Chapter 1.42
Intelligent and Adaptive Web-Based Instruction

Beverly Woolf
University of Massachusetts, USA

Mia Stern
IBM Rational Software, USA

ABSTRACT

This chapter describes Web-based instructional tutors that support active and engaging learning. Towards that end, a theoretical foundation for designing such tutors is proposed and two Web-based tutors described. The tutors reason about a student's knowledge and their own teaching strategies while taking advantage of the possibilities of the Web, by being open to other resources (Web sites) and other people (online communities). One tutor, Rashi, provides problem-based activities and tracks a student's critical thinking in biology and geology, and the second, iMANIC, uses hypermedia to customize online lectures for individual students based on learning need. This work provides promising data points for the development of authentic and effective learning that can take advantage of the possibilities of the Web, without being rooted in extensions of what already exists in the classroom, such as lectures or bulletin boards.

INTRODUCTION

The educational potential of the Web is apparently limitless, supplying asynchronous education for millions of students who have only an Internet connection and a computer. The potential benefits outweigh anything provided by a classroom or teacher—courses installed and supported in one place, available anytime, anywhere, using multiple media, individualized for the student and targeted at all learning levels.

However, issues of style, technology, and pedagogy challenge achievement of quality Web instruction. The quality of such instruction is of

critical concern because enabling full access to *poor* or *non-existing* online resources does not provide good education. Currently, no gatekeeper, for example, "Amazon.com for education," exists to evaluate instructional resources or record the opinion of students and teachers about their effectiveness. Other distance learning issues focus on isolation felt by students while working with online teaching and teachers unable to locate resources for a specific domain and student. Although schools enjoy greater connectivity and teachers use the Web more (Tech-Ed, 2000), grade school teachers do not utilize the Web for student instruction (Cuban, Kirkpatrick, & Peek, 2001).

Students are frustrated and increasingly dissatisfied by the digital disconnect they are experiencing at school. They cannot conceive of doing schoolwork without Web access and yet they are not being given many opportunities in school to take advantage of the Web. (Levin & Arafeh, 2002, p. v)

Middle and high school students want to be assigned activities "that are relevant to their daily lives" and to have Internet access beyond that available in computer labs.

Current Web instruction is not typically personalized for an individual student. Authors tend to prepare material appropriate for a fixed and undifferentiated body of students, each student receiving the same material presented in the same way. For example, a request for information about a topic on the Web typically elicits tens of thousands of responses geared to providing unstructured and non-prioritized material, including slides, class notes, glossaries, and the like, presented in a static and non-personalized manner.

The potential exists to tailor Web material to individual students, where material is customized for a student's learning level and style. Thus, a query from a grade-school child about "thyroid" might elicit a definition and simple graphic. A visually handicapped student would receive a spoken discussion and a pre-medical student, a formal description, lists of signs and symptoms within a case study, a quizzing module and perhaps real-time experimental data. Providing the same amount of customization in a classroom or non-computer environment is nearly impossible.

Issues of pedagogy and style need to be addressed before widespread customizable Web education becomes available on a global scale. The next section provides a theoretical basis for designing customized and adaptive Web education. Then, two intelligent and adaptive Web tutors are described: the first tutor helped students use critical thinking while proposing hypotheses, and the second tutor generated new content and new pages for each student based on learning needs. The future of Web-enabled instruction is discussed in the next to last section and then the founding principles of the Internet and their impact on education are discussed in the last section.

THEORETICAL BACKGROUND

Educators from pre-school to graduate school are rethinking the very nature of teaching, learning, and schooling, based on opportunities provided by the Web (Owston, 1997). In order to fully realize this educational potential, a new theoretical framework needs to be developed that focuses on what instruction is wanted and needed on the Web, and how to build such instruction. Any such framework should begin with the premise that students need to be involved, engaged, and active in authentic and challenging work. Like all other learning environments, the Web is only useful if the learner is motivated and wants to learn. It is well known that page turning or browsing does not ensure effective learning. Flashy graphics and simulations are not enough; the experience must be authentic and relevant to the learner's life (Schank, 1994). A theoretical model for Web instruction is needed that moves beyond the "Tyranny of the Button" (Woolf & Hall, 1995) and includes use