Scaffolding Student Learning in Information-Dense Technology-Enhanced Teaching and Learning Environments

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Abstract: This paper is fundamentally about supporting learning in technology-enhanced educational settings where students are often confronted with very large amounts of information, and where they are also required to exercise a great deal of independence as part of their learning activity. First, it outlines very briefly, the critical attributes of such educational settings, the challenges to learning that they pose, and some ways of supporting students in their learning as they are confronted with these challenges. The paper also discusses the pedagogical foundations for building these types of cognitive supports and discusses some preliminary work that is being carried out on these lines at The University of Melbourne in Australia.

Technology-Enhanced Learning Environments

For the purposes of this paper, technology-enhanced learning environments refer to those educational settings where some element of instructional technology (such as CD-ROMS or the Web) is used to support the interaction between the teacher, the learner and the educational content. Students in these educational settings are often confronted with very large amounts of information by way of databases and other resources (making them information-dense) which they are required to use to pursue self-directed and open-ended inquiries. Interest in building these educational environments, where students are immersed in learning by doing and where the meaning of knowledge and skills are realistically embedded in authentic problem situations, has been growing in the last decade (see Brown, Collins, & Duguid, 1989). These environments are designed not so much to "instruct" as to provide contexts wherein understanding and insight can be uniquely cultivated. Papert's concept of "microworlds as incubators for knowledge" reflects the philosophical bias of these technology-enhanced, student-centered learning environments (Papert, 1993, p. 120). They are called student-centered because the focus in these learning environments is more on learning, and less on the delivery of the content. Examples of these student-centered learning designs are goal-based scenarios (Schank, 1997), and problem-based learning (Koschmann, Kelson, Feltovich & Barrows, 1996).

Challenges and Problems of these Learning Environments

Technology-enhanced student-centered learning environments do not, in themselves, lead to learning efficiency or effectiveness. Indeed for some learners, the use of technology and the student-centered nature of these learning environments can be quite daunting, and pose a real threat to their success and motivation to learn. While creating opportunities for student-centered learning, these environments also create demands for new skills in managing complex information and higher order cognitive processes. Being successful in such learning environments requires the ability to organize, evaluate, and monitor the progress of one's learning. Not all learners have the skills to function efficiently and effectively in such educational settings. Students need help with acquiring learning strategies to enable them to organize and reflect on information they have encountered. They have to be taught the learning skills and self-monitoring (i.e, metacognitive) strategies which would in turn enable them to take advantage of rich databases, and open-ended inquiries (see Weinstein & Mayer, 1986; Jonassen, 1988). While a considerable amount of work has been done in supporting students' learning with various types of learning strategies in such educational settings (see for example, Bernard & Naidu, 1992; Edelson, Gordin, & Pea, 1999), work on supporting student learning with software-based cognitive tools is still lagging.
What does this Work Involve?

Weinstein and Mayer (1986) suggest that the development of learning strategies (i.e., in learning how to learn) can influence learner characteristics. They argue that employing these strategies and methods can help with the encoding process, which in turn affects learning outcomes. These authors have identified several categories of learning strategies, namely rehearsal, elaboration, organizational, self-monitoring and motivational strategies. These strategies provide a pedagogically sound framework for supporting "learning how to learn", and they can also be used to guide work on scaffolding and supporting student learning in information dense, technology enhanced learning environments. They have guided the research and development work that is reported in this paper.

As part of our work on the design and development of technology-enhanced learning environments, we have been exploring both, the pedagogical designs and the technical architecture of a variety of these types of learning supports. Some examples of these are comparison frames to view content elements in relation to each other, clusters for organizing data by themes, modeling and simulations for exploring dynamic processes, and chronological traces for providing students with representations of their own actions.

Comparison frames (an instance of an elaboration strategy) are particularly useful in areas such as medical and the biological sciences where students are often observing cells and images of anatomical parts to determine unique characteristics and/or abnormalities. Clustering (an instance of an organizational strategy) is useful for organizing data or information to draw out and represent meaningful relationships among them. Interactive modeling and simulation (instances of elaboration and self-monitoring strategies) are useful approaches to support tutorials in applied domains such as in mathematics as well as in the natural sciences. As part of this, concrete dynamic models with which the student can interact and experiment are used to represent abstract concepts. Chronological traces (an instance of organizational and self-monitoring strategies) allow students to observe their own actions and problem-solving behavior after they have reached a solution, and compare it with other solutions.

The presentation of this paper will focus on "The Skin Atlas" which is an instance of an elaboration strategy. The "Skin Atlas" is a multimedia module that contains images of the histology and pathology of human skin and associated disorders, which allows students to study specific images in detail and to select and compare images.

Conclusion

We believe that the kind of work that is described in this paper has the potential to significantly expand our knowledge about scaffolding student learning in information dense, technology enhanced learning environments. By improving the scaffolding of student learning in these environments, we hope to assist the efficiency of student learning. Furthermore, a record of students’ actions at a number of levels (e.g., gathering, comparing, clustering, and organizing data, as well as self-monitoring), has the potential to provide a richer picture of their learning activities. These can be reflected upon by students themselves for revision and group discussions, by the teachers for assessment purposes, and by researchers to understand and improve student's learning experience in terms of content gathered, and the types of reflective learning activity in which they have been engaging.

References