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# Cognitive Tools for Learning

Edited by

**Piet A. M. Kommers**

Department of Education  
Twente University  
P.O. Box 217  
7500 AE Enschede, The Netherlands

**David H. Jonassen**

School of Education  
University of Colorado  
P.O. Box 173364  
Campus Box 106  
Denver, CO 80217-3364, USA

**J. Terry Mayes**

Institute for Computer-Based Learning  
Heriot-Watt University  
Edinburgh EH14 4AS, UK

With special assistance from  
Alcindo Ferreira



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## Preface

# Cognitive Tools: Prospects for Exploratory Learning Environments

There were several reasons to address the theme of cognitive tools as discussed in this book and in the corresponding NATO Advanced Research Workshop held in July 1990.

Discussions about the educational impact of hypertext and hypermedia began at conferences in the USA and Europe from 1987 to 1990. They introduced the idea that open learning resources permit students to grasp those elements which are essentially missing in their own knowledge. This idea of 'pick your own concepts' was appealing to those educators who could not accommodate the monolithic tradition of programmed instruction, computer-based tutoring in the prescriptive cultures of behaviorism and task analyses. Beside the potential to navigate through hypermedia resources, educators stressed the merit of 'creating your own ideas' in a flexible information environment. Consuming the ideas of others in combination with reconstructing your own prior concepts about the key issues in a new domain could generate new and powerful learning effects. This led to an interest in flexible, personalized information tools and was the main reason that 'cognitive tools' became a topic of interest for learning.

The second reason was our awareness that it was not only hypermedia that provided the potential of open exploratory learning environments. In fact many diverse approaches can claim the same potential. Allowing the student to reflect on his/her personal knowledge or the information presented during instruction allows for *cognitive amplification*. Some tools that provide this are:

**Semantic networking.** The goal of semantic networking tools is to supply the student with a graphical (spatial) arena in which concepts and relations between them can be visualised. This type of activity is often referred to as *concept mapping*. It stimulates the user to make decisions about mental perspectives. Mapping makes it easy to derive the overall shape of a semantic structure.

**Expert systems** created by the students elicit tacit knowledge from learners as they attempt to integrate new knowledge in different contexts, and relate those new concepts into already existing schemes. This approach is promising, because computers can readily execute declarative assertions like rules and facts. Knowledge engineering is a rapidly developing discipline. We as educators may learn a lot from this new discipline. Much attention has been paid to the logical aspects of knowledge, presumably because of the implementation languages such as PROLOG. Expert system shells provide a 'knowledge workbench' for students in complex domains like multivariate processes, diagnosis and fault finding, decision making, and logic for problem-solving tasks.

**Hypermedia** can also be used as cognitive tools. Not only can users benefit from the flexibility of consulting information, but also the mental effects of creating personal annotations, reflections and actions, are very engaging. Some of the learning outcomes from using hypermedia overlap those of semantic networking, expert systems and micro worlds.

**Cooperative Learning Environments** are facilities for multiple-user interactions. We foresee that many of the currently individual man-machine tasks, like writing texts, designing products, creating and consulting databases, making computer-based tools for decision making and computer-based learning, will become communicative and cooperative in the next five years. Timbuktu and Gossip, as cognitive tools, open the discussion about the type of problems that must be solved in designing cooperative environments. As we experienced in the Gossip and Timbuktu sessions during the conference, a key problem to explore is the complexity of parallel thoughts, which need to be synchronized and reformulated into superordinate phrases in order to facilitate further cooperation.

**Micro Worlds** are the most prominent and traditional members of the family of cognitive tools. Computer-based microworld programs may allow students to intervene in a microcosmic reality in complex but well defined ways.

Developing new educational cognitive tools is a provocative new approach in the context of instructional design. The learning goals which should be reached become clear only after having explored the different ways of using the tools, while traditional instructional design starts with clear objectives. This is one of the reasons why there are only a few settings which allow educators to think freely about new metaphors for learning environments. May this book be one of them.

## **Acknowledgements**

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