ΜΕΡΟΣ ΤΕΤΑΡΤΟ

Μαθησιακές και διδακτικές δραστηριότητες με ΤΠΕ

INQUIRY LEARNING IN TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS

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Modern theories on learning and instruction call attention to learning environments that create constructivistic, situated, and collaborative learning experiences. Simulations offer specific features that enable self-directed, highly autonomous, high interaction learning. First, learning in these environments differs from learning in expository environments in that it puts a higher emphasis on inquiry processes such as hypothesis generation and testing and on regulative processes such as planning and monitoring. Second, these environments offer specific opportunities to situate learning in realistic settings, but they also offer the possibility to adapt reality to support learning. Third, inquiry learning presents opportunities for negotiation and collaboration. This presentation will set out characteristics of simulations discuss characteristic inquiry processes and associated problems, and relate them to instructional design. In the presentation a number of simulation based learning environments will be demonstrated.

INTRODUCTION

New types of (on-line) learning environments are becoming available for use in the actual classroom rapidly. Trends that nowadays dominate the field of learning and instruction are *constructivism*, *situationism*, and *collaborative learning*. More specifically, we can say that the new view on learning entails that students are encouraged to *construct their own knowledge* (instead of copying it from an authority be it a book or a teacher), *in realistic situations* (instead of merely decontextualised, formal situations such as the classroom), *together with others* (instead of on their own). These new trends have not emerged just by themselves; they are based on changing epistemological views. First, knowledge is not seen anymore as something that may have an *individual flavor* and may thus be potentially different between people. Second, these individual knowledge states are exchanged between professionals that seek for mutual understanding and agreement. In this respect knowledge has a strong *social character*. Third, we have started to value knowledge that is *applicable in realistic situations*, and thus is not restricted to abstract knowledge. Technology plays a major role in implementing these new trends in education. Constructivism is supported by computer environments such as hypertexts, concept mapping, simulation, and modeling tools (see de Jong & van Joolingen, 1998), realistic situations can be brought into the classroom by means of video, for example in the Jasper series (Cognition and Technology Group at Vanderbilt, 1997) and collaborative learning is supported in Internet based learning environments such as Co-Lab (van Joolingen, de Jong, Lazonder, Savelsbergh, & Manlove, 2005).

CHARACTERISTICS OF COMPUTER SIMULATIONS

Computer simulations are programs that hold a computable model of some kind of reality. Students can manipulate the simulated reality by changing values of input variables, and the output is usually displayed in several formats (e.g., animations, graphical displays, and numbers). These characteristics make simulations well suited for implementing the trends above. First, simulations elicit a learning process that is called inquiry learning. In inquiry learning, a domain is not directly offered to students; rather students have to induce characteristics of the domain from experiences or examples. Inquiry learning can be defined as an approach to learning that involves a process of exploration, that leads to asking questions and making discoveries in the search for new understandings (National Science Foundation, 2000). This is a learning approach that is in line with contructivistic principles. Second, simulations can easily be used to introduce realities in the classroom. Interfaces of simulations (or even virtual realities) may mimic any reality. Third, inquiry learning is very appropriate for collaborative learning, as is real, scientific, inquiry since it requires students to make decisions along the way (e.g., which hypothesis to test) that are good anchor points for knowledge exchange and negotiation (Gijlers & de Jong, 2005).

INQUIRY LEARNING

Though simulations seem to be able to take a central role in realizing the above mentioned trends in education, students do have considerable trouble in realizing an effective inquiry process. Knowledge about the inquiry process and the related problems students experience may help to design adequate cognitive scaffolds.

Inquiry learning processes

Although there may be some variations, for example in the way data are gathered (e.g., from experimentation or from data sets), and variations in the complexity of the experimentation, there is a fair consensus about which processes basically comprise inquiry learning. The different classifications in the literature differ mainly in their granularity, ranging from very detailed to rather broad, but basically do not differ in the processes that are distinguished. In de Jong (2006b), I introduced a set of learning processes that form a suitable basis for describing inquiry learning. In *orientation*, the student makes a broad analysis of the domain; in *hypothesis generation*, a specific statement (or a set of statements, for example, in the form of a model) about the domain is chosen for consideration; in *experimentation*, a test to investigate the validity of this hypothesis or model is designed and performed, predictions are made and outcomes of the experiments are interpreted; in *conclusion*, a conclusion about the validity of the hypothesis is drawn or new ideas are formed; and, finally, in *evaluation*, a reflection on the learning process and the domain knowledge acquired is made.

Problems that students experience

In a review of research de Jong and van Joolingen (1998) concluded that students may have serious problems with all of the above mentioned inquiry learning processes. In general, students may have trouble stating hypotheses, designing experiments, and interpreting data; they often do not engage in overall planning and do not adequately monitor what they have been doing (de Jong & van Joolingen, 1998). These inquiry process problems may be associated with wrong mental models of systems in general (Kanari & Millar, 2004; Kuhn, Black, Keselman, & Kaplan, 2000) and it may lead to a misinterpretation of experimental outcomes from the experiments that were performed in the inquiry (Chinn & Brewer, 1993). On this basis and also based on overall research in inquiry learning many researchers, therefore, conclude that students need guidance in the discovery process (de Jong, 2006a; Mayer, 2004).

Providing students with cognitive scaffolds

In the software students can be supported with cognitive tools or cognitive scaffolds to ensure an effective inquiry learning process. An example of this is providing students with assignments. These assignments help to students in their planning activities and they help to focus on relevant aspects of the simulation (van Joolingen & de Jong, 2003). Another example is a *monitoring tool*. A monitoring tool helps students to save all their experiments, to re-order, and to replay them. A *hypothesis scratchpad* offers students elements (variables, relations, conditions) for composing hypotheses. Students can also be provided with hints on how to experiment, or on how to reflect over the knowledge that is acquired. Another way to support students is to offer them just-time background information or explanations. Finally, the inquiry process can be subdivide in several phases and for every phase students can be offered a specific structure to work in. Extensive overviews of cognitive tools or cognitive scaffolds can be found in Quintana et al. (2004) and de Jong (2006b). Another way to improve the results of inquiry learning is to combine the inquiry process with a product to design, which could be a concept map, a runnable model, or instruction for fellow students (Vreman-de Olde & de Jong, 2006).

CONCLUSION

Large scale environments show that inquiry learning based on simulations can be an effective learning process (Hickey & Zuiker, 2003; Ketelhut, Dede, Clarke & Nelson, 2006; White & Frederiksen, 1998) . However, the inquiry process needs to be scaffolded to reach these results. This scaffolding can be offered in the software, but could also be offered by the teacher or a co-learner. If it is offered by a co-learner we create collaborative inquiry environments. Combined with more realistic interfaces simulations can indeed offer educational opportunities that combine contructivist, collaborative, and situational characteristics. For sure, to give inquiry learning a place in the curriculum a balance needs to be found between inquiry learning and other ways of learning and instruction so that an integrated, attractive, and effective curriculum results.

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