities (rectangles) occur.

Key in all of this is that the environment as a whole, as well as each of the three sub-environments, has the necessary technological, social and educational affordances to provide opportunities to learn (Kirschner & Kreijns, 2004). Affordances – technological, educational or social – determine how individuals or groups interact with the different aspects of their environments and with each other. Technology that is easy to learn and easy to use will allow different use than technology that isnot.

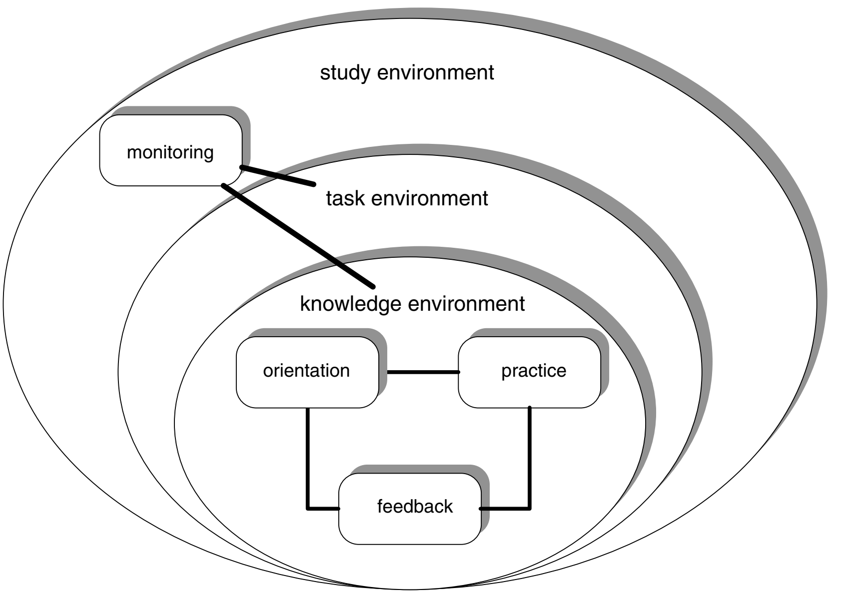

Fig. 1. Illustration of a study environment for the acquisition of competence.

Pedagogy that gives control to team members affords different learning than pedagogy that is instructor centered. Finally, being able to experience where others are and what they are doing in a distributed group affords different learning and social contacts than where this is invisible.

In the hypothetical environment shown in Fig. 1, the outermost layer is the study environment, the place where students find a sufficient number of source materials and aids, and in which they are given a chance to construct an orientation basis of their own (Vygotsky, 1978 in Van Parreren, 1987) or with each other and determine their goals and the activities they will involve themselves in. These source materials and aids are located within two overlapping layers, the task environment and the knowledge environment.

The task environment consists of the assignment or problem, the limiting conditions within which the student is expected to finish the assignment or solve the problem, and the aids available. The problem or assignment resembles, as closely as possible, those situations that will be encountered in the 'real world'. Limiting conditions (e.g., constraints, conventions, requirements) and aids (e.g., technical and mind tools, communication media, supportive people) are defined by the characteristics of the situation. The situation can require co-operation with fellow students, for instance in a business simulation or can put a student in a more isolated role, for instance in a case-assignment.

The knowledge environment is the sum of all domain-specific and domain-independent knowledge available for the task. Some of that knowledge is available to the student as prior knowledge. Some is knowledge that can be obtained from books and other sources (including the instructor and fellow students) which are accessible to the student. The knowledge environment is an aid for completing the task and therefore in this model considered a part of the task environment. This knowledge environment is part of the task environment, where the other aids presented in the previous paragraph are available and can be used. The knowledge environment and the task environment are set up in such a way that the student has all the aids needed to achieve intended results. Hence, the knowledge environment needs to 'fit' in the design of the task environment.

In these environments, orientation, practice and feedback take place. Orientation takes place largely in the knowledge environment as the student seeks to answer the questions: What should I do? When should I do it? How have others done it? Why should I do it? When should I do it? Why should I do it in that way? The point is to allow the student to answer these questions in the knowledge environment, so that the orientation basis is as complete as possible before the student begins to practice. The design of the knowledge environment should make this possible, and it should take into account the prior knowledge that the student possesses, the way in which this prior knowledge is activated and the way in which new knowledge can be integrated into the existing knowledge structures.

Practice is chiefly done in the task environment. Students tackle the various problems using the knowledge available. They use declarative, procedural, strategic and situational knowledge to solve the problems. All these knowledge elements play a role in acquiring competence and return in the exercises presented to the student.

Finally, feedback is the link between the knowledge environment and the task environment. The result of the operations with knowledge (within the task environment) may or may not be the intended one. Consequently, the image of the situation may have to be adjusted, as will the procedural and strategic knowledge (within the knowledge environment). A student may receive highly personal feedback from a teacher or tutor or fellow students (peers), or more standardized feedback from a computer program.

The task of monitoring the study process as a whole takes place more at a metacognitive level within the study environment. Monitoring can be undertaken by an external supervisor, an expert, by fellow students or by the learners themselves. The ultimate goal of education is that the student ultimately assumes the role of self-monitor, who reflects on her/his own learning process and results, and who attempts to identify what has gone wrong and how (s)he can do better or work faster next time.

Each of these elements is indispensable for the acquisition of competence, and should be adequately attended to and coordinated throughout learning. This is the point of departure for the design of education aimed at the acquisition of competence and thus:

- Design of the knowledge environment must consider issues such as prior knowledge, the availability of relevant sources, and so on.
- Cognitive processing must be maximized within the limits of cognitive capacity. This means stimulating a systematic working method in which monitoring and reflection form an essential part.
- Designing the task environment to involve generating problems and problem situations which are as authentic and realistic as possible, and in which the aids available are as genuine as possible.

The goal of this special issue is to showcase a number of fruitful approaches to the design of learning environments rooted in theory, backed by empirical data, and aimed at making learning more efficient, effective and appealing.

3. The contributions

In this special issue, each of the facets just described will be discussed. The special issue begins with a contribution by De Westelinck, Valcke and Kirschner who, in their article *Multimedia learning in social sciences: limitations of external graphical representations*, study the effects of making use of Mayer (2001) cognitive theory of multimedia learning (CTML) in the knowledge domain of the social sciences. In a series of six empirical studies, the central question was researched whether adding external graphical representations improves retention and transfer. These studies question the generalizability of Mayer's cognitive theory of multimedia learning to the knowledge domain of the social sciences. The research hypotheses build on the assumption that this knowledge domain differs in the way instructional designers are able to develop adequate depictive external graphical representations. Earlier CTML-research has mostly been carried out in the field of the natural sciences where the graphical representations are depictive in nature and/or where the representations can be developed from existing or acquired iconic sign systems. The results indicate that CTML has to be extended when learners study learning materials with external graphical representations that reflect low levels of repleteness and do not build on an iconic sign system previously mastered or acquired by the learners. The research results reveal that studying this type of representation does not result in higher test performance and does not result in lower levels of mental load.

Continuing on this issue of *external representations* (ERs), Van Drie, Van Boxtel, Jaspers, and Kanselaar cross the boundary between the knowledge environment and the task environment to study how the use of different types of ERs affect study, communication and learning behaviour of collaborating learners. In their aticle *Computer support for collaborative learning of historical reasoning* the authors focus on the effects of ERs on both the process of collaboration and the effects of collaborative learning. The main aim of this process-oriented research is to identify processes that constitute productive collaborative activities. Specifically, it investigated the effects of the joint construction of three different types of ERs (i.e., matrices, diagrams, and outlines) on the collaborative process and the learning outcomes. By providing representational guidance, the study aimed at promoting co-elaborated and domain-specific reasoning. Since it is assumed that the representational format may be of influence on the collaborative process and outcomes, three representational formats, namely an argumentative diagram, an argument list and a matrix, were compared with a control group. Student pairs from pre-university education collaborated on a historical writing task in a CSCL environment. In this research interaction processes, quality of co-constructed representations, quality of study products (essays), and scores on an individual post-test were analyzed. The results indicated that each representational format has its own affordances and constraints. For example, Matrix users talked more about historical changes, whereas Diagram users were more focused on the balance in their argumentation. This study shows that a collaborative writing task is useful for promoting historical reasoning and the learning of history. Moreover, the representational format seems to influence aspects of the collaborative learning process, especially domain-specific reasoning. However, this did not result in differences in the quality of historical reasoning in the essay, nor in outcomes on the post-test.

Mäkitalo, Weinberger, Häkkinen, Järvelä, and Fischer take this study of what occurs in the task and study environments a step further in their article *Epistemic cooperation scripts in online learning environments: fostering learning by reducing uncertainty in discourse*. As was the case in Van Drie et al. the authors here too attempt to influence how online learning environments can support collaborative learning, but now from a more social rather than cognitive point of view. Online learning creates a problem for participants who have not previously worked with each other, namely the *uncertainty* which arises when participants do not know each other. According to the uncertainty reduction theory, a low uncertainty level increases the amount of discourse and decreases the amount of information seeking.

Therefore, uncertainty should influence online discourse and learning. This study investigates the effects of an epistemic cooperation script with respect to the amount of discourse, information seeking and learning outcomes in collaborative learning as compared to unscripted collaborative learning. The aim was also to explore how and what kind of information learners seek and receive and how learning partners react to such information exchange. The results indicate that the epistemic script increased the amount of discourse and decreased the amount of information seeking activities. Without an epistemic script, however, learners achieved better learning outcomes. The results of two qualitative case-based analyses on information seeking are also discussed.

Beers, Boshuizen, Kirschner, and Gijselaers present in their article *Computer support for knowledge construction in collaborative learning environments*, both empirical research as well as a tool to tackle a different aspect of uncertainty when working together in the task and study environments. Educational institutions and business/government organizations increasingly use multidisciplinary teams to construct solutions for complex problems. Research has shown that using such teams does not guarantee good problem solutions. Common ground is vital to team performance and this common ground can best be achieved when teams negotiate meaning. This contribution studies the effects of an ICT-tool (NTool; Negotiation Tool) to allow/force team members to make their individual perspectives on a problem or its solution explicit and clear. The tool makes use of a framework of negotiation primitives and rules (support) and was embedded in a collaborative learning environment in three ways, which differed from each other in the extent to which users were coerced to adhere to the embedded support principles (scripting of negotiation behavior). The results showed that the three versions of NTool differed with regard to negotiation, negotiation of meaning per contribution, and common ground. Testing revealed that coercion, as hypothesized, was significantly correlated with negotiation and negotiation per contribution. NTool appears to affect the negotiation of common ground, and it does so increasingly with more coercion. High coercion – strict adherence to a negotiation script – resulted in more explicit negotiation of common ground. Intermediate coercion resulted in the least common ground, because it strongly disrupted typical group processes. Questionnaire data about common ground showed the same picture where the intermediate coercion version of NTool resulted in less common ground than the other versions, as perceived by the participants. Interview data suggested that high coercion disruption of typical discussions can be accommodated.

As stated in the previous section, the ultimate goal of education is that the student ultimately assumes the role of self-monitor, who reflects on her/his own learning process and results, and who attempts to identify what has gone wrong and how (s)he can do better or work faster next time. De Jong, Kollöffel, van der Meijden, Kleine Staarman, and Janssen make the switch from external regulation of the learning process to internal, self-regulation in their contribution *Self-regulative processes in individual learning and group regulation processes in(3D) CSCL contexts*. The article presents three studies of student regulation of their own learning, that is the self- and group regulative abilities to select and direct actions according to plans, learning goals, and curriculum standards. In the first study, the temporal organization of the self-regulation process was examined within an individual learning context. Multilevel analysis showed linear and quadratic relations between self-regulation process and the phase of learning. An unexpected negative direct relation between self-regulation and test performance was only found for the process of "directing". In the two other studies, collaborative computer learning within a 3D environment, on the one hand, and within the context of literacy practices, on the other hand, was examined. Self-regulative processes as "monitoring," "directing," and "testing" occurred less frequently than "grounding" and "common agreement" activities. In all three studies, the students rarely "orient" themselves towards the learning task. It is concluded that the adequacy of regulation and not the frequency is important for student learning. Learning regulation need not just be based upon "good strategy" but on the specific requirements of the learning context, personal competencies, and the potentials and constraints of the more general learning environment. "The more regulation, the better the learning" should probably be replaced with "The more adequate the regulation in relation to personal needs and external constraints on the learning process, the better the performance."

Finally, Van Joolingen, De Jong, Lazonder, Savelsbergh, and Manlove present the contours of a *complete* collaborative learning environment in which groups of learners experiment through simulations and remote laboratories. In their contribution *Co-Lab: research and development of an online learning environment for collaborative discovery learning*, the authors present a state of the art study environment based on insights gleaned from instructional theory and empirical research. As an environment, Co-Lab proved suitable to provide a means for an integrated approach for collaboration, modeling and inquiry. In this respect it is possibly the first environment in which these three learning modes are brought together and integrated. Co-Lab's structure keeps the complexity of the environment within reasonable limits and provides specific instructional support such as a process coordinator and a qualitative modeling tool where these limits might be exceeded by challenging assignments for engaging students in an authentic inquiry context. The studies performed with Co-Lab indicate that the way of offering support is well on track, however more research is needed to understand Co-Lab and to make sure that it will eventually be used in classrooms. Research is needed and planned into the assessment of learning in collaborative inquiry environments: how can we assess learning products such as inquiry skills, deeper domain knowledge and skills for collaboration.

Acknowledgements

Most of the articles in this special issue were originally presentations at the Netherlands Educational Research Association (NERA) invited symposium at the 2003 AERA conference. In the name of all of the authors I like to thank the NERA, the AERA and especially the discussant at that symposium Professor Roy Pea for their comments, support and ideas.

References

Clark, R. E. (1994). Media will never influence learning. *Educational Technology Research and Development, 42*(2), 21–29.

Kirschner, P. A., & Kreijns, K. (2004). The sociability of computer-mediated collaborative learning environments: Pitfalls of social interaction and how to avoid them. In R. Bromme F. Hesse & H. Spada (Eds.), *Barriers and biases in computer-mediated knowledge communication – and how they may be overcome*. Dordrecht, NL: Kluwer.

Kirschner, P. A., Vilsteren, P., van Hummel, H., & Wigman, M. (1997). A study environment for acquiring academic and professional competence. *Studies of Higher Education, 22*(2), 151–171.

Mayer, R. E. (2001). *Multimedia learning*. Cambridge, MA: University Press.

Van Parreren, C. F. (1987). *Ontwikkelend onderwijs [Developing education]*. Amersfoort, NL / Leuven, BE: ACCO.

Paul A. Kirschner
Education Technology Expertise Center
Open University of the Netherlands
PO Box 2960, NL-6401 DL Heerlen, The Netherlands
Tel.: +31 45 576 2361; fax +31 45 576 2802
E-mail address: paul.kirschner@ou.nl

Available online 18 November 2004