Chapter 8.8
From Non-Adaptive to Adaptive Educational Hypermedia:
Theory, Research, and Design Issues

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ABSTRACT

In this chapter, it is argued that research involving adaptive educational hypermedia will be advanced by attention to two main areas: (a) the articulation of principled design features for adaptive hypermedia systems and (b) rigorous research documenting the learning efficacy of particular design approaches for different domains and learner groups. As an example of design and research in these two areas, a case study of a program of hypermedia research related to the knowledge mediator framework (KMF) is provided. First, a discussion of non-adaptive KMF hypermedia design elements and learning tasks is provided, followed by a short overview of the research findings from studies involving the use of different KMF systems. Next, current efforts are discussed to create adaptive KMF hypermedia using a learning agent module that employs semantic assessment and learner modeling in order to provide adaptive content and adaptive learner scaffolding. A general consideration of theory, research, and methodological issues related to current work in the field of adaptive educational hypermedia is also provided.

INTRODUCTION

The use of hypermedia technologies for learning in conjunction with collaboration technologies (or e-learning, as some have construed such approaches) has the potential to transform globally the infrastructures of education. Anywhere, anytime access to distributed information resources, online Web courses offering accredited degrees or subjects of personal interest and enrichment, corporate training, and professional development are but a few of the areas that employ at the core

technologies involving the use of hyperlinks to interconnect digitally encoded nodes of text, multimedia, dynamic computer models, and potentially even immersive "virtual reality" simulations.

However, despite the pervasive and increasing use of hypermedia technologies for educational applications, a critical look at the research into learning with hypermedia systems raises important issues. Although there have been empirically successful examples of educational hypermedia systems, many earlier systems have been criticized for being atheoretical and for focusing on technical issues rather than those of learning and cognition (Jacobson, 1994). There has also been widespread criticism of methodological flaws in much of the hypertext and hypermedia literature (Dillon & Gabbard, 1998; Shapiro & Niederhauser, 2003; Tergan, 1997). More recently, of relevance to themes in this volume, there have been proposals to address problems with educational hypermedia through the use of "adaptive hypermedia" that employ techniques derived from work on artificial intelligence and intelligent tutoring systems (Brusilovsky, 1996, 2001). Unfortunately, as pointed out in a recent comprehensive review of the literature related to learning with hypertext and hypermedia that included a section on adaptive hypermedia work (Shapiro & Niederhauser, 2003), no studies to date have rigorously documented the educational effectiveness of adaptive hypermedia approaches (although the review authors comment further work in this area is warranted).

Given these concerns about current research related to adaptive educational hypermedia, it is argued in this chapter that future work in this area will be advanced by attention to two main areas:

- The articulation of principled design features for adaptive hypermedia.
- Careful and rigorous research documenting the learning efficacy of particular design approaches for different domains and learner groups.

Further, given much of the work on adaptive hypermedia has been developed in the information systems, computer science, and engineering communities, it will be important that these two design and research areas also be informed by theory, research, and principles from the science of learning. Research in this area, that integrates cognitive science and educational research, has been rigorously exploring various dimensions of competent human performance, cognition, learning, and teaching for nearly 50 years (National Research Council, 2000).

In order to illustrate how learning science-based design principles and research methods may be employed in educational hypermedia research and development projects, this chapter discusses as a case study a program of research related to the knowledge mediator framework (KMF) (Hynd, Jacobson, Reinking, Heron, & Holschuh, 1999; Jacobson, 2004; Jacobson & Archodidou, 2000a, 2000b; Jacobson, Maouri, Mishra, & Kolar, 1996; Jacobson & Spiro, 1991, 1995). This chapter first provides an overview of KMF hypermedia design elements and learning tasks, followed by a short overview of the research findings from three major studies involving the use of different KMF systems. Next, current efforts are discussed to create adaptive KMF hypermedia using a learning agent module that employs semantic assessment and learner modeling in order to provide adaptive content and adaptive learner scaffolding. The chapter concludes with a general consideration of theory, research, and methodological issues related to current work in the field of adaptive educational hypermedia.

KMF HYPERMEDIA TOOLS FOR LEARNING

KMF hypermedia systems provide a set of hyperlinked resources that support learning activi-

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