Chapter XIV
Conceptual Customization for Learning with Multimedia:
Developing Individual Instructional Experiences to Support Science Understanding

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ABSTRACT

This chapter discusses an emerging theme in supporting effective multimedia learning: developing scalable, cognitively-grounded tools that customize learning interactions for individual students. We discuss the theoretical foundation for expected benefits of customization and current approaches in educational technology that leverage a learner's prior knowledge. We then describe the development of a customized tool for science learning, called CLICK, that uses automatic techniques to create knowledge models that can be fed into cognitively-informed pedagogical tools. CLICK leverages existing multimedia resources

in educational digital libraries for two purposes: (a) to generate rich representations of domain content relevant for learner modeling that are easily scaled to new domains and disciplines, and (b) to serve as a repository of instructional resources that support customized pedagogical interactions. The potential of the CLICK system is discussed, along with initial comparisons of knowledge models created by CLICK and human experts. Finally, the chapter discusses the remaining challenges and relevant future extensions for effective customization tools in educational technology.

INTRODUCTION

Increasingly, classrooms are comprised of diverse learners who are experienced with technology and expect it to play an increasingly significant role in their educational experiences (Hanson & Carlson, 2005). The challenge for researchers and multimedia designers is to identify how educational technology can support useful learning processes and improve outcomes for a broad array of students. However, developing effective educational technology that is robust for a wide variety of learners in a range of educational contexts has been an elusive goal.

We take a learner-centered approach to improving the impact of multimedia materials. We use automatic techniques to develop rich representations of domain knowledge and student understanding that allow us to customize learning interactions based on the conceptual needs of individual learners. Our work targets the large-scale development of individually-targeted materials for educational technology, and can be contrasted with a long history of design-centered efforts to improve the general quality of learning materials that are used by all students regardless of their individual learning needs or existing knowledge. Early efforts to improve the design of learning materials included attempts to supplement traditional learning materials with visual representations, effectively creating simple forms of multimedia by the addition of diagrams (Dwyer, 1967, 1968, 1969) and pictures (see Levie & Lentz, 1982, for a review) to text resources. As multimedia resources with varied content such as text, audio, diagrams, and animations have become more common, researchers have had some success in identifying general design principles to support student learning (e.g., Mayer, 2001). However, these design-centered principles have been targeted toward broad categories of learners (e.g., students with existing high or low prior knowledge). There is little evidence that design-centered approaches can successfully remediate specific student knowledge deficits, especially for learners who have existing knowledge in a domain.

Adaptive technologies that respond to individual student knowledge and interactions do exist—for example, intelligent tutors (Anderson, Corbett, Koedinger, & Pelletier, 1995; Koedinger, Anderson, Hadley, & Mark, 1997) and animated conversational agents (Graesser et al., 2004)—but these technologies typically are difficult and impractical to implement for a wide variety of topics. As a general rule, the more detailed the conceptual feedback offered by technology, the less able the technology has been to scale quickly to new tasks, domains, and disciplines. However, as the prevalence and availability of educational multimedia increases, so does the opportunity to leverage existing computational techniques and digital resources to achieve the next generation of educational technology: tools that perform conceptually-rich student assessment, that scale to new topics and domains using automated processes, and that support customized pedagogical interactions for individual students with a range of prior domain knowledge.