Using the Internet to Improve University Education: Problem-oriented Web-based Learning with MUNICS

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ABSTRACT

A principled approach to the design of problem-oriented, web-based learning at the university level is presented. The principles include providing authentic contexts with multimedia, supporting collaborative knowledge construction, making thinking visible with dynamic visualisation, quick access to content resources via ICT, and flexible support by tele-tutoring. These principles are used in the MUNICS learning environment, which is designed to help students of computer science to apply their conceptual knowledge from the lectures to complex real-world problems. For example, students may model the information flow in an educational organization with a dynamic visualisation tool. A main finding in the formative evaluation study with the prototype is the ignorance of the students concerning the additional content resources. This finding is discussed on the background of the well-known phenomenon of insufficient use of help systems in software applications.

Keywords

collaborative knowledge construction, dynamic visualization, problem-oriented learning, tele-tutoring, university education, web-based learning

PRINCIPLES FOR PROBLEM-ORIENTED, WEB-BASED LEARNING AND THEIR USE IN THE DESIGN OF MUNICS

In problem-oriented environments, (1) *authentic problem contexts* are seen as the starting points of learning processes. MUNICS(*)is based around an authentic multimedia case. As the content area is "distributed work groups", the case is about the inefficient distribution of information within an organisation. This case study represents a typical class of problems in computer science and a real-life scenario. The students are encouraged to actively request the information they need. Ideally, (2) *learners engage in collaborative knowledge construction* when dealing with these problems, discuss different perspectives and share their prior knowledge. In MUNICS, learners collaborate in small groups (three to five students). MUNICS offers multiple communication tools including a *chat tool* for synchronous communication and a *shared document repository* to facilitate co-operative document management. (3) *Making thinking visible with dynamic visualisation.* Especially when dealing with complex problems, visualization may enhance the construction of mental models of the topic and lead to deeper understanding. MUNICS includes the *Modeler Tool* (Koch et al., 2001) for collaborative dynamic visualization over the web. The tool enables modelling, analysis of static as well as dynamic aspects, and simulation of the flow of information. *(4) Quick access to content resources via ICT.* In problem-oriented learning, increasingly self-directed exploration of the problem and the task domain is emphasised (Gräsel, Fischer, & Mandl, 2001). MUNICS provides background knowledge like the hypermedia material of two lectures on the topic under consideration. For both lectures, *lecture notes* in HTML are available online. *(5) Providing flexible support by tele-tutoring*. Apart from content resources - a human tutor or an expert is available. Students can use the *chat tool* in the MUNICS environment to get in touch with the tutor.

Goals of the formative evaluation study

We implemented a prototype of MUNICS and conducted a formative evaluation study. The primary goal was to assess the extent to which the principles were realized in the prototype and what modification of MUNICS could improve objective and subjective learning processes and outcomes.

METHOD

(1) Sample. Eleven computer science students from the Technical University of Munich volunteered to test the learning environment. The participants were separated into learning groups of two or three students. (2) *Data sources, variables, and instruments*: As instruments to evaluate the realization of the principles we used (a) observation protocol, (b) a knowledge Test, (c) a personal data questionnaire; (d) a questionnaire concerning acceptance, (e) interaction protocols from the communication tools; (f) an individual work report and (g) a face-to-face group discussion at the end of each session. (3) *Procedure*. The session started with a short introduction about the purpose of the study and its course. Then students were asked to complete the questionnaire on personal data, followed by the prior knowledge test. After an introduction into the functionality of MUNICS, the students started to work on the problem. The learning group members were located in

different rooms, each equipped with a computer. After collaboration (approx. 2 hours), the learners were asked to complete the work report, the knowledge test, and the questionnaire on acceptance. Finally, members of the learning group discussed their experiences face-to-face.

RESULTS AND CONCLUSIONS

(1) Providing authentic contexts for learning. The observation protocols revealed that all participants used and explored the Interactive Problem Context intensely – this part of the work occupied about half of the overall working time. This observation is in line with the subjective evaluation of the learners. *(2) Supporting collaborative knowledge construction.* Questionnaire data indicated, that students accepted learning in small groups to a high degree. However, they rated the quality of collaboration for their own learning group as relatively low. The analysis of the interaction protocols revealed that the central focus of students' discourse was about coordination of. Conclusion: Scripted co-operation might structure learners' collaborative activities more appropriately. A main question is, how detailed such a script should guide the interaction. More controlled research on this issue is needed. *(3) Making thinking visible with dynamic visualisation.* Participants used the Modeler Tool collaboratively. Nevertheless, they evaluated the functionality and the usability of the tool to be still in need of improvement. The group discussion revealed that students felt restricted by the tool. On the other hand, the group discussions also showed that the dynamic representation was seen as very helpful for deeper understanding. Conclusions: This can be seen as the more general problem of finding the right specification level in designing representation tools. Domain-specific structures might facilitate collaboration by providing a kind of initial common ground (Fischer et al., in press). However, a highly specified structure might force more advanced students to change strategy. There is hardly any research on the interaction between the degrees of freedom of a representation tool and prior knowledge. *(4) Quick access to knowledge resources.* Most of the students hardly ever used the resources at all. Conclusions: At first glance, the phenomenon might be attributable to bad design of the online lecture notes. However, we argue that the problem points to a more general issue. Studies in different domains and with different tasks showed that students refrain from using background knowledge, glossary or help information, even when experiencing knowledge gaps (Gräsel et al., 2001). More basic research on this topic is needed which can shed light on psychological mechanisms responsible for this effect. (5) *Providing flexible support by tele-tutoring.* The facility of consulting the tutor was frequently used. Students emphasised the importance of the tutor. Moreover, they were satisfied with the support they received. Conclusions: The effect of an expert or tutor participating in peer collaboration is a neglected area of research. On the one hand, this might be detrimental to intensive and high-level negotiation processes, because there is someone who knows the right answer (so why have an argument?). On the other hand, a tutor can introduce the relevant topics, reducing the risk of collaborative construction of misconceptions and thematic vagabonding.

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