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Work in Progress: Learning Styles, Media Preferences, and Adaptive Education

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Abstract: Student models in traditional computer-based instructional programs used information about coverage of subject material, and numbers of and types of errors, to control the order of presentation and difficulty levels of subsequent instructional material. We believe a Web-based instructional system must also include information about student learning style and media preferences to optimally adapt multimedia materials to the student. This knowledge is difficult to capture in transient Web contacts. We argue it should be captured and made available by the browser.

Keywords: adaptive instruction, learning styles, media preferences

This paper is based on work begun with Fuyau Lin and Sherry Herrgott [3] and recently continuing with Sally Wood. I provide a general overview of the tutorial systems we are building, and some "speculative" comments related to WWW-based user modeling. Use of the pronoun "we" signifies ideas that have been discussed with my colleagues and on which there is agreement. Use of "I" signifies my personal ideas precipitated by this workshop and about which my collaborators and I have generally not had serious discussion.

Context

We are working on developing supplemental enrichment tutorials for Freshman-level engineering courses in introductory programming and basic concepts in electrical engineering, and a survey course on understanding digital technologies aimed at a broad cross-section of non-engineering students. In this work we are particularly interested in the role of both discrete (text, graphics, animation) and continuous (video and audio) media, and in adapting the tutorials to allow each student to most effectively gain the knowledge she needs.

Our experience with student use of WWW information is that students demonstrate a great range of enthusiasm and persistence in seeking materials, and the poorer students (those most in need of supplemental enrichment) are the least effective at ferreting out the necessary information. This implies that simply providing a hypermedia enrichment environment may lead to an enjoyable experience but not necessarily to successful learning [5]. We believe the key to successful learning is an adaptive hypermedia environment which preserves most of the WWW's traditional freedom of movement through the material while providing guidance on topic selection and, optimally, making choices on the set of media available to the student based on past learning experiences.

We make a distinction between communication and true interaction [4]. Communication involves the transfer of information from a source to a recipient. True interaction requires communication in two directions, with the information provided by each party influencing the actions of the other. Greater degrees of interaction are achieved by using more of the historical context of the dialog to influence actions. The dialog between student and tutor moves closer to true interaction as the interface increases in adaptability.

Our first attempts at developing adaptive interaction have been based on the use of interactive forms and CGI. Forms are the mechanism for returning particular response information from the student and the CGI provides the programmatic mechanisms to record that input, relate it to previous inputs, and to select a particular set of choices sent back to the student for subsequent hypermedia browsing. Thus the structure for WWW-based education becomes a hypermedia document with periodic evaluation activities. The evaluation exercises are presented as forms, which are completed by the student and submitted by sending them to the server for evaluation.

What to Model

Intelligent tutoring systems need at least three components in addition to the instructional materials themselves: a model of the student, a model of the content and conceptual relationships in the instructional materials, and an instructional strategy (or strategies) for presenting information in an effective (preferably optimal) manner.

These three components interact to modify the order of presentation of material, selection of hints and corrections, and style of interaction with the student. Traditionally, the student model includes information about coverage of a syllabus of subject material, an estimate of the student's knowledge based on the dialog and answers to evaluation activities, and categorization of student errors into predefined classes of common misconceptions about the subject matter.

However, we believe that to effectively adapt interaction among different individuals, a student model must also include information about:

Learning Styles

Dunn, et al. [2] describe learning style as the manner in which various elements of four basic stimuli (environmental, emotional, sociological, and physical) affect a person's ability to absorb and to retain information, values, facts, or concepts. There is little adaptive interaction can do to modify the environmental and emotional stimuli, although the self-control and stimulation available through the WWW are often cited as enhancing factors for students' motivation and persistence. Similarly, there is little interaction can do about sociological stimuli in a 1-to-1 dialog. So our efforts at adapting the interaction to the student primarily address the physical stimuli through changes of medium, level of content, and pace.

Attempts at incorporating learning styles into adaptive web-based tutorial software (e.g., Carver et. al.[1]) have explicitly collected that information by having students complete evaluation questionnaires and storing that information once. See the How to Model section for some thoughts on this.

Media Preferences

Although there is some indication that individual preferences don't necessarily correlate with improved learning [5], certainly students (and web surfers in general) vote with their mouse in favor of sites that provide content and a format they prefer. There is relatively little we can do about content (it's hard to put MTV clips in the middle of a lesson on pipelined architectures) but we believe that greater use of the media formats that an individual student prefers (consistent with media choices recommended by his learning styles) will make it more likely that he will actually make significant use of supplemental materials.

We hope to provide a rich diversity of media for most of the subjects covered in our tutorials, track how often each student chooses which medium, and over time modify the types of media offered to a student in various situations. However, it is difficult to get a large enough sample of media during a single course to meaningfully make such distinctions.

How to Model

In our first attempts, both the information forming the student model and the adaption logic that determines what materials to present next, and in what format, are located on the HTTP server and are referenced by the CGI programs as needed to modulate the interaction with the student. The browser with which the student is actually viewing the instructional materials simply displays the WWW hypermedia and transmits the forms filled in by the student back to the server and the CGI.

In a restricted, registered class situation this is feasible. In fact, since students may well access the supplemental materials from many different machines on campus, it is probably preferable to keep the user model stored centrally. But it is certainly contrary to the connectionless, free moving nature of the WWW, as well as the way most other people seem to access the web (from one or two machines, e.g. from work and home).

In the near term (five years) I believe that the content model and (to a lesser extent) instructional strategies will continue to be subject-specific. The traditional components of the student model (topic coverage, correct and wrong responses, etc.) are also subject-specific.

But I believe much of the information related to learning styles and media preferences is not subject-specific, and generalizes across many forms of interactive dialog. Thus it seems much more effective to collect and store those components of the user model in the browser, and upload them to each server accessed, as appropriate. This certainly provides a much broader sample for making determinations about media preferences, and is even compatible with the idea of access from several different browser machines (I have different media preferences at work, enjoying a switched ethernet connection, than I do at home at the end of my 28.8 modem).

How to gather this information? We want all of our materials to function with standard web browsers, which means the information would probably have to be collected by the browser. I believe it would be possible to define a set of information about media preferences and collection mechanisms to obtain that information that would be usable by a large portion of the WWW community. It seems less likely that we could reach agreement on a learning styles taxonomy, but perhaps could agree on a format to store information on various learning styles, which could be collected and cached by an applet, and accessed as appropriate. {wild speculation mode on} Perhaps we could even infer something about learning styles from media preferences, or from analysis of facial expressions as people reacted to our interfaces. {wild speculation mode off}

Our group is too small to consider implementing a prototype of such a browser, but would be interested in cooperating with others who might have the resources to do so.

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