USING THE ADAPTIVE NAVIGATION SUPPORT TECHNIQUE OF LINK HIDING IN AN EDUCATIONAL HYPERMEDIA SYSTEM: AN EXPERIMENTAL STUDY

By

MARK DAVID MANN

Bachelor of Arts
Southwestern University
Georgetown, Texas
1987

Master of Arts
Southern Nazarene University
Bethany, Oklahoma
1992

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Dean of the Graduate College

PREFACE

This study was conducted to provide new knowledge about adaptive hypermedia systems (AHMS) and the adaptive navigation support technique of link hiding. AHMS have been shown to increase efficiency in time required to work through a series of tasks, and to minimize wandering through an information space. Specific objectives of this research were to identify (a) the significance of the AHMS and the navigation support technique of link hiding to improve posttest performance on the hypertext markup language competency examination (HTMLCE) which measures student proficiency in the hypertext markup language (HTML), and (b) to identify the extent of the significant differences in means between control and experimental groups who participated in differing learning environments in a series of lessons on the subject of HTML.

I would like to thank my wife, Vera, for her steadfast support of my efforts in this study. I would further like to thank my doctoral committee— Dr. Bruce Petty (Chair), Dr. Sally Carter, Dr. Kouider Moktari, and Dr. Ken McKinley—for their guidance and support in the completion of this research.

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I. INTRODUCTION

In this study, the intent was to show that an adaptive hypermedia system (AHMS) which used the adaptive navigation support technique of link hiding was more effective than a tradtional hypermedia system in teaching the hypertext markup language to prospective preservice teachers. With the rapid deployment of internet access to U.S. public schools, there is a need for teacher preservice training in the area of hypermedia authoring and hypermedia instructional strategies. The investment of millions of dollars for internet infrastructure and the frenzy to provide connectivity to the internet has not been matched by a careful analysis of online materials that are being delivered to students via the internet. Teachers should be equipped to mediate in the process of online learning by providing skills to organize and modify online materials as well as assess learning via online materials. Empirical studies have begun to assist in the process of defining the limitations of traditional hypermedia and to seek to find improvements in current practice. In this study, the author set out to determine if the AHMS technique of link hiding would significantly enhance the delivery of online materials by comparing HTML Competency Examination (HTMLCE) scores of students who studied using both traditional and adaptive hypermedia systems.

In an attempt to improve the effectiveness of hypermedia, adaptive hypermedia systems, which incorporate a user model to help guide a student through a hypermedia space, have been developed. The propensity of getting "lost in hyperspace" (Boyd, 1997) and the lack of navigational aids in hypermedia are the focus of improvements in the design of hypermedia systems that teachers should not only be aware of, but also, experience. Current research in adaptive hypermedia systems (AHMS) which compares the effectiveness of instruction delivered to subjects using traditional hypermedia systems (THMS) versus AHMS has thus far focused primarily upon issues such as the efficiency of adaptive hypermedia to deliver instruction and less upon issues such as posttest performance. Most AHMS research is also confined to the field of computer science. As a result, the content or curriculum delivered via AHMS that has been studied has been curriculum related to the learning of computer programming languages. The broadening of the scope of AHMS research into the realm of education technology with subjects who are preservice teachers is new. Furthermore, the curriculum developed for this study, a nine lesson module on the hypertext markup language (HTML), is also a departure from the traditional use of adaptive hypermedia as a teaching tool for learning programming languages. Although HTML is used by computers in the formatting of text to be displayed by a web browser, it is usually not classified as a programming language, and is generally perceived as easier to learn than a programming language.

This study examined the effectiveness of an introductory course on the subject of HTML authoring presented through both THMS and AHMS. The HTML authoring course was given to prospective preservice teachers taking a course in multimedia at a midwestern US University. The findings of this study answered questions about the value of AHMS vs. THMS in assisting learners in the comprehension of somewhat technical material (the HTML lessons), which this researcher argues has value in the classroom to teach basic programming concepts without exposing the subjects to extremely complicated material. At a more practical level, the findings in this study will assist educators in evaluating implementation, in terms of value and cost, of AHMS vs. THMS for their own hypermedia or “web based” curriculum.

The Internet Gets to the K-12 Classroom

There is evidence to show that "web based" curriculum is expanding in the educational marketplace in geometric proportions. The implications of this growth are just beginning to be analyzed. The information presented in Software Publishers Association's (SPA) *1998 Education Market Report: K-12* indicates the internet is emerging as a viable tool for learning. In recognition of its importance, schools are beginning to move toward greater Internet connections in classrooms and in centralized locations such as libraries and media centers. The penetration of internet access and local area network infrastructure in K-12 schools in 1998 is summarized as follows:

- In 1997-98, more than $2 billion will be spent on accessing the Internet (not including the proposed $2.25 billion from the Universal Service Fund in 1998).
- Sixty-three percent of schools currently have a Local Area Network (LAN) (with more than 88% of all high schools having a LAN connection).

High Schools, which report the highest percentage of LAN connections, are creating an infrastructure which will benefit from lowering computer costs and new set-top box (TV Based Internet Access) technologies which put free web browsers in the classroom. School districts that do not have funds available for network infrastructure and computer hardware on the internal network have viable alternatives to delivering web content to its' students. Low cost internet access devices increase the possibility for a school district to distribute online curriculum to the classroom. The Teknema set-top box is one of the first internet appliances that costs under $300 dollars per unit and offers internet connectivity at a price affordable enough to “plug in” to the existing network infrastructure.

The Opportunity for Hypermedia Collaboration

Because the world wide web: 1) operates with open standards, 2) has nearly free content development costs, 3) is capable of creating dynamic multimedia content, and 4) is viewable through free yet powerful web browsers, there are compelling reasons to base hypermedia authoring efforts on the web using web based technology. With regard to internet based curriculum that will take advantage of the new network infrastructure and web standards such as HTML, it is clear that both commercially and teacher developed hypermedia will inhabit the online curriculum landscape, and provide content for millions of students worldwide.

A common transition to be made by developers of hypermedia content will be from proprietary development platforms to more common world wide web based document standards such as HTML. In the 1980’s and early 1990’s hypermedia systems developed for education were created using proprietary tools such as HyperCard and AuthorWare. Although these tools are effective for creating hypermedia, they have the disadvantage of requiring specialized and often times expensive software for the creation process and then require a separate proprietary product for viewing the hypermedia documents that it creates. Often, these viewing tools are not available for all computer operating systems, and thus, audience is limited in size. In contrast, documents formatted with HTML can be created using free tools such as SimpleText for the Macintosh and NotePad for Dos/Windows. HTML document creators have a known publishing standard, HTML 4.0, which was created by the world wide web consortium to which they adhere when creating HTML documents. This standard, HTML 4.0, makes documents created within the guidelines of the standard viewable across many different computer operating systems. HTML 4.0 compliant web browsers are available at no cost for Macintosh, PC, Unix, and TV Set-Top Boxes. The potential audience for educational hypermedia created with HTML is much greater than a hypermedia environment created with a proprietary authoring system. Furthermore, new multimedia web standards such as, SMIL, (Pronounced “Smile”) are being developed as HTML like languages that will natively work in web browsers and will allow easy integration of video and audio to web pages. Data structuring languages such as XML 2.0 will also become a web standard and will offer means of sharing database information that can be manipulated by the end user eliminating delays and network congestion. The emergence of HTML, to be followed by SMIL and XML will enrich content delivered via the web and drive proprietary standards to be nearly obsolete.

With a common language, HTML, and a common distribution method, the world wide web, the inevitability of vast storehouses of curricular material available on the internet is clear. At this time, there are already several widely visited sites on the world wide web that are collection points for teacher contributed curriculum lesson plans and materials. Thus, with the presupposition established that hypermedia authors have a great advantage by using HTML and should use web based technology for ease of distribution and extreme cost savings, we will briefly look at educational hypermedia’s future markets in terms of web based curriculum created by the professional software developer and by the professional teacher.

Professional Web Based Hypermedia Authors

Once again to emphasize the magnitude of the question of AHMS vs. THMS and the necessity to migrate research ideas that have historically been relegated to the field of computer science into the realm of education technology, we need only look at the projections that professional educational market research agencies make regarding hypermedia and "web-based" online curriculum. Cowles/Simba forecasts that sales of subscription-based online curriculum supplements will grow at a compound annual rate of 32.5% from 1997-99, reaching $17.6 million in 1999, the fastest growth of any segment in the educational software market. "While revenues are small compared to other segments, the online curriculum market is poised to explode," said Al Branch, Jr., editor of the Cowles/Simba newsletter, Electronic Education Report, and lead author of the report. "Over the next year or so, more and more schools will have completed their Internet wiring projects, and those schools will be looking for safe, branded instructional content over the Web." (Branch, 1998). What remains to be seen, however, is whether online curriculum will be structured as adaptive hypermedia which incorporates student models of known knowledge of the content domain into the nodes displayed to the user. Or, if online curriculum will be modeled after traditional hypermedia which more closely resembles an ordinary website. In practice, to prevent teachers or school boards from committing curriculum dollars to inferior products, teachers must be informed about the advantages of adaptive hypermedia so that they can make educated choices about the online curriculum they purchase. Or, preferably, to better equip teachers who may choose to develop their own adaptive hypermedia projects.

Teachers as Web Based Hypermedia Authors

As teachers gain hypermedia authoring skills in order to create web based content, teacher created hypermedia, authored with HTML, will resemble and potentially surpass "professional" educational software packages. This transformation will occur among teachers who undergo training and grasp the essentials of HTML documents and then, go the extra pedagogical step and implement adaptivity into their online curriculum to create an adaptive hypermedia system (AHMS). There are steps that have to be taken in order for AHMS projects to be implemented successfully in the K-12 environment. Researchers at the Apple Classroom Of Tomorrow (ACOT) have identified five stages of instructional change that occur gradually as a result of transforming the technological aspects of the learning environment. These include:

1. Entry- Educators struggle to cope with the change of the learning environment.

2. Adoption**-** Educators move from the initial struggles to successful use of technology on a basic level (e.g., correlation of drill and practice software to classroom instruction).

3. Adaptation**-** Educators moved from basic use to discovery of its potential for increased productivity (e.g., use of word processors for student writing).

4. Appropriation- Having achieved complete mastery over the technology, educators use it "effortlessly" as a tool to accomplish a variety of instructional and management goals.

5. Invention**-** Educators are prepared to develop entirely new learning environments that utilize technology as a flexible tool. (Branch, 1998)

As teachers become more familiar with the aspects of hypertext and get familiar with hypermedia design, they will proceed across the stages that the ACOT has outlined above and begin to explore the ideas of adaptive hypermedia. A key point made by a study from the Software Publishers Association is, "Professional development is key to utilizing technology in education. Although technology use continues to grow in schools, educators still lack sufficient training on incorporating technology into the curriculum." A Market Data Research survey confirms that so far as teachers are concerned, internet training has not reached them. The MDR survey reports that 80.5% of ten thousand teachers surveyed cited insufficient teacher training as the primary obstacle to Internet use. (Karnes, 1997). Obviously, there is a large gap that must be traversed. This study presumes that training will occur, not only for internet use, but also for internet publishing. The role that hypermedia, and particularly adaptive hypermedia, play in the training of teachers will be as an important tool to facilitate effective internet use in the classroom and unleash the inventiveness and creativity of teachers.

Purpose of the Study

This specific purpose of this study was to apply quantitative methodology to the adaptive hypermedia technique of adaptive navigation support. The study attempted to determine if an adaptive hypermedia system using the adaptive navigation support technique of link hiding would significantly improve posttest scores of the prospective preservice teachers on a series of nine lessons on the subject of html. A quasi-experimental study was conducted using a posttest only control group design where a traditional hypermedia system (THMS) and an experimental adaptive hypermedia system (AHMS) delivered the material of the HTML lessons. The lessons consisted of beginning, intermediate, and advanced topics on the subject of HTML. The process of transforming a THMS into an AHMS involves a significant restructuring of the way the information in a hypermedia system is designed and delivered. Results of this study should be conclusive enough to alert the educator to the value of an AHMS to engage the learner, and as a result of this engagement, produce higher quality results for learners who have opportunity for an online learning experience.

Research Questions

In this study, two groups, a control group using a traditional hypermedia system (THMS) and an experimental group using an adaptive hypermedia system (AHMS) with the adaptive navigation support technique of link hiding, were instructed using nine lessons on the subject of HTML. Participants were given a posttest examination, the HTML Competency Examination (HTMLCE).

Null Hypothesis

There is no significant difference between the average mean scores of both the experimental (AHMS Treatment) group and the control (THMS) group on the Hypertext Markup Language Competency Examination (HTMLCE).

The first statistical task, using Pearson r, was to see if the subjects of the experimental and control groups had an equivalent base knowledge of HTML prior to participation in the html lessons. The next step, using the t-test, was to calculate the difference in the average mean scores of the two groups. The t-test determined whether the differences measured between the means of the control and experimental group on the HTMLCE Posttest were significantly different and could be attributed to the treatment given to the experimental group.

Significance of the Study

Within the community of educators, the world wide web has been seen as an information resource and a tool for collaboration and publication. On this basis it has been enthusiastically used in classrooms, but its full value as a teaching medium for individual instruction has yet to be realized. A key component in the transformation of the web into achieving its full value as a teaching medium will be the development of adaptive hypermedia systems which can adapt to specific users and guide them in the learning process.

Kay and Kummerfield (1994, [HREF 1]) note that "Hypertext Systems such as the World Wide Web hold great promise as a vehicle for delivering self-paced instructional material". The web's first great step to prominence came with the application of a hypertext based graphical user interface to the Internet. The second great step, which is giving the Web intelligence, i.e. the ability to "understand" the user, to customize information and presentation, and to dynamically support navigation is the next significant leap. It will move the web from a popular entertainment medium to one which is a valuable teaching mechanism in its own right. In terms of research, this study investigated the power inherent in adaptive hypermedia to improve comprehension through customization. The particular customization employed was with adaptive navigation support (ANS), and the ANS technique of link hiding. Any adaptive hypermedia system (AHMS) which employs either adaptive navigation support (ANS) or adaptive presentation (AP) must inevitably support claims of effectiveness through empirical evidence. To date, experimental studies have not been produced to support the direct connection between the ANS technique of link hiding and the teaching of the subject of html. A significant difference of means on tests of html competency (between experimental and control groups) challenges the status quo in educational technology curriculum which use traditional hypermedia systems (THMS) in the classroom for instructional purposes.

Definition of Terms

Adaptive Hypermedia System- AHMS

A hypermedia system is a complex piece of software, consisting of several parts which serve different purposes. In a web based AHMS, we can distinguish for instance:

1. *The Presentation Level or user interface* is the World Wide Web Browser. In this study Netscape Communicator 4.04 is the browser that will be used.

2. *The Hypertext Abstract Machine, serving nodes and links*. The World Wide Web Server is also referred to as the HTTP server. HTTP stands for HyperText Transfer Protocol. In this study the webserver used is WebTen by Tenon Systems and Microsoft Internet Information Server.
3. *The Database level, providing efficient storage and retreival of data*. Data collected from different nodes in the hypermedia system goes into the persistent object database of Interaction/IP version 2.1, or to a text file using a microsoft frontpage “bot”.

Anchors

In most hypertext systems all links are *directed*, so they have a source node and a destination node. Usually the link is connected to a small portion of the source node, a word, a phrase, a picture, ... This part is called the *anchor* of the link. The anchor is usually distinguished visually from "normal" content. The text may be underlined or appear in a different color (or both). An image may have a colored border to indicate it is an anchor, etc. The anchor is tied very closely to the designated part of the (source) node.

Bookmarks

Unlike the cluttering or defacing of a paper book, a hypertext system lets users mark nodes, by putting a name in a list of bookmarks, doing no damage to the document itself. This bookmark name can be a system-defined name or a name the user can choose. Most hypertext systems do not display the list of bookmarks unless you ask for it, so the bookmarks do not hinder the reading process. The ability to add a bookmark and to jump to the indicated node at any time is beneficial to the online learner. Browsers for the world wide web save bookmarks as an html file, so that the bookmark node can be used like an ordinary node in the hypertext document.

Databases

In order to efficiently store large amounts of small data items, *database systems* were developed. A database system groups data items together, using hierarchical or relational structures, and moderates the requests for concurrent access to the data items which it groups into a single file, a set of files, or one or more disk partitions. While file systems are typically incorporated into the computer's operating software, database systems are not. Typically a database system will not allow read access to a single data item while that item is being updated. Object-oriented database systems promise a solution to this problem. Programming languages such as Lisp's Common Lisp Object System (CLOS) have object oreinted data structures inherent to the language that can be used as a storage layer for an adaptive hypermedia system.

Links

A hypertext *link* connects two nodes, and is normally directed, meaning that it has a *source node* and a *destination node*. Normally, a link is associated with a specific part of the source node, like a word, phrase or picture. This part is called the anchor of the link. The destination is the entire destination node. In some hypertext systems it is possible to designate a part of the destination node as the destination. We then talk about a *source anchor* and a *destination anchor*.

Lost in Hyperspace

Many hypertext researchers refer to the problem of disorientation. Nielsen (1990) has verified this problem with users of relatively small hypertext documents (showing that it is not solely a problem with giant hypertext documents). The "lost in hyperspace" phenomenon is a combination of two problems: 1) once the user finds an interesting node with information that is of value, the user must read the information carefully because they fear they may not be able to find it again later. 2) while browsing the user gets confused about where he or she is located in the document structure.

Markup Languages

Hypertext documents are made up by text interspersed with "markup" commands. Some document-processing or hypertext systems use a binary format, not readable by humans. Microsoft Word and WordPerfect are examples of these two kinds. Other systems use a human-readable form of markup, which uses special symbols to denote the markup. A commonly accepted standard for human readable markup languages is SGML, the Standard Generalized Markup Language, an ISO standard. There are two hypertext markup languages that use the SGML syntax: *HTML*, and more recently, a new markup language has been introduced, as a simplified version of SGML: XML (for eXtendable Markup Language).

HTML is the standard that is used in the World Wide Web. It is now standardized by the World Wide Web Consortium. HTML is a language built on formatting constructs that can be divided into logical units of beginning, intermediate, and advanced concepts. Using Gagne's principles of Instructional Design, nodes which teach html are organized hierarchically in this study. XML is deemed the successor of HTML. While the set of available tags in HTML is fixed, XML allows for the definition of new tags. Browsers can be informed about how to present these tags through style sheets.

Nodes

The information in a hypertext document is divided into pieces, called *nodes.* Each node should form a unity. Especially when converting existing (paper) documents into hypertext, the decision what information to put into a single node is the most difficult one. There are no general rules for the ideal size of a node. Some systems provide nodes of a fixed size. Some provide nodes consisting of several "pages."

Node Size

An experiment with students at the University of Maryland compared a single text, presented in two ways: as 46 short articles ranging from 4 to 83 lines, and presented as 5 articles of 104 to 150 lines. Readers were asked to answer multiple choice questions during a limited time. The readers of the short articles needed less time to answer more questions correctly than the readers of the longer articles. In large hyperdocuments cutting the nodes into smaller pieces makes the structure more complicated, thereby also creating browsing problems. To correct this problem, adaptive navigation support is needed.

Scripting

The World Wide Web provides no scripting language, but its HTTP servers may execute external programs. Scripting that is executed by the Server is known as Server side scripting. This study depends almost exclusively on Server Side scripting for the adaptive hypermedia components. Common Lisp Scripting is made possible by the Interaction/IP server plug-in. Client-side scripting is scripting that takes place on the web browser without requiring a data “trip “ back to the server. Different WWW browsers offer different scripting languages of their own. Netscape created Javascript, a scripting language with a syntax similar to that of the Java programming language. JavaScript is used in this study to validate form field input prior to sending form data to the server.

Uniform Resource Locators

A Uniform Resource Locator, or URL, is a unique name that identifies a part of a node somewhere in the world. In the World Wide Web the standard protocol is http, the HyperText Transfer Protocol. However, other protocols such as gopher, ftp and telnet can be used with most browsers as well. The destination anchor must be defined in the node. So only parts of a node that are indicated by the author can be selected.

The syntax of a URL for the World Wide Web is:

protocol://host:port/nodename#anchorname

The complete syntax description for URLs can be found in two standard documents: rfc1738 for absolute addresses and rfc1808 for relative addresses.

User Modeling

All adaptive hypermedia systems (AHS) need to store some knowledge they have about each individual user, in order to use that knowledge to adapt the information to each user. Such a *user model* may contain information about very different aspects of a user, including: domain knowledge, goals and interests, background and experience, and user preferences. A common technique for storing all these kinds of aspects of a user is a *set of attribute-value pairs* that can be collected from an HTML form.

User Models of Domain Knowledge

In an AHMS the *domain model* consists of a set of *concepts or lessons*. The user learns about concepts by reading about them and/or by taking tests or performing assignments. There can be a one-to-one correspondence between concepts and nodes (a "fine grained" approach), but a single concept may also correspond to a large set of nodes (a "course grained" approach). In this study, the “fine grained” approach is used in the concept mastery quiz which follows each of the first five lessons of the HTML lessons for the experimental group that uses the AHMS. De Bra (1997) points out different techniques (value sets) that are used to model a user's knowledge about a concept: In the *Boolean* model a concept is either known or not known by the user. This approach is only usable with a fine-grained user model: each time a user reads a node, the concept that corresponds to that node becomes known. The HTMLCE (used for this study) uses the Boolean model to capture data about the users domain knowledge for particular nodes as they are studied.

World Wide Web

World Wide Web (or WWW or Web for short) is a very large hypertext, consisting of many thousands of information servers, located all over the world, on Internet hosts. The World Wide Web Consortium (W3C) provides a lot of information on the technology used in WWW, and on the latest developments in web related standards. The W3C publishes reference material on HTML, including a definition of the evolving html standards: HTML 2.0 (1996), HTML-3.2 (1997), and HTML-4.0 (1999). All documents (nodes) in the World Wide Web are written in the same generic markup language: HTML. The basic elements in HTML are *tags*, which give meaning to the text embedded within the start and stop tags. For instance, all nodes of the HTML Lessons have a "title" tag, coded as:

<title>CoolTutor.Com Lessons</title>.

All HTML commands must go inside the brackets < and >, except for special characters, for which an ampersand is used. For instance, ë is a code that generates the ë symbol.

The most important HTML tag is the *anchor*. An anchor is the starting point for a link to another node. HTML allows for links to other HTML nodes, on the same

computer or any other Internet site, and also allows for links to other information services, like the popular file transfer protocol (FTP) servers.
The anchor for the link leading to this node looks like:

Mark's Dissertation.

This is a simple anchor leading to a node that is located on the same computer as the previous one, and even in the same directory. More complicated anchors may show the complete URL of their destination, which indicates the protocol to use, the Internet host to retrieve the node from, and a complete path for the file containing the node.

II. Review of the Literature

Introduction

The purpose of the literature review is to understand more clearly the motivation for transforming a traditional hypermedia system (THMS) to an adaptive hypermedia system (AHMS). The characteristics of adaptive hypermedia, if understood, can assist the hypermedia author in effectively creating adaptive hypermedia. The adaptive hypermedia system (AHMS) is a complex structure which incorporates theory from a number of disciplines. There are multiple influences on the design and implementation of the adaptive systems: Studies of pedagogically based architectures for computer-based learning environments, learning and cognitive theory, instructional design principles, developments in software tools and methods, and empirical studies about the nature of the user and the effectiveness of the environment, all contribute to AHMS development.

The first area to explore, of those influencing AHMS, is instructional design. Particularly, Gagne's Task Analysis which focuses on precision in the defining of performance objectives which greatly influences instructional design and builds strategies to assess students for "mastery" of material. We then turn to the literature about hypertext to explore the differentiation between regular text and hypertext, and the characteristics of hypertext in the educational context. From the field of hypermedia authoring, we investigate more fully the cognitive skills gained by the student who either experiences or creates hypermedia. To understand the implementation of user modelling in adaptive hypermedia, and to further understand the different types of adaptive hypermedia, we turn to the field of intelligent tutoring systems.

The structure of an AHMS involves the application of user models which allow intelligent adaptation of content and specialized delivery of information to the user, i.e. an intelligent tutoring system. With the inclusion of instructional design principles informed by mastery learning, the content domain of an adaptive hypermedia system can be designed with prerequisite based modules that are properly sequenced. Taking full advantage of the tools of the world wide web, and the hypertextual environment of the web browser, a user interface can be designed that is both simple and elegant. This is the primary message of the review which is undertaken of the pedagogic domain concepts introduced in HyperTutor. Hypertutor introduces important concepts in user modeling and ties together schematically the different pieces of an adaptive hypermedia system.

Along with HyperTutor, other previous empirical studies which examine the effectiveness of adaptive hypermedia systems will be investigated. It is suprising to find that there are not yet many empirical studies which deal with adaptive hypermedia systems and adaptive navigation support techniques. The few studies that do exist, however, provide guidance for statistical and research methodologies that can be employed. The analysis of MetaDoc by Boyle and Encarnacion confirm the increases in reading comprehension scores and decreases in search and navigation time that can occur using the adaptive presentation technique of text adaptation. Groundbreaking work by Kaplan (1993) and Brusilovsky (1994) on HyperFlex and ISIS-Tutor respectively, highlight benefits of Adaptive Navigation Support through link sorting, link hiding, and link annotation.

Individualized Instruction

One of the most interesting aspects of collaborative hypermedia authoring is the revision process that a hypermedia space undergoes over time. The implementation of an adaptive hypermedia system requires revision of hypermedia to include a user model to collect data about the student using the system. However, before examining individualized adaptivity in relation to adaptive hypermedia, some general thoughts on adaptivity are offered.

A characteristic of teaching excellence is the understanding of the value of adaptability, which is the ability to adapt to specific needs and knowledge levels of individual students. To effectively present information to the student based upon the comprehension level that the student using the hypermedia space possesses requires a tremendous amount of planning and effort. A mastery of the subject matter, as well as comprehension of student capabilities and recognition of a student's readiness to learn, are among the essential components of effective teaching. Preventing cognitive overload, a primary cause of student disorientation and apathy, is another important goal of effective teaching.

Knowing the value of adaptability is not enough, however, to carry out the task of meeting the needs of all students in the classroom environment. Time with students for one-on-one interaction is an additional ingredient required to adapt curriculum to an individual student. In the current U.S. public education system, there are factors which contribute to the lack of individualized instruction time. An increase of student to teacher ratios in many school districts is a simple mathematical reason for a decline in individualized instruction. Furthermore, upon examination of the mandate that teachers have to meet the goal of covering all of the material in a given course, we recognize the conflict that exists between the necessity to deliver all of the curriculum to the students, and the need to pause for individualized instruction, to help those in the class who do not "get it." If the teacher pauses too often to help those who may only lack a solid foundation in the topic at hand, then, the teacher runs a risk of falling behind in the "delivery" of curriculum.

In traditional instruction, the bell curve which plots grades as frequency distributions, students and teachers expect that only a few will receive an "A" in the topic or course. Gagne (1988, p.43) observed that these expectations fix academic goals at low levels and reduces both student and teacher motivation. Gagne (1988, p. 247) describes the particular educational practice that produces these effects as "group-paced" instruction, in which all students must try to learn at the same rate and by the same mode of instruction. When both pace and mode are fixed, the achievement of each student becomes primarily a function of his/her aptitude. However, if either pace and/or mode of instruction can vary among learners, the chances are that more students can become successful in their learning. (Bergeron, 1997, p.124). Modularized and Individualized instruction, presented in adaptive hypermedia can address the problems of pace and to some extent (depending on alternative modes available) learning style differences. Gagne contends that if proper conditions can be provided perhaps ninety to ninety five percent of the students can actually master most objectives now only reached by "good students." (Gagne 1988, p. 247).

Another consideration, when looking at the role of adaptive hypermedia to assist teachers in providing individualized instruction is that such tools may prevent teacher burn-out in U.S. public schools. Because teachers are often evaluated by administrators based upon student performance, the daily pressures that build in the workplace can lead teachers to an early exit from the educational system into alternative career paths.

Unique Opportunities for Instruction via AHMS

Technology has long been offered as a solution to the problem of the lack of individualized instruction in the classroom. Accompanying the commercial deployment of radio, television, and computer technology have been educational technologists with products that were supported by research, tested in the classroom, and launched nationally. Nevertheless, although pockets of success stories have surfaced with the accompanying acclaim and notoriety associated therewith, the general way in which technology has been used in the classroom has yet to profoundly change the way most daily interaction occurs in the classroom setting. This is not to say that neither radio nor television technologies have not made profound changes and tremendous impact in hundreds, if not thousands of classrooms across the United States. They most certainly have. Had the educational television landscape in the 1960's classroom had the capabilities where all classrooms could broadcast to one another 24 hours a day as can be done via internet multimedia technologies, a different impact would have been felt at that time. Today, the scale and penenetration of internet technologies has created an unprecedented open channel for interactive multimedia, manifested initially in hypermedia and further in adaptive hypermedia.

Task Analysis

With task analysis, the foundational work for creating AHMS can begin. In the context of developing a user model for an adaptive hypermedia system, learning concepts can be divided into beginning, intermediate, and advanced categories where concept mastery prerequisites are required for entry into intermediate from beginning, and advanced from intermediate levels. One of the most common techniques in designing lessons for computer instruction is that of *task analysis*. Task analysis is a theory developed by educational psychologist R. Gagne (1977) as a general procedure for designing effective lessons, and is a top down procedure well suited to the needs of computer instruction. Task analysis involves the process of repeatedly dividing teaching tasks into simpler components called subtasks. Once a set of subtasks has been obtained, instructional objectives can be summarized, and the actual design of the adaptive hypermedia components can begin.

Gagne defines a key component to designing effective lessons as the ability to have precision in the creation of objectives. (Gagne, p. 123) An instructional designer should define the capability sought, and state a defined observable action when creating performance objectives. To further elaborate, performance objectives should include five components: 1) The situation in which the content is to be learned. 2) The Learned Capability Verb [LCV]. 3) The Object which describes the Learned Capability. 4) An Action Statement, and 5) any constraints that are part of the learning objective. Standard Learned Capability Verbs to describe human capabilities include [discriminates, identifies, classifies, demonstrates, generates, adopts, states, executes, chooses] For Gagne, the correct LCV is determined by the type of Action the performance intends to describe. Whether the capability is an Intellectual Skill, Cognitive Strategy, Verbal Information, Motor Skill, or Attitute determines which is the proper LCV to use in the performance objective. Gagne further defines subcategories of intellectual skills as that of Discrimination, Concrete Concept [identifies], Defined Concept [classifies], Rule [demonstrates], and Higher-Order Rule [generates].   An example of employing this method to create a learning objective would be:

> {Situation} Given an illustration of three plane figures, two the same and one different, the student {LCV} discriminates {object} the figure that is different {action} by pointing to it {constraints} within thirty seconds.

A complementary result of specifically defined performance objectives is clearly identifiable assessment of the student's learning of the material. Gagne created a phrase for assessment called, " objective-referenced assessment." The method of objective-referenced assessment is to build tests that directly measure the human performances described in the objectives of the course. "Such measures of performance make it possible to infer that the intended performance capability has indeed been developed as a result of the instruction provided." (Gagne, p. 243). Thus, In terms of continuity between objective and test validity, Gagne argues that the objective-referenced orientation to assessment greatly simplifies the concept of validity in performance measurement.

> This approach to accessment results in a direct rather than an indirect measure of the objective. Thus it eliminates the need to relate the measures obtained to a criterion by means of a correlation coefficient, as must usually be done when indirect measures are used or when tests have been constructed without reference to any explicit performance objectives….Validity is assured when the assessment procedure results in measurement of the performance described in the objective. (Gagne, p. 245).

The objective-referenced assessment instrument is valuable to adaptive hypermedia. Since similar tests can be given prior to the instruction, adaptive hypermedia has provisions which allow students to bypass instruction they do not need. The verbs [LCV and action] used to describe objectives are equally crucial as a basis for planning the performance accessment in both the pre and post tests. The capability verb is the intent of the objective and the action verb is the indicator that the intent has been achieved by the learner.

Hypertext

The task of transforming traditional printed text curriculum into an AHMS is an objective whose success depends upon understanding the dynamics and characteristics of the new environment. From the educators perspective, effective design of adaptive hypermedia is best carried out by understanding the essential components of a hypermedia system. With the delivery of information based on the world wide web (a hypertextual environment), there are comprehension issues which should accompany the deployment of hypertextual information to any student population. Hypertext, whose literature historically has termed pages as nodes, is characterized as a node-link structure and is most often not read in a linear manner as is conventional text. Nielson (1990) describes hypertext as a means of flexibly organizing and presenting information. By clicking on hotlinks on a website, users “navigate” contextual connections. The contextual nature of logically related nodes raises new issues about the model of learning on which hypertext, and a hypermedia system is based. In this study, principles embodied in the design and the implementation of a hypertext-based system made to maximize learning with an “expert-system overlay” will be explained, evaluated, and compared to a hypertext system which uses a more learner directed navigational approach.

Text takes on a second dimension in the hypertext environment. Pages of information are no longer organized in a straight line linear format, where information is read from top to bottom. Instead, hyperlinks enable texts to be organized by thematic association and/or with semantic structures. In the 30-year evolution of hypertext, scholars and practitioners have addressed the strengths and weakness of hypertextual environments and attempted to provide additional tools to assist users who navigate the hypertextual spaces. Largely, the groundbreaking work of Metadoc introduced hypertextual spaces to the third dimension of hypertextual environments, which attempts to allow the computer to deliver hypertext content to a user based upon the model that the computer has of the user at any particular moment of the interaction between the user and the computer. To work with, and teach from, curriculum that is based online, it is essential that one understand the theoretical foundation of hypertext and the changes that have occurred within hypertextual environments over time. This third dimension to hypertext allowed the computer to make choices "on behalf" of the student as he/she progresses through a given body of material or content domain. These type of hypertexts are generally characterized as teacher centered or teacher directed.

Hypertextual analysis and design is not a new field of research. Far before the World Wide Web became a reality, the study of effective hypertextual design was in full swing. John Ecklund, Australian Scholar, and a leader in the adaptive hypermedia movement declares,

> "Hypermedia usability research developed long before the Web arrived. New technologies - such as adaptive hypermedia systems - have been developed in response to problems observed in hypermedia use. Applying the research findings in closed corpus hypermedia to the broader domain of the Web is a logical step, and one in which navigational issues are emphasized." [HREF 2]

It has been suggested by Ibrahim and Franklin (Brusilovsky, 1997, p. 57) that the pedagogical use of the Web can evolve along two major axes: a closed body of material where the technology is used mostly for its hypermedia and distance delivery capabilities, or an open corpus approach which exploits the enormous amount of information that is accessible via Internet, whether or not it has been put there for educational purposes. In this study, we focus on adapting hypertext to present information in different ways to different users.

Hypermedia Systems

There are two primary areas of focus in the body of literature on HMS as they related to the educational classroom setting. The first is Hypermedia Authoring, which focuses upon the educational benefits of participation in a hypermedia authoring project. The second area of focus deals with effective use of existing hypermedia systems.

Hypermedia Authoring

The literature on hypermedia authoring can be summarized as focusing upon qualitative studies that emphasize the benefits of the collaborative authoring of hypertexts. Such studies take a more global view, often relegating the nuts and bolts of hypermedia authoring, html coding, to a secondary focus. Overarching design issues which deal with the internal structure of the HMS and the representation of the content imposed on the hypermedia (HMS) through the sequencing of the nodes and links is the primary focus of studies which deal with link authoring (Bergeron, 1997). Bergeron discusses the partitioning of web pages into concept-related nodes in which the concepts are logically ordered and linked by an expert who imposes his understanding of how learning is sequenced in the domain. Jonassen & Wang (1993) have conducted studies comparing the link mapping in a HMS of novices who tend to organize links according to easily recognizable similarities such as terminology, with a HMS of experts who use a more hierarchical structure with a greater number links between similar concepts and fewer links between clusters of different concepts.

Effective Use of Hypermedia

The second area of focus in the literature dealing with hypermedia systems looks at the value of existing hypermedia systems to present information to the learner. The literature about effective classroom use of hypermedia can be separated into two categories, the open corpus hypermedia and the closed corpus hypermedia. An example of an open corpus hypermedia would be the World Wide Web itself. Studies in this area typically highlight learning skills that are enhanced by the discovery based learning that is required by navigating the hypermedia to relevant information. Literature about closed corpus hypermedia is more relevant to this study and will be examined in detail.

Both open corpus and closed corpus Hypermedia Systems (HMS) can be learner centered environments where the decisions made in the navigation of the hypertext are made by the learner. Students move from one website to another gaining information as encountered in an unstructured manner. Proponents of a THMS state that THMS offers learners complete control over the viewing of the material, within their navigational abilities. It is a cognitive tool, allowing students to explore and make sense of a knowledge corpus, "constructing" meaning in a self motivated and self directed fashion (Jonassen, 1992).

Critics of Traditional Hypermedia Systems (THMS) are quick to point out; however, that not all students possess the same navigational abilities. A common thread of criticism about a THMS from the reader learners perspective is that there is a lack of navigational assistance available in a THMS system to the students who need it the most.

(Linard & Zeiliger, 1995, [HREF 3]). Duchastel (1992) goes so far as to say that a THMS is predominantly a non-pedagogical technology in which learning relies on the users interest and purpose through the use of a variety of navigational aids in a database of hyper linked information.

There is a growing body of empirical evidence to suggest that learners tend to make poor decisions in learner controlled systems (Jonassen, 1990; Jonassen & Wang, 1993). In THMS systems, students become lost, skip important content, choose not to answer questions, look for visually stimulating rather than informative material, and use the navigational features unwisely. Furthermore, where the hyperspace is very large and when the system is likely to be used by people with unequal knowledge of the content domain, the risk of unproductive wandering in the link network is very high. Spyglass Technologies recently collected data on student's use of open corpus hypermedia (the World Wide Web) and found the majority of sites downloaded to the school network were entertainment related.

In summary, THMS's are a passive environment that does not "know" the knowledge state of the user. There are weaknesses in internally structured THMS, which strengthens the case for a more dynamic external structure to be applied to the THMS. The Adaptive HMS (AHMS) should account for specific knowledge and tasks of an individual user.

Adaptive Hypermedia Systems

In contrast to THMS based website design, in the Adaptive Hypermedia System (AHMS), the primary presupposition is that definitive assistance in website navigation is necessary for hypermedia to be effective. Educators (de La Passardiere & Dufresne, 1992) have suggested that a HMS with a form of expert assistance or guidance, perhaps as individualized navigational advice or help sequences would provide more structure to the information space and more direction for the user to help solve these problems of disorientation. Brusilovsky [HREF 4] provides two main categories of features which can be dynamically adapted in an AHMS: Adaptive Presentation (AP) and Adaptive Navigational Support (ANS). Adaptive Presentation (AP) works at the content-level. The information contained in the hypermedia nodes (or pages) can be presented in an adaptive fashion, to vary the detail, explanation, or media use (text, graphics, sound). Adaptive Navigational Support (ANS) works at the link level and modifies link-anchors (hotlinks in hypertext) using several mechanisms to provide guidance and navigational support.

Methods and techniques for adaptive navigation support

According to Brusilovsky, adaptive navigation may be implemented in a number of ways (Brusilovsky, 1995): These are: direct guidance, reordering of links, adaptive link hiding, adaptive annotation, or map adaptation. Direct guidance is a technique with its roots in Intelligent Tutoring Systems (ITS) research. On the basis of the user model, the system decides what is the best next node for user's visit; the "best next link" can be either one among those of the current page (and then it can be outlined) or a dynamically generated link, usually a "next" button, which is added as a complement of the current page.

The link re-ordering technique sorts the available links on the basis of information contained in the user model, displaying the most relevant links on top. There has been criticism of the link-reordering technique due to the effect that it has on novices. The changes in the ordering of links disrupt consistency in nodes, and can cause navigation problems for the beginning user.

Link hiding is currently the most frequently used technique for adaptive navigation support. The idea is to restrict the navigation space by hiding links that do not lead to "relevant" pages, i.e. not related to the user's current goal or not ready to be learned. All kinds of links can be adapted according to this scheme by real hiding or by displaying hot words as normal text (also known as “Soft Link Hiding”). Hiding can help to support both local and global orientation to the content that is being studied. Local orientation is achieved when, by limiting the number of navigation opportunities to reduce cognitive overload, it enables the users to focus on analyzing the most relevant links. On the other hand, by hiding links the size of the visible hyperspace is reduced and thus, global orientation is simplified. (Soft Link Hiding is the Adaptive Navigation Support (ANS) technique that will be employed in the study.) The individualization of information (adaptive presentation) and the providing of navigational support (adaptive navigation) are performed within an adaptive hypermedia system on the basis of information that is kept in the student model.

Student Modeling Techniques

The student model can be based upon a number of characteristics of the learner. The students’ learning goals, knowledge level, or learning style preferences can be the basis for collecting data in a user model. Beaumont (1995, HREF 5) classifies two types of acquisition of knowledge about the user, implicit and explicit. Implicit information is information gathered by the adaptive hypermedia system by means of the system’s information tracking capabilities. A good example of a collection of implicit information about the user in the context of the World Wide Web is the history list, which is collected by the document object container of a web browser. There are programming techniques that easily allow capturing of history list information into a user model without the users intervention. This information can be used to adapt a website based upon the users prior visits to other pages within the website. Explicit information is information that is manually entered by the student as a direct answer to a request for information. Judd (1997) favors the explicit method for getting information from the student, "Not only do we get instant reliable feedback on the user's understanding… we enable the system to respond with all available pedagogical strategies, i.e. a wrong answer can result in comments or additional questions from the system." Gagne's task analysis approach to designing curriculum would consist of explicitly questioning the student at the start of the session, and again after the material of each instructional objective has been covered.

A second case of user modeling which employs the link hiding method comes from the work of Calvi and DeBra (DeBra, 1997, p.224-225). DeBra's use of the Adaptive Navigation Support (ANS) technique, link hiding, can be described as follows: The user model determines which documents are available to a student. A new student can access basic concepts, that have no prerequisites. Acquiring basic concepts enables the student to consult documents related to more advanced concepts. Associated to the is prerequisite of relationship between two concepts, there is a threshold, that represents the minimal level of expertise a student must have attained on the prerequisite concept in order to access the more advanced concept. DeBra's notion of "acquiring a concept" means to get a level of expertise for it that is equal or superior to the associated threshold value. The documents accessible to a particular student are called relevant documents. Relevant documents are those that explain a relevant concept. Additionally, among all documents referring to relevant concepts, the system chooses those having a difficulty level considered to be appropriate for that user at that particular instant. In practice, when appropriate documents are recalculated, the result is shown in the user interface. Links to 'too easy' documents are removed from the screen while links to more difficult documents - which have just become 'appropriate' - are added to it.

The Pedagogic Domain

HyperTutor (Perez, 1995) is an adaptive hypermedia system which offers an excellent schematic of the structure of adaptive hypermedia, and explains the idea of relevant documents more clearly. Literature about HyperTutor discusses the pedagogic domain of an AHMS. "Each concept of the pedagogic domain has attached information that organizes it from a pedagogical point of view, and that makes the teaching-learning process simple, clear, and efficient. This information includes the concept's intrinsic learning difficulty, relationships with other concepts, different perspectives for teaching a concept, etc…" (Perez, p.3) In this research study of AHMS, the software programmatically constructs pedagogic relationships among nodes based on difficulty levels. Perez creates organizational structure he refers to as Curriculum Decision Rules (CDR's). CDR's are used to decide which new concepts should be accessible via the hyperspace. The main parameters of CDR's are (1) the pedagogical relationships, (2) their difficulty level (expressed in the Pedagogic Domain), (3) known concepts, and (4) the student learning characteristics. (or mastery level.)

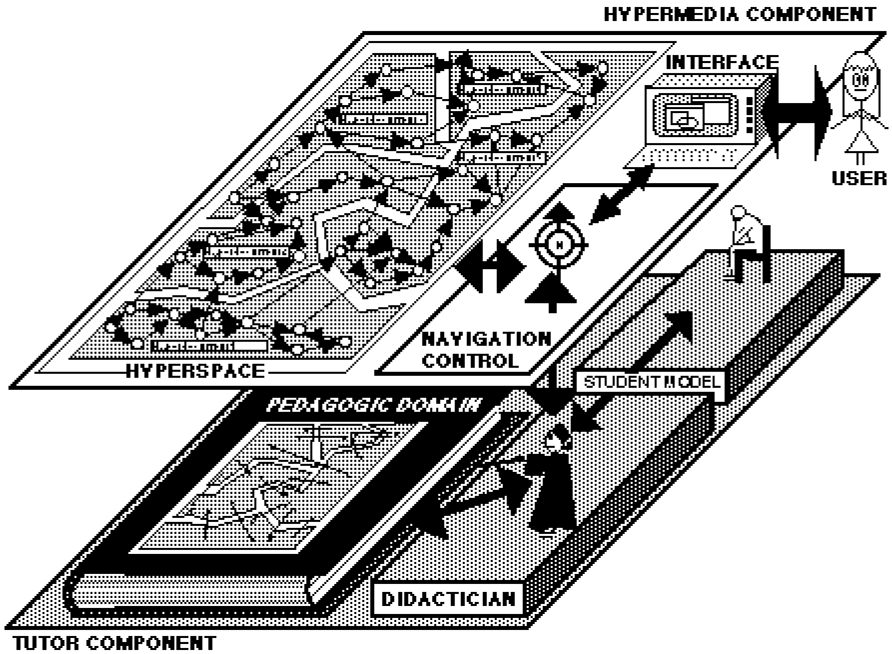

Figure 1. The Perez Hypertutor Model

The above illustration by Perez reflects the elegance of the Perez AHMS. The apparent complexity is hidden from the user, who as a result of the AHMS, sees a simpler navigation space via navigation controls which limit clickable links into hyperspace to only relevant links, and adapts text to the skill level of the user. The AHMS methodology in practice curtails concerns about a student getting “lost in hyperspace” and being unproductive with their learning time. Like Perez, Gagne has given a method to didactically create a set of objectives that can skillfully assist in the division of a content domain into identifiable prerequisite components. These components can then be put in a pedagogical framework of if-then constructs that can interact with a user model that tracks a user’s progress.

The debate over the value of AHMS

In the discipline of computer assisted instruction, the desirability of building user models and adaptive hypermedia systems has been the subject of debate. Lesgold (Brusilovsky, 1998, p. 75) mentions two opposing groups. The “model builders” who consider detailed user modeling essential in individualized Computer Assisted Instruction, and the “model breakers” who question both the feasibility of constructing adequate user models and the benefits of using them. Perkins (1986) classified as a “Model Breaker,” believes that complex user models don’t necessarily produce corresponding gains in teaching efficiency. The “model builders,” however, have begun to construct empirical evidence which suggests that user modeling and adaptive hypermedia systems can increase comprehension of content and reduce the learning time required to master a content domain. It is the goal of the “model builders” to enhance the case for Adaptive Hypermedia Systems.

Previous empirical studies that are relevant to adaptive hypermedia

Although the number of methods to employ adaptive hypermedia are several, there are a relative few number of reported AHMS’s that have been validated by a special study. In this section we will review the most important reported studies to date.

Evaluation of an Adaptive Presentation Technique

The most comprehensive evaluation of adaptive presentation in hypermedia was performed by Boyle and Encarnacion (Brusilovsky, 1998 p. 42) with their system MetaDoc. The goal of the experiment was to compare three kinds of hypertext: normal hypertext, stretchtext (i.e., hypertext extended with stretchtext functionality), and adaptive stretchtext in the context of on-line information access. Two kinds of tasks were used to compare these kinds of hypertext: reading comprehension tasks and navigation tasks. The systems compared were the original MetaDoc with all functionality and two "disabled" versions of MetaDoc: the stretchtext version which had all stretchtext functionality, but no user modeling and adaptation and the hypertext-only version which had no stretchtext functionality at all. The subjects (computer science students) were randomly assigned to one of the three systems forming three groups: the hypertext group, the stretchtext group and the MetaDoc group. The subjects had some time to learn their systems and to browse the actual document. Each subject then received a booklet with five search and navigation questions and eight reading comprehension questions. The subject was allowed three minutes to find the answer to the search and navigation questions and then five minutes for the reading comprehension questions. For each question the subject was allowed three tries in finding the correct answer. For the search and navigation questions, the subject simply pointed out the location of the answer. For reading comprehension questions, the answer was provided orally.

The main results of the experiment are shown in the Table 1. Analysis of Variance (ANOVA) was the primary statistical test used. For all shown parameters the effect was significant at the one percent (P=.01) level. On a paired test a significant difference for reading comprehension time was found between stretchtext and MetaDoc groups. For the reading comprehension correctness and the search time a significant difference was found between hypertext and both other groups, though no significant difference was found between stretchtext and MetaDoc. For the three other parameters related with navigation: search correctness, number of visited nodes (including repetitions), and number of operations, no significant difference was found.

	Hypertext	Stretchtext	MetaDoc
Reading comp time (seconds)	Expert 1780 Novice 1930	Expert 1250 Novice 1780	Expert 810 Novice 1420
Reading comp. Correct Answers	Expert 5 Novice 3	Expert 6.5 Novice 7.0	Expert 7 Novice 7
Mean Search Time (sec)	Expert 755 Novice 725	Expert 645 Novice 530	Expert 555 Novice 575

Table 1. Results of MetaDoc evaluation

Thus, the experiment has shown that stretchtext-based content adaptation is an efficient adaptation technique which can increase user performance by improving reading comprehension. With this technique, reading comprehension time decreases significantly, without loss in understanding. In fact, understanding even increases, but this effect is possibly provided by the stretchtext technology itself rather then by the adaptation technique. At the same time, content adaptation does not affect user navigation. For all navigation-related parameters including time and number of visited nodes there was no significant difference between adaptive and non-adaptive versions of MetaDoc.

Evaluation of an Adaptive Navigation Support Technique: Sorting

The first evaluation of adaptive navigation support by sorting was performed by Kaplan (1993) with their system HYPERFLEX. They performed two pilot studies. In the first small study (with four subjects) they examined the usefulness of goal-directed search in the hypertext. The subjects were asked questions relating to information stored in the hypertext. Each user answered ten questions. For five of these questions there existed relevant goals among the system supported goals. That is, the user could select this goal as the current goal and use the adaptively sorted list of links to related nodes as a navigation support. For five other questions no relevant goals were provided. In the version of HYPERFLEX used in this experiment the users were not able to create their own goals. The results of the experiment shown in Table 2, demonstrate that goal-based adaptive sorting seriously decrease search time and the number of searched topics, while the correctness of answers even increased slightly.

	Search time	# of Topics	% correct
With relevant goal	462 sec.	8.8	83%
No relevant goal	716 sec.	12.2	75%

Table 2. First pilot study with HYPERFLEX

The goal of the second pilot study was to compare the efficiency of two main methods of adaptation in HYPERFLEX: current-node-based adaptation (the user selects the current node of interest and the system orders the relevant links according their relevancy to the current node) and "current goal" based adaptation (the user selects the current goal and the system orders the relevant links according their relevancy to the current goal). Three versions of HYPERFLEX were used in experiment: the version with node-based adaptation only, the version with goal-based adaptation only, and a fully functional system with both kinds of adaptation available.

	Search time	# Topics	Time per topic
With Current Goal	387 sec.	8.6	45 sec.
With Current Node	356 sec.	6.8	52 sec.
Fully Functional	345 sec	9.0	38 sec.

Table 3. Second pilot study with HYPERFLEX

While the results of both studies should be interpreted with caution due to the small sample size (the original paper contains no data about significance of the results), they show that sorting-based adaptive navigation support can improve user performance in information search tasks.

Evaluation of Adaptive Navigation Support Techniques: Hiding and Annotation

The first evaluation of adaptive navigation support by hiding and annotation was performed on the ISIS-Tutor at Moscow State University. (Brusilovsky, 1994) The goal of the study was to check the efficiency of these two adaptation technologies and, in particular, to compare these technologies in an educational context. ISIS-Tutor uses adaptive annotation as a primary technique for adaptive navigation support. As an optional mode of work, ISIS-Tutor also implements adaptive hiding of links. The idea of hiding in ISIS-Tutor is to reduce the cognitive load by hiding from students all links to nodes which they are "not expected to learn". There are two kinds of hidden nodes in ISIS-Tutor: not-ready-to-be-learned nodes and ready-to-be-learned nodes that are outside the current educational goal. In normal annotation mode, the links to these nodes are not specially annotated. In hiding mode, these links are hidden. Hiding mode in ISIS-Tutor is more advanced then typical hiding. It is a combination of hiding and annotation, because learned, in-work and ready-to-be-learned nodes are still annotated as in normal annotation mode.

In the empirical study, three versions of ISIS-Tutor: a non-adaptive version "A" which provided neither annotation nor hiding; a normal version "B" with adaptive annotation; and a version "C" that worked in hiding mode. In adaptive versions of ISIS-Tutor links to not-ready-to-be-learned nodes were not specially colored, ready-to-be-learned were colored red, both in-work and learned were colored green, and learned concepts was additionally marked with a "+" sign. Links to nodes which are within the current educational goal were marked with a "-" sign. Links to not-ready-to-be-learned nodes and nodes outside the current educational goal were not specially annotated in version B and hidden in version C.

Twenty-six subjects (first year computer science students of the Moscow State University) took part in the experiment. They were briefly introduced to ISIS-Tutor and then had up to 45 minutes to work with the system. The same educational goal (ten concepts and ten test problems) was given to each student. To complete the course, each user had to solve all ten problems. The subjects were divided randomly into three groups. Group A worked with version A (non-adaptive version). Group B worked with version B (adaptive annotation). Group C worked with version C (adaptive annotation and hiding). All actions of students working with the system were recorded and then analyzed to compare various aspects of user performance. The most important data analyzed were the time required to complete the course and the overall number of navigation steps.

According to the results of the experiment with HYPERFLEX, both the time and the number of steps were less for adaptive versions.

Group	Number of Steps	Concept Repetitions	Task Repetitions
A. Non-adaptive	81.33	11.17	6.17
B. Adaptive annotation	65.20	5.00	0.80
C. Adaptive annotation and hiding	58.20	4.80	0.40

Table 4. Results of the experiment with ISIS-Tutor

The overall number of navigation steps, the number of unforced repetitions of previously studied concepts, and the number of task repetitions (i.e., trials to solve previously visited task) are less for both versions with adaptive navigation support. For the overall number of navigation steps and the number of task repetitions the difference was significant (the researchers have used ANOVA to check the significance). On a paired test the significant difference for all three variables was found between non-adaptive group and joint adaptive group (B+C), but no significant difference was found between the two adaptive groups.

The results of the experiment with ISIS-Tutor show that both applied adaptive navigation support techniques - hiding and annotation - are efficient adaptation techniques. These techniques can improve user performance in hypermedia by significantly reducing navigation difficulty. Adaptive annotation and hiding in an educational context can reduce user's floundering in the hyperspace and make learning with hypermedia more goal-oriented. With these kinds of adaptive navigation support, the user can achieve the same result using a smaller number of navigation steps and visits to the nodes of a hypermedia system. Adaptive presentation in hypermedia can reduce the time for learning the material and improve the comprehension of the material. At the same time, adaptive annotation of links can reduce the number of visited nodes thus further reducing the learning time. When used together, adaptive presentation techniques and adaptive navigation support can improve the effectiveness of learning with hypermedia.

Summary

The summary of the review of literature is a two step process. First, regarding relevant empirical studies, is the concern for the gap in the current literature to do a straightforward analysis of the effects of adaptive navigation support techniques on comprehension of the content being studied. Hyperflex uses the adaptive navigation support technique of link sorting and measures the efficiency with which a learner can locate information in a hypermedia system. ISIS-Tutor which also employed adaptive navigation support techniques, in this case, link annotation and link hiding, focused primarily on navigation efficiency, and not on overall comprehension. In the ISIS-Tutor research, overall mastery of the content domain was not the research focus. Instead, the data analyzed were time required to complete the course, and overall number of navigation steps. The other study reviewed, MetaDoc, although it did measure comprehension summarily, cannot be classified as an adaptive hypermedia system using adaptive navigation support , but rather, as an adaptive presentation system. MetaDoc's adaptivity rests in hiding and or displaying content based on a user's knowledge of the content domain, rather than hiding or displaying links to more advanced nodes. Furthermore, just because adaptive presentation assists in reading comprehension, does not mean that adaptive navigation support will do the same. More research is needed to answer this question.

Secondly, the review of the literature also highlights the formative nature of learning theory as it relates to hypertext, the essence of the World Wide Web. In the debate over directions that hypertextual educational environments should take, the “model builders” and the “model breakers” disagree over whether hypermedia should have “expert imposed structure” or “ unrestricted browsing and discovery oriented content”, as the primary design premise. Those who build models which impose structure on a hypertextual environment only do so effectively when they follow curricular models such as Gagne’s task analysis in the task of building effective student models which generate adaptivity in the learning environment.

III. Methodology

Subjects

On March 4, 1999, forty two subjects from four sections of a multimedia course in a midwestern US University participated in a one sitting experimental study on the subject of learning the hypertext markup language (HTML) via computer. Of the forty two subjects, twenty one used a traditional hypermedia system (control group) and the other twenty one subjects used an adaptive hypermedia system (experimental group). The instrument used to gather the data on posttest scores was the HTML Competency Examination (HTMLCE). The subjects participation was via the world wide web from desktop computer web browsers located on computer workstations in the university computer lab.

Instrument/Materials

The evaluation instrument used in the study to determine the value of the dependent variable was the HTML Competencies Examination (HTMLCE). The author of the instrument was the researcher. The purpose of the HTMLCE was to evaluate the student's knowledge of HTML at beginning, intermediate, and advanced levels. There are ten items on the HTMLCE. The responses on the exam were multiple choice. Scoring on the exam is equal to the number of correct answers divided by the total number of questions (10). HTMLCE was given to subjects as both a pretest and posttest.

HTMLCE was evaluated for its' Content Validity by experts in the field of Web Page Design. The experts were asked to evaluate the key aspects of content validity, the item validity and sampling validity of HTMLCE. Experts from USWEB, parent company for USWEB Learning, [HREF 6] an organization which has set professional standards and provides professional certification for HTML authoring competencies, graded HTMLCE highly for content validity. Experts at a USWEB Learning Authorized Training Center, also rated HTMLCE highly. In their evaluation, USWEB also subjected HTMLCE to the Split-Half Reliability test for internal consistency reliability and found from the pool of twenty questions, paired responses were ninety percent accurate. The researcher controlled for test-retest reliability by making use of the random entity in Interaction/IP which selected from a pool of questions items used on the concept mastery quizzes at the end of each HTML lesson for the experimental group using AHMS. This prevented the experimental group from having any distinct advantage over the control group on the HTMLCE posttest.

A computer lab within the education department of the university was used to access both the control groups' (THMS) and experimental groups'(AHMS) HTML Lessons. The students were in their normal classroom environment since the lab was the ordinary meeting place for the students participating in the study. The computers used in the lab were Pentium Class machines with 32 MB of Random Access Memory (RAM). These specifications met Microsoft's Certified Technical Education standards for equipment used in Microsoft level one and level two courses. Compared to the online Microsoft specifications, [HREF 7] the computer hardware requirements for the HTML Lessons was at a level one course equivalency.

Design Procedures

Because the groups were formed from enrollees in existing courses, the study can be classified as quasi-experimental. That is, the researcher worked with an intact group (course enrollees from four sections of the same course) and randomized within the groups. The research design used in this study was the posttest only control group design. The pretest was used primarily to confirm equal knowledge of HTML. The participants in the study were randomly placed within either the AHMS or THMS systems. In the study, anonymity of subjects was guaranteed, and all subjects participated on a voluntary basis. The dependent variable was the HTMLCE. The independent variable was the adaptive hypermedia System (AHMS) which used the adaptive navigation support technique of link hiding with a small degree of adaptive text presentation to clarify the initiation of adaptive navigation support techniques as they were put into action on the screen. The AHMS was the treatment applied to the experimental group. A traditional hypermedia System (THMS) which did not use any adaptive navigation support technique was the form of instruction given to the control group.

The HTML lessons themselves consisted of nine lessons. There were three lessons at the beginner level, two at the intermediate level, and four at the advanced level. Grouping the lessons in this manner provided a way to build a hierarchical structure for the lessons which moved the users of the AHMS in an orderly fashion from beginner to intermediate to advanced concepts, while simultaneously offering some degree of independent navigation among the nodes that the system determined the user was ready for. Such structure enabled the adaptive navigation support technique of link hiding to be most effective. Links to more advanced concepts could be “unhidden” from the users customized lesson index and thus accessible via html link in a timely fashion, precisely when the user showed mastery of prerequisite concepts.

The experimental and control groups were formed by random assignment of class members from four sections of an undergraduate educational media course. In each section, participants were randomly selected to work with either the AHMS or the THMS to learn HTML. The student's seat in the lab determined the type of learning environment (AHMS or THMS) that they interacted with when working on the HTML lessons on the computer. In each class session, the students were divided evenly between the AHMS and THMS environments. Two websites, www.cooltutor.com for AHMS and www.packetdata.com for THMS, were used to collect the data for the study. When the students sat down at the computer, they were told to open Netscape Navigator 4.0 and go to a bookmark which read "CoolTutor HTMLCE." The CoolTutor HTMLCE bookmark was mapped to either the AHMS or THMS website. Although the content of the HTML lessons for both the experimental and control groups was the same, adaptive hypermedia and user modeling were used on the AHMS site to modify the lesson index that was seen by users of the AHMS. Other advantages of using two different web sites for this study were 1) load balancing (less network traffic as loads are divided by two) and 2) easier separation of delimited textual data collected from the subjects of each hypermedia system.

Once the subjects were seated at their computers, all subjects were read a script outlining the instructions for what they were to do during the fifty minutes that each subject was asked to participate. The script reminded the subjects that their participation was completely voluntary, and that their results had no bearing on their grade or credit earned in their course. Subjects were also reminded that their participation in the study, and all of the scores that were collected, were completely anonymous and untraceable to them personally. The subjects were also informed that the HTMLCE score data that were collected was accomplished through a secure internet connection, extracted from the researchers world wide web servers, and stored under lock by the researcher.

Once the ground rules were set, and the subjects within each class session were evenly distributed between AHMS and THMS learning environments, the subjects entered their quizID's on the www.cooltutor.com (AHMS) or www.packetdata.com (THMS) homepage prior to taking the pretest. This ID stayed with the users throughout their visit to the web site. (see appendix D for HTMLCE screenshot.)

Data Analysis

The quiz ID allowed for comparison between the same user's pretest and posttest scores. When the student submitted their pretest to the web server, the web server automatically collected each student's pretest score and recorded the score in a delimited text file. This process was repeated at the end of the learning session when the posttest was taken, so that the posttest also has a corresponding quiz ID identifier. Nowhere was the name of the subject identified in the submission of the HTMLCE scores. At the end of the session, the delimited text file kept both the pretest and posttest scores and a single quiz ID which could then be compared without the need to know the individual user's name.

For example, the data file: Quiz ID= 123, Pretest Score=3, Time=01:21p, Visited=02 & Quiz ID= 123, Posttest Score=7, Time=02:30p, Visited=27, showed that the student with quiz ID of 123 had a pretest score of 3 and a posttest score of 7. The file also showed that the student took 1 hour and 9 minutes to complete the module, and visited 25 pages during their visit. Although this was a posttest only quasi-experimental study, the pretest score was necessary to assure that the t-test was the proper test to use on posttest data. Rather than simply measuring gain scores, which does not accurately measure the effects of the treatment because of the ceiling effect, only posttest data were analyzed to determine the effect of the treatment on the experimental group. The ceiling effect could happen if pretest scores were high for a certain group, and thus, gains scores would be minimal, and would not accurately reflect all of the learning that had taken place.

To test the significance of the difference in means scores, a risk level called the alpha level was set to .05. The .05 alpha value is defined by saying that five times out of one hundred a researcher would, by chance, find a statistically significant difference between the means even if there was none. Another item that needed to be defined to calculate the T-Value were the degrees of freedom (df) for the t-test. In the t-test, the degrees of freedom is the sum of the persons in both groups minus 2. Given the alpha level, the df, and the t-value, the difference between the means was calculated for significance.

IV. Findings

Introduction

The three following sections report the results of the study. The first two of these deal with descriptive statistics. Van Wagenen (1991, p. 74) argues that a description of what you have observed, prior to any inferential statistical data, should always come first. These descriptive data are called the primary evidence. Descriptive data that will be given are:

1. Differences in means between control and experimental groups on HTMLCE posttest
2. Standard Deviation of scores for both control and experimental groups on HTMLCE
3. The correlation coefficient for the pretest/posttest scores of both groups

The findings in this study support the rejection of the null hypothesis which states that no significant difference can be found in HTMLCE scores of subjects using a THMS or an AHMS when learning HTML. In order to reject the null hypothesis, the first assumption, based on both groups' equivalent pretest scores on the HTMLCE, was confirmed. It was shown that each group (control and experimental) had very little knowledge of the subject matter in the lessons, HTML. Due to the pretest equivalence and the posttest score variability, the low correlation of pretest/posttest scores allowed use of t-test for inferential statistical data. The section entitled Findings reports inferential statistics using the t-test and takes into consideration the following research question, "Are the Scores for the group who studied the HTML course curriculum via the AHMS significantly higher, as determined by the t-test, than the students who studied the HTML course curriculum using a THMS? That is, is the actual mean difference observed higher than the difference in means which is expected by chance for the same number of participants?"

Response Rate and Demographic Data

Of the forty three subjects that participated in the study, forty two completed both the pre and post tests. One subject became ill and was unable to complete the lessons. This student's pretest data was not used in the study. Because Demographic Data was not formally collected in this anonymous random sample, none will be reported here.

Response Means

There is Strong Support in the primary data and descriptive statistics for the hypothesis that an Adaptive Hypermedia System which employs the adaptive navigation support technique of link hiding improves performance in learning HTML.

Group (treatment)	Number of Participants	Posttest Mean of Group	Posttest Standard Deviation	Posttest Standard Error Mean
Experimental Group (AHMS)	21	7.33	1.96	0.43
Control Group (THMS)	21	4.62	2.16	0.47

Table 5. Response Means

Data regarding participants taking the hypertext markup language competency exam (HTMLCE) after studying lessons on the hypertext markup language using either traditional or adaptive hypermedia are summarized in Table 5.

Students who learned using the adaptive hypermedia system (AHMS) which used the technique of link hiding (M = 7.33) scored significantly higher than the students who studied the lessons using a traditional hypermedia system (THMS) (M = 4.62). To determine whether or not the difference in means between the control and experimental group was significant, a t-test for independent samples was employed. Nearly equal scores on the pretest by both control and experimental groups and the wide range of scores on posttest showed a low correlation coefficient between pretest and posttest scores. This predicates the use the of t-test for inferential statistical data.

Correlation of Pretest/Posttest Data

Group (treatment)	Number of Participants	Pretest Means	Pretest/Posttest Correlation Coefficient	Required Coefficient for T-test	Required coefficient for ANCOVA
Experimental Group (AHMS)	21	0.05	0.1950	< 0.42	>0.42
Control Group (THMS)	21	0.05	0.1721	< 0.42	>0.42

Table 6. Correlation of pretest/posttest scores on the HTMLCE

For both the Experimental and Control Groups, the pretest mean score was very low, averaging 05% out of 100% on the pretest. The pretest means for both groups was 0.05 out of a possible 10.00. Pretest/Posttest Correlation Coefficients for both groups were below the 0.42 limit. For the Experimental Group (r=0.19), for the Control Group (r=0.17). Thus, the t-test was used to measure all inferential data concerning T Values and P Values, which help determine the significance of the results found.

Inferential Statistical Data

There was convincing evidence that the experimental group which used the Adaptive hypermedia system as the adaptive navigation support technique of link hiding produced test scores that were significantly greater than the scores of the students in the control group who used a traditional hypermedia system.

Number of Participants	Actual Mean Difference	Standard Error	T- Value
21 + 21= 42	2.71	0.614	4.42

Degrees of Freedom	Prescribed Probability P Value	Yates Statistical Table Value for given alpha, DF.	Actual Probability P Value
40	0.05	2.02	0.001

Table 7. T-Test Results

Experimental – Control group mean scores (7.33 - 4.62) equals the actual mean difference (2.714). The actual mean difference divided by the Standard Error (0.614) equals the T-Value. The T-Value is then compared to the Statistical table for the Distribution of T. Since the T-Value in the study of 4.42 is greater than 2.02 (Fisher and Yates), the null hypothesis for this study was rejected. Results of the t-test for independent samples indicated a significant difference in mean scores for the two groups. $t(40)= 4.42$, $p=.001$.

V. Summary, Conclusions, Discussion, and Recommendations

Summary

Due to the increase in the availability of the internet for students in k-12 schools, and due also to the volume of web content that is retrievable by students from the classroom, a body of research called adaptive hypermedia has been gaining interest in the educational research community. Adaptive hypermedia fills a void for educators who see potential for the world wide web as more than another entertainment medium or classroom babysitter. Adaptive hypermedia can assist the educational researcher in getting a vision of the web's potentially dynamic role in education because it gives insight into possible structures for the web. These adaptive web structures focus upon adapting content presentation and adapting content navigation uniquely for each individual who interacts with the site that they are visiting. For many educators, this is a new idea. The idea is new primarily because today most websites customize neither presentation nor navigation for the individual student.

This study was conducted to test the effectiveness of an adaptive hypermedia system to teach the hypertext markup language to potential preservice teachers. Teachers in schools where the internet is available in the classroom serve as gatekeepers to the internet. As such, teachers need to understand viable and effective options that they have as professionals with internet resources at their disposal. Thus, using aspiring teachers as subjects in this study and using HTML, the language of the world wide web, as the material tested in the study served a complimentary purpose.

Findings

The low correlation coefficient between pretest and posttest scores on the HTMLCE verified that participants had very little prior knowledge of HTML. Based on posttest scores, the experimental group (using the adaptive hypermedia system) mean scores were significantly higher than those of the control group (using the traditional hypermedia system). Posttest mean scores for the control group were 4.6 while posttest mean scores for the experimental group were 7.3. Using the t-test for significance, the mean difference of 2.71 between the groups proved to be significant ($P < .001$) insofar as there is a less than one in one thousand chance that a difference in means which could be expected by chance would be higher than the actual mean difference observed for the same number of participants.

Conclusions

From the findings outlined above the following conclusions can be drawn: Students who used an adaptive hypermedia systems via the world wide web will likely perform significantly better with the assistance of an adaptive hypermedia system than those students who use a traditional hypermedia system that does not use the adaptive navigation support technique of link hiding. Particularly, the adaptive navigation support technique of link hiding assists students to better comprehend content and thus perform better on exams which cover material that is presented with link hiding enabled. The user model working in conjunction with link hiding enables or disables links based upon the students current knowledge level or proven mastery of the content domain. This technique was shown to bear significant differences in posttest scores as shown by the inferential statistic, the t-test. It can further be concluded that an adaptive hypermedia system using the adaptive navigation support technique of link hiding can help to prevent cognitive overload and a disorientation effect, the “lost in hyperspace” phenomenon, which can distract and/or disorient the learner. Students who use a traditional hypermedia system are more likely to experience the negative factors of cognitive overload or disorientation which will, in turn, lower their scores on posttest examinations.

Discussion

Based on the conclusions noted above, the question must be raised as to why more educational websites are not using adaptive hypermedia as the primary method of delivering online course material. The lack of web design tools available to simplify the complexity of creating user models which integrate with online curriculum is one glaring problem. One buzzword in the marketplace used to describe a website that is adaptive is the phrase, “database driven.” However, most database driven website design tools are built for the programmer and require experience and skill in database design, implementation, and sufficient experience in HTML. The tool that was used in this study to create the adaptive hypermedia website is called Interaction/IP. Of the several tools on the market today that are available to create interactivity (most were tested by the researcher in the design phase of this study), Interaction/IP is the easiest to use and tailor to the research needs of the educator interested in implementing adaptive hypermedia. Most of the programming constructs required to create adaptivity could be accomplished in Interaction/IP with dialog boxes in the conditional entity creation window (see Appendix B). Although Interaction/IP is a Macintosh application, it should be noted that Interaction/IP is built on top of the programming language LISP, and so can be ported to any operating system which has a LISP compiler. This would include Windows NT, UNIX, and LINUX, the three primary server operating systems installed today.

Recommendations

Recommendations for Practice

Educators who are interested in educational software development and in exploring the benefits and nuances of adaptive hypermedia should reconsider the definition of computer literacy to include goals which incorporate the learning of a programming language and the use of data structures within that programming language to store and retrieve information gathered from the users of the programs they create. On the Macintosh and Unix side, LISP based tools such as Interaction/IP offer a simple point of entry with a learning curve capable of traversal. On the Windows side, Microsoft FrontPage 2000 looms on the horizon as a tool which will offer simple data structures for manipulating information collected from students. Microsoft also provides the visual basic scripting engine for providing the conditional constructs that are required to create adaptive hypermedia. A second consideration in the process of entry into AHMS is to learn about adaptive hypermedia itself. The task of learning adaptive hypermedia requires a willingness to explore research conducted in the field of computer science where adaptive hypermedia and user modeling have their roots.

Recommendations for Further Study

The result of educators, particularly education technologists, gaining knowledge about adaptive hypermedia will be the creation of countless learning environments where further research can flourish, and the “art” of creating more effective adaptive hypermedia can be developed. The research community interested in adaptive hypermedia will be able to conduct much needed correlational and experimental studies which will take into account the many variables which can influence learning in an adaptive hypermedia environment.

One observation made during the data collection phase of this study highlighted a difference between an adaptive and traditional hypermedia system. Due to the inherent necessity within an adaptive hypermedia system to collect information from the student about their grasp of content within an individual lesson so that more advanced lesson material can be presented adaptively (i.e. when the student is ready for it), a small feedback screen was shown to the user upon completion of each lesson's concept mastery quiz to notify the user that the lesson index was either going to change or remain the same. Further studies could help clarify the role that the adaptive presentation technique of providing text based instructional cues to the learners as they moved from the concept mastery quiz back to the lesson index played in the results of this study. The adaptive presentation of text is still categorized as adaptive hypermedia, and in this study has been shown to be effectively complementary to the adaptive navigation support technique of link hiding. The primary purpose of this study, to show the significance difference in means between groups using an adaptive hypermedia system versus a traditional hypermedia system is well supported. Follow-up studies could attempt to isolate the adaptive presentation elements (concept mastery quiz- textual feedback) from the adaptive navigation support elements (link hiding) and insert a third group (a second experimental group) which used only adaptive navigation support and did not have any adaptive presentation elements (concept mastery quiz-text feedback). However, the results of such manipulations could be negative. The reason why concept mastery feedback was included in this study as a compliment to link hiding was that a degree of adaptive presentation is necessary to explain the changes that take place when adaptive navigation support and link "un" hiding begins working in the system. The adaptive navigation components, (new links appearing on the web page where plain text existed previously) were they to dynamically change without explanation when the user returned to the lesson index page from a particular lesson, might confuse the learner and cause an unwanted disorientation about the lessons at hand.

If this researcher had to define the types of adaptive hypermedia employed in the HTML lessons, it would be 95% adaptive nagivation support (ANS) based link hiding and 05% adaptive text presentation (AP). The primary use of AP was one screen which gave the same message every time a subject answered a question on the concept mastery quiz. The concept mastery feedback response was either : "you have answered correctly, the lesson index will now show new links for you to explore. Click here to return to the lesson index." Or, "your answer was incorrect, the lesson index will remain the same, please try again." (see Appendix D, p. 104) Without this bridge to understanding what links were (or weren't) being adapted around you, I presume that adaptive navigation support would be less effective. Further research is necessary to understand more completely the potential dependent relationship between adaptive navigation support and adaptive presentation techniques which highlight with textual instructions the kinds of navigation changes that are taking place. In future research, adaptive presentation components which attempt to explain navigational changes could be left out, and the subsequent results on the HTMLCE posttest for such a group could be analyzed. Or, (see appendix A) a fourth group could be formed where Adaptive Presentation of text could be the only adaptation offered. For the purposes of this study, the emphasis was on the adaptive navigation support offered by link hiding with supporting adaptive presentation of text only when necessary. This study produced generalizable results about Adaptive Hypermedia's effectiveness to effect performance on the HTMLCE. Future studies will be needed to more completely understand the relationship between the components of an adaptive hypermedia system and how different combinations of adaptivity in adaptive hypermedia systems effect performance and comprehension of HTML.

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HREF 1
http://www.ncsa.uiuc.edu/SDG/IT94/Proceedings/Educ/kummerfeld/kummerfeld.html

HREF 2
http://www.scu.edu.au/ausweb95/papers/hypertext/eklund/index.html

HREF 3
http://www.irpeacs.fr/papers/rz/artmosc.htm

HREF 4
http://www.edfac.usyd.edu.au/projects/ah/Brusilovsky.html

HREF 5
http://www.edfac.usyd.edu.au/projects/ah/Beaumont.html

HREF 6
http://www.hycurve.com/

HREF 7
http://www.microsoft.com/train_cert/

Appendices

A - Example of Adaptive Presentation of Text

Quiz-Tables Entity
Purpose: to be used in a future study highlighting adaptive presentation of text to users.
1. To give dynamic feedback to the user based upon answers given on pretest.
2. To give value for all prerequisites so that link hiding effects can work
Notes: Code written in Macintosh Common Lisp. In Interaction/IP this code can be placed on the Webserver as a function entity. Whenever a reference is needed to bring the function entity to the node, the xml syntax “&quiz-tables;” is used. This code is used for form action at http://www.cooltutor.com/quiz

```
----------------------------------------------------------------------------------------------------------------------------------
-
(html2::table :border "3"
(html2::tr
(html2::td "The Question")
(html2::td "Your Answer")
(html2::td "Tutorial Reference"))

(html2::tr
(html2::td "What is the latest standard being developed by the W3C?")
(html2::td
(cond
((equalp "a" (argument-value "quiz1-1"))
(html2:strong "a is the wrong answer. The standard has moved past 3.2 as well."))
((equalp "b" (argument-value "quiz1-1"))  (list (html2:img :src "thekid.gif")(html2:strong "b is the correct
answer")))
((equalp "c" (argument-value "quiz1-1"))  (html2:strong "c is the wrong answer. html 2.0 has by net time,
been around for a long time"))))
(html2::td (html2:a :href "http://www.cooltutor.com/09_17.html" "Session #1")))

(html2::tr
(html2::td "What is the proper markup for a H1 Heading?")
(html2::td
(cond
((equalp "a" (argument-value "quiz1-2"))  (html2:strong "a is the wrong answer. You forgot the forward-
slash on the trailing endtag."))
((equalp "b" (argument-value "quiz1-2"))  (html2:strong "b is the wrong answer. Always make sure that
your heading tags match. h1 to /h1."))
((equalp "c" (argument-value "quiz1-2"))  (html2:strong "c is the wrong answer. The end tag is a forward
slash, not a backslash."))
((equalp "d" (argument-value "quiz1-2"))  (list (html2:img :src "thekid.gif")(html2:strong "d is the correct
answer")))))
(html2::td (html2:a :href "http://www.cooltutor.com/tutorials/tutor1" "Lesson #1")))

(html2::tr
(html2::td "What is the proper way to resize a font in HTML?")
(html2::td
(cond
((equalp "a" (argument-value "quiz1-3"))
(html2:strong "Because the opening and closing tags do not match with this choice. That should have been
your first clue that the choice 'a' was incorrect."))
```

```
((equalp "b" (argument-value "quiz1-3"))  (html2:strong "Incorrect. Addsize is not a tag in html."))
((equalp "c" (argument-value "quiz1-3")) (list (html2:img :src "thekid.gif") (html2:strong "c is the correct
answer" )))
((equalp "d" (argument-value "quiz1-3"))  (html2:strong "d is the wrong answer. This choice doesn't close
the opening font tag, nor does it offer an end font tag."))))
(html2::td (html2:a :href "http://www.cooltutor.com/tutorials/tutor1" "Lesson #1")))

(html2::tr
(html2::td "What is an example of a functioning Table Row?")
(html2::td
(cond
((equalp "a" (argument-value "quiz1-4"))
(html2:strong "a is the wrong answer. Row and Item1 aren't valid html tags."))
((equalp "b" (argument-value "quiz1-4"))  (html2:strong "b is the wrong answer. tr is the correct tag for the
table row, your table definition tag is incorrect.  Also notice that placing doctors, a data item, inside a tag
would have made this item invisible."))
((equalp "c" (argument-value "quiz1-4"))  (list (html2:img :src "thekid.gif") (html2:strong "c is the correct
answer")))
((equalp "d" (argument-value "quiz1-4"))  (html2:strong "d is the wrong answer. There are two key
problems with this choice. First, this choice begins and ends the table row before any data is entered in the
table row. Second, the table definition opening tag doesn't include the greater than sign on the
opening td tag. Note that the entire td part should have been embedded within the tr and /tr tags."))))
(html2::td (entity-value "prereq1")))

(html2::tr
(html2::td "Show an example of a correctly built external link")
(html2::td
(cond
((equalp "a" (argument-value "quiz1-5"))  (list (html2:img :src "thekid.gif")(html2:strong "a is the correct
answer")))
((equalp "b" (argument-value "quiz1-5"))  (html2:strong "b is the wrong answer. You have reversed the
location of the hotlink and the URL. There is another choice that has the two in the proper place."))
((equalp "c" (argument-value "quiz1-5"))
 (html2:strong "c is the wrong answer. Although in principle, you have identified correctly the anchor and
hotlink, you have not used proper html markup."))
((equalp "d" (argument-value "quiz1-5"))  (html2:strong "d is the wrong answer. The first half of this
answer is correct, however, you must close the opening anchor tag with a greater than sign, and review how
to create a hotlink. There is no tag attribute anchor tags called link. The hotlink simply sits
between the opening and closing anchor tags. "))))
(html2::td (entity-value "prereq2")))
```

B. Interaction/IP Dialog Box for Conditional Entity Creation

Interaction/IP Dialog Box for Conditional Entity Creation
Name of entity: prereq4
Purpose:

1. To give dynamic toggle so that ready to be learned links will appear as links, and not ready to be learned links will only appear as text, i.e. they will not be clickable.
2. Dialog filled out and saved assigns value to entity named prereq4
3. Entity can be referenced in nodes using XML entity syntax: &prereq4;

Notes: All prereqruisite entities can be referenced anywhere in the adaptive hypermedia space, allowing for dynamic update of student's access to more advanced nodes. In Perez (1995), the conditional entity technique emulates the curriculum decision module (CDM) and the Exercise Selection Module (ESM). Based on values of prerequisites students will or will not be granted access to higher level concepts.

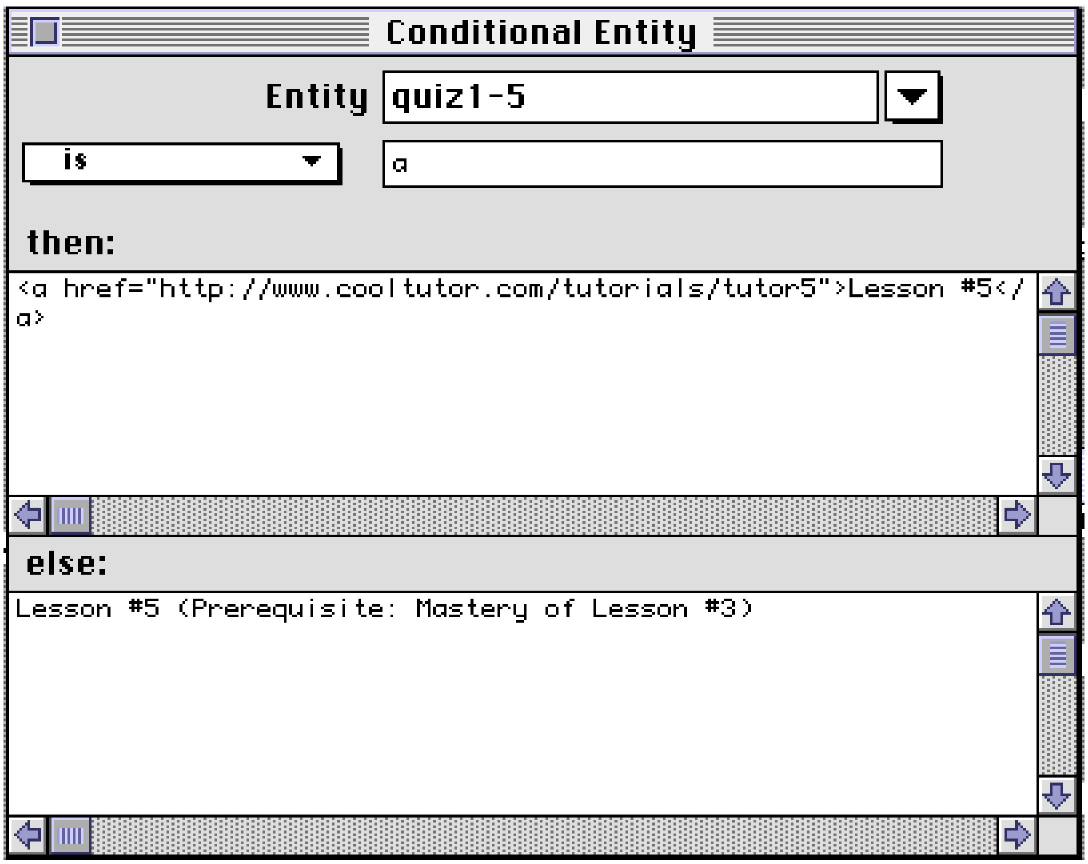

Figure 2. Interaction/IP Dialog Box for Conditional Entity Creation

In the code that appears above, if answer 5 on the pretest quiz is A, then the student will be given html code that is a link to Lesson #5. If the answer is not A, then the student will only see plain text, and thus, will not be allowed or able to enter the Lesson #5 node until prerequisite has been met.

C. Dynamic HTML code generated by Interaction/IP for HTMLCE

Notes: Select tags generate name=value pairs for each quiz question. These values stay with the student until the student changes the values by completing mini-quizzes at the end of each tutorial lesson. The name=value pairs (for example quiz1-1="a") are integrated into Interaction/IP by the use of a type of XML entity called an argument entity. If, a student selected "html 3.0" as the answer for question #1, then the value "a" would be assigned as shown above. The values of argument entities can be changed dynamically. This allows the student to change the values for particular quiz questions over time while visiting corresponding nodes on the site.

After completing all of the quiz questions, on submission of the form, the node named quizmaster is called. Quizmaster is identified in **bold** below as the action attribute value of the form tag in the html document. All entities on the quizmaster node will be dynamically generated before delivering them to the student. The quiz-tables function entity (see appendix #1) is listed in the quizmaster node. At the time of submission, questions 1-10 are given individual values based upon the student's answers. The system is able to keep track of multiple users simultaneously.

There is also JavaScript used in the quiz page to ensure that students enter their quiz ID on the quiz. If students enter a false name, the system is still able to track them to a particular machine via IP address.

```
<html>
<head>
<TITLE>CoolTutor Quiz</TITLE>

<SCRIPT LANGUAGE="JavaScript">

function formCheck()
{
   if (document.theform.quiztaker.value == "")
   {
    alert("Please enter your quiz ID, so the HTML tutor can process your quiz!");
    return false;
    }
}

</SCRIPT>
</HEAD>

<BODY BGCOLOR="#060506" TEXT="ffff9c" LINK="ffff9c" VLINK="#ff9c4a">

<CENTER><FONT SIZE=+2> | <A HREF="http://www.cooltutor.com/index?id=18X8L">home</A> | <A

HREF="http://www.cooltutor.com/chat/room1?id=18X8L">chat</A> | <A

HREF="http://www.cooltutor.com/forum/index?id=18X8L">forums</A> | <A

HREF="http://www.cooltutor.com/quiz?id=18X8L">quiz</A> | <A

HREF="http://www.cooltutor.com/tutorials/lessons?id=18X8L">lessons</A> | <A

HREF="http://www.cooltutor.com/tutorials/index?id=18X8L">composer</A> | <A

HREF="http://www.cooltutor.com/help?id=18X8L">help</A> | </FONT></CENTER><P>
```

```
<FORM NAME="theform" METHOD="post" ACTION="quizmaster" ONSUBMIT="return formCheck
()">

<INPUT NAME="id" TYPE="HIDDEN" VALUE="18X8L">

<TABLE BORDER=1>
<TR>
<TD COLSPAN=2>Please enter your quiz ID here:
<INPUT TYPE=text NAME="quiztaker" VALUE="">
<TR>
<TD><H2>Quiz #1</H2>
<TD><B>Quiz Answers</B>- Click down arrow to make choice. At the bottom of
quiz click Submit Answers button to check answers.

<TR>
<TD WIDTH="300"><B>What is the latest standard being developed by the W3C?</B>
<TD><SELECT NAME="quiz1-1">
<OPTION VALUE="a">html 3.0
<OPTION VALUE="b">html 4.0
<OPTION VALUE="c">html 2.0
</SELECT>

<TR>
<TD><B>What is the proper markup for a h1 heading?</B>
<TD><SELECT NAME="quiz1-2">
<OPTION VALUE="a">&lt; h1 &gt; hi mom &lt; h1 &gt;
<OPTION VALUE="b">&lt; h1 &gt; hi mom &lt; h2 &gt;
<OPTION VALUE="c">&lt; h1 &gt; hi mom &lt; \h1 &gt;
<OPTION VALUE="d">&lt; h1 &gt; hi mom &lt; /h1 &gt;
</SELECT>

<TR>
<TD>What is the proper way to resize a font in html?
<TD><SELECT NAME="quiz1-3">
<OPTION VALUE="a">&lt; fontsizing +3 &gt; hi mom &lt; /font &gt;
<OPTION VALUE="b">&lt; addsize +3 &gt; hi mom &lt; /addsize &gt;
<OPTION VALUE="c">&lt; font size="+3" &gt; hi mom &lt; /font &gt;
<OPTION VALUE="d">&lt; font size="+3" hi mom &gt; <P>
</SELECT>

<TR>
<TD><B>Which is an example of a functioning table row?</B>
<TD><SELECT NAME="quiz1-4">
<OPTION VALUE="a">
&lt; row &gt; &lt; item1 &gt; farmers &lt; /item1 &gt; &lt; item1 &gt; doctors &lt; /item1 &gt;
<OPTION VALUE="b">
&lt; tr &gt; &lt; tr1 &gt; farmers &lt; doctors &gt;
<OPTION VALUE="c">
&lt; tr &gt; &lt; td &gt; farmers &lt; td &gt; doctors
<OPTION VALUE="d">
&lt; tr &gt; &lt; /tr &gt; &lt; td farmers, doctors &lt; /td &gt;
</SELECT>

<TR>
```

```
<TD><B>Which is the proper example for building an external link?</B>
<TD><SELECT NAME="quiz1-5">

<OPTION VALUE="b">
&lt; a href="go home" &gt; http://www.compsmart.com &lt; /a &gt;
<OPTION VALUE="a">
&lt; a href="http://www.compsmart.com/" &gt; go home &lt; /a &gt;
<OPTION VALUE="c">
&lt; anchor="www.compsmart.com" hotlink="go home" &gt;
<OPTION VALUE="d">
&lt; a href="http://www.compsmart.com" link="go home" &gt;
</SELECT>



<TR>
<TD><B>The following is an example of an image tag...</B>
<TD><SELECT NAME="quiz1-6">
<OPTION VALUE="a">
&lt; image &gt; mama.gif &lt; /image &gt;
<OPTION VALUE="b">
&lt; img &gt; src="mama.gif" &lt; /img &gt;
<OPTION VALUE="c">
&lt; img source=yes &gt; mama.gif &lt; /source &gt;
<OPTION VALUE="d">
&lt; img src="mama.gif" &gt;
</SELECT>

<TR>
<TD><B>If the following (<I> &lt; a name="homepage" &gt; </I>) were the named anchor to an

internal link, what would the anchor href look like?</B>
<TD><SELECT NAME="quiz1-7">
<OPTION VALUE="a">
&lt; a href=internal link &gt; homepage  &lt; /a &gt;
<OPTION VALUE="b">
&lt; intlink=homepage &gt; go to homepage &lt; /intlink &gt;
<OPTION VALUE="c">
&lt; a href="#homepage" &gt; go to homepage &lt; /a &gt;
<OPTION VALUE="d">
&lt; a href="jumptoanchor" src=homepage &lt; /a &gt;
</SELECT>

<TR>
<TD><B>Which of the following is NOT an input type form tag?</B>
<TD><SELECT NAME="quiz1-8">
<OPTION VALUE="a">radio
<OPTION VALUE="b">submit
<OPTION VALUE="c">select
<OPTION VALUE="d">checkbox
</SELECT>

<TR>
<TD><B>Which is a valid navigation bar?</B>
<TD><SELECT NAME="quiz1-9">
```

```
<OPTION VALUE="b">&lt; a href="quiz.html" nav="quiz" &gt; &lt; a href="index.html" nav="index"

&gt;
<OPTION VALUE="a">| &lt; a href="quiz.html" &gt; quiz &lt; /a &gt; | &lt; a href="index.html"

&gt; index &lt; /a &gt;  |
<OPTION VALUE="c">&lt; a href="quiz.html" &gt; quiz  &lt; a href="index.html" &gt; index &lt; /a

&gt;
<OPTION VALUE="d">none of the above
</SELECT>

<TR>
<TD>
<B>Which tag would not be used in the creation of a client side image map?</B>
<TD><SELECT NAME="quiz1-10">
<OPTION VALUE="a"> &lt; area &gt;
<OPTION VALUE="b">&lt; client &gt;
<OPTION VALUE="c">&lt; map &gt;
<OPTION VALUE="d">&lt; img &gt;
</SELECT>

<TR><TD COLSPAN="2" ALIGN="middle"><INPUT TYPE="submit" VALUE="Submit Answers">

</FORM>

</TABLE>
<P>
<HR>
<CENTER><FONT SIZE=+2> | <A HREF="http://www.cooltutor.com/index?id=18X8L">home</A> | <A

HREF="http://www.cooltutor.com/chat/room1?id=18X8L">chat</A> | <A

HREF="http://www.cooltutor.com/forum/index?id=18X8L">forums</A> | <A

HREF="http://www.cooltutor.com/quiz?id=18X8L">quiz</A> | <A

HREF="http://www.cooltutor.com/tutorials/lessons?id=18X8L">lessons</A> | <A

HREF="http://www.cooltutor.com/tutorials/index?id=18X8L">composer</A> | <A

HREF="http://www.cooltutor.com/help?id=18X8L">help</A> | </FONT></CENTER><P>
<HR>
</BODY></HTML>
```

D. The HTML Competency Exam and the HTML Lessons

Figure 3. Screenshot of the HTMLCE

Students click on arrows (pointing downward) to open the drop down list boxes to make their choices for each question. At the bottom of the page is a submit button that is pressed to submit answers to the server. There is also the use of an adaptive presentation technique called **text adaptation** that is used to force students to go to the quiz before attempting lessons or the html composer. This is accomplished with Interaction/IP using a conditional entity in combination with XML Marked Sections.

Please note that screenshot version of HTMLCE was modified for the purposes of anonymity. The actual HTMLCE and HTML lessons used in the study follow this page as a continuation of Appendix D. They were copied from the world wide web address: <http://www.cooltutor.com/>, a website created for the purposes of this study. To see the full AHMS in action it is recommended to go to the cooltutor.com site. However, the plain text version lesson examples are included herein for convenience purposes.

The HTMLCE, Lesson Index, and Lessons 1a, 3, 5, and 7

THE HTMLCE as Administered to Subjects.

Please enter your Quiz ID:

Please answer the following questions so that this sites' navigation support will be tailored to your current understanding of HTML, the
hypertext markup language. After you click the submit button at the
bottom of the page, you will go to the lessons index. Links to lessons
are adaptive. As you gain knowledge of the content, (i.e. you meet
prerequisite knowledge requirements), links to more advanced concepts
will be made available to you.

What is the latest version of html?

html 3.0
html 3.2
html 4.0
I don't know

What is the proper markup for a H1 Heading?

< h1 > hi mom < h1 >
< h1 > hi mom < h2 >
< h1 > hi mom < \h1 >
< h1 > hi mom < /h1 >
I don't Know

What is the correct way to resize a font in HTML?

< fontsizing +3 > hi mom < hi mom < /font >
< addsize +3 > hi mom < /addsize >
< font size="+3" > hi mom < /font >
< font size="+3" hi mom >
I don't know

What is an example of a functioning table row?

< row > < item1 > farmers < /item1 >
< tr > < tr1 > farmers < doctors >
< tr > < td > doctors < td > farmers
</tr > < td farmers, doctors < / >
I don't know

What is a working example for building an external link?

< a href="http://www.compsmart.com/" > go home < /a >
< a href=go home > http://www.compsmart.com < /a >
< anchor=www.compsmart.com hotlink=go home >
< a href="http://www.compsmart.com/" link=go home >
I don't know

The following is an example of a working image tag...

< image > mama.gif < /image >
< img > src="mama.gif" < /img >
< img source=yes > mama.gif < /source >
< img src="mama.gif" >
I don't know.

if < a name="homepage" > what does the anchor href look like?

< a href=int link > homepage < /a >
< intlink="homepage" > go home < /intlink >
< a href="#homepage" > go home < /a >
< a href=go home src=homepage < /a >
I don't know

Which of the following cannot be an input form tag attribute?

radio
submit
select
checkbox
I don't know

Which is a standard navigation bar?

| quiz | < a href="home.html" > home |
<a href="quiz.html" nav=quiz, home >
< a href=quiz.html--- home.html >
I don't know

Which tag would not be used in the creation of a client side image map?

< area >
< client >
< map >
< img >
I don't know

SUBMIT ANSWERS

The HTML Lesson Index- as displayed to AHMS USERS scoring 0 on pretest.

Instructions: Links to lessons are listed below. To make an inaccessible link available, you can show mastery of a prerequisite concept by correctly answering the concept mastery quiz question at the bottom of the page of each prerequisite lesson. After you have answered correctly, links to more advanced concepts will be made available to you.

Lesson #1a- BASIC HTML

Lesson #1b- TEXT FORMATTING (Prerequisite: Mastery of Lesson #1a)

Lesson #2- TABLES (Prerequisite: Mastery of Lesson #1a)

Lesson #3- EXTERNAL LINKS (Prerequisite: Mastery of Lesson #1b)

Lesson #4- WEB GRAPHICS (Prerequisite: Mastery of Lesson #1b)

Lesson #5- INTERNAL LINKS (Prerequisite: Mastery of Lesson #3)

Lesson #6- FORMS (Prerequisite: mastery of Lesson #2)

Lesson #7- NAVIGATION BARS (Prerequisite: Mastery of Lesson #3)

Lesson #8- IMAGE MAPS (Prerequisite: Mastery of Lesson #4)

Notes:
For users of AHMS the lesson index was adaptive. Links are available based on the students knowledge level as shown in the HTMLCE pretest, or on concept mastery quizzes.

Above Lesson 1a is available (underlined). Lessons 1b- Lesson 8 will not be available until concept mastery is shown on prerequisite lessons. In the AHMS, url jumping can be disallowed by using the marked section feature of Interaction/IP (see appendix E).

For users of THMS all links were available at all times regardless of pretest score on HTMLCE..
For users of THMS the lesson index was NOT adaptive.

Lesson 1a, 3, 5, and 7 as displayed to all users (THMS and AHMS)

Lesson 1a

The first tutorial at the cooltutor.com website is about HTML basics. The most recent version of HTML is version 4.0. The basics of html allow for text formatting and give instructions to the web browser regarding where to create line breaks and carriage returns, and how to display text. The way that HTML does this is with something called a TAG. TAGS are the building blocks of HTML.

* First, you are given examples of tags that create line breaks and carriage returns. These tags can be used in html as single elements or instances. That is, one paragraph tag is all that is needed to create a carriage return and a line feed in an html document.

* The second section in this lesson will show examples of tags that require what is called a start and a stop tag. Thus, I have color coded these tags for you in green and red. (green meaning start and red meaning stop.) When using start and stop tags, the web page author must include the stop tag at the end of a particular formatting instruction. Otherwise, the web browser will continue to render the text on the page using the same element throughout.

* For all of these examples, you should open a text editor and type the tags into a new document. Then, you should open the file in the web browser to see your results. Feel free to experiment so that you can gain understanding of how the tags work to manipulate text. Make sure you save the file as "test.html"

HTML BASICS

section #1

LINE BREAKS
PARAGRAPH BREAKS

section #2

HEADINGS
BOLD TEXT
ITALICIZED TEXT
UNDERLINED TEXT

----

section #1

Line Break tags
make a line break in your
html document.

Paragraph tags < p >

make a line break and a carriage return

in your html document.

Heading tags increase boldness and size of font in an html document.

You TYPE:
< H1> heading size #1 </H1>

result:

Heading Size #1

You TYPE:
<H2> heading size #2 </H2>

result:

Heading Size #2

You TYPE:
< B > bold font < /B >

result: **Bold Font**

You TYPE:
< I > Italicized Font < /I >

result: *Italicized Font*

You TYPE:
<U> underlined text </U>

result: <u>Underlined Text</u>

Concept Mastery Quiz

What is the proper markup for a H1 Heading?

< h1 > hi dad < /h1 >
< h1 > hi dad < h2 >
< h1 > hi dad< h1 >
< h1 > hi dad < \h1 >
I don't Know

| SUBMIT ANSWER |

| back to lesson index without doing concept mastery quiz|

Lesson #3

External Links

In order to make links in html you must use the Anchor tag. The anchor tag in it's simplest form looks like this:

<a>hotlink

Step #1- Create Your Hotlink

Between the <a>and the < /a > tags type the text that you want the person browsing your webpage to click upon.

For example, typing: < a > Go To Tutorial < /a >

would display: Go to Tutorial to the end user. Of course to really make this work for yourself, you need to do a few more steps...

Step #2- Add Important Tag Attributes to the opening Anchor < a > tag

Within the < a > tag itself are two important attributes that we will be examining and using in our html markup. The first attribute to the opening anchor tag is the hypertext reference or href . The hypertext reference, href, refers to the place where the browser will go when the hotlink is clicked upon by the user.

figure 1
< a href > hotlink < /a >

The href is located within the <a> tag itself and is thus considered to be an attribute of the opening < a > tag. The next thing about href's that you should know is that href attributes have no value until you give them a value. The value could be any file that you want the href to point to. The href points to what is called in html a Uniform Resource Locator or URL. URL's can be files on your local harddisk or URL's can be webpages from the internet.

type of url	URL path
webpage absolute url	http://www.cooltutor.com/index.html
webpage relative url	index.html
local file	file:///C|/temp/index.html

The following is an example of an href attribute and href value (absolute URL) embedded in an opening anchor tag.

Thus written, the file index.html is the absolute URL for the hypertext reference to index.html. Notice that attribute values are placed inside quotes (attribute name="attribute value" or href="index.html"). On some servers quotes are very important. As a rule, always put your attribute values in quotes.

Step #3- Type completed LINK into HTML

Once you get the href built with the href's URL, and then add the target attribute's name and value, you still need to put both steps of the process together. The table below will illustrate the finished product of a working hypertext link. Remember that the HOTLINK goes between the:

< a > and the < /a > tags.

Also remember that your < a > or opening < a > tag has grown considerably larger, since you have recently added the href attribute to the opening < a > tag.

Note the purple coloration of the opening < a > tag to see the tag grow as each attribute is added.

base tags	< a > HOTLINK < /a >
add href to opening anchor tag as attribute=value pair	< a href="http://www.cooltutor.com/index.html" >
add hotlink	< a href="http://www.cooltutor.com/index.html" > GO TO TUTORIAL < /a >

Concept Mastery Quiz

What is a working example for building an external link?

< anchor="www.cooltutor.com" hotlink=go home >
< a href="go home" > http://www.cooltutor.com < /a >
< a href="http://www.cooltutor.com.com/" > go home < /a >
< a href="go home! >go home
I don't know

| SUBMIT ANSWER |

| back to lesson index without doing concept mastery quiz|

Lesson #5
Internal Links

Part #1

Creating a link within a web page is a skill that will prove beneficial to you in your website and webpage construction. You may recall during lesson #3 we learned how to make links between pages. The skill that you will learn in this lesson will add another dimension to your link making capabilities.

Revisiting the Anchor Tag- Two Key Attributes

The anchor tag, as you may have guessed, is the only tag involved involved in the creation of links within a page. Remember when we created a link to another page we used the < a href="http://www.abc.com/" > hotlink < /a > markup to get the job done.

To create a link within an individual page we still do use the anchor tag < a > and the < /a > tags, only in the case of making links within pages, the markup for the anchor tag will differ significantly from the markup used to create links to other pages.

The two attributes to the anchor tag involved in creating links within
pages are the href and the name attributes. You are most familiar with the href attribute so let's start with it...

The HREF attribute

The following table illustrates how to create a Linking Anchor Tag by
attaching the href attribute to the anchor tag.

Table 1a

Linking
Anchor Tag: < a href="#target" > go to target < /a >

result: go to target
(you'll jump to name attributes, below)

The NAME attribute

The name attribute to the anchor tag creates what I call the linked anchor tag. The name attribute is the attribute used to determine where the linking anchor tag will point the browser within the document. An additional point that you have probably already noticed is that The < a
name="target" > will align the linked anchor tag with the top of the
browser window in which it is called.

Table #1b

Linking
Anchor Tag: < a href="#target" > go to target < /a >
result: go to target (name attribute heading)

Linked
Anchor Tag < a name="target" >

The key point here is that the value or name that you assign to the anchor href attribute must match the anchor name attribute.

Thus, if I wanted to link to another place in this document where I have a large graphic with the words "the next dimension", I would make sure that the Linking anchor tag's href attribute and the Linked anchor tag's name attribute matched. For an example look at table #2 below.

Table #2

Linking Anchor Tag:	< a href="lesson5.html#dimension"> THE NEXT DIMENSION < /a >
Linked Anchor Tag:	< a name="dimension" >

THE NEXT DIMENSION

note that if you could have seen the html for this section of the tutorial it would have looked like this:
< a name="dimension" > < font size=+2 > THE NEXT DIMENSION < /font >

back to table #2 (you can also jump back up the page, too!)

Part #2 of Lesson 5

For a more concrete demonstration of linking within a page and the kinds of things that you can do with the anchor tag, take a look at the Company Contacts example below.

Company Contacts

1. Andrew Atkinson
2. Betty Banks
3. Charlie Cardenes
4. Gregory Garcia
5. Harold Hanes

Directory

Andrew Atkinson	Chief Engineer of the Civil Engineering Division	andy@acme.com ----------------- phone ext. 355

back to top

Betty Banks	Chief Engineer of the Mechanical Engineering Division.	bbanks@acme.com ----------------- phone ext. 365

back to top

Charlie Cardenas	Computer Technician	techguy@acme.com ----------------- phone ext. 387

back to top

Gregory Garcia	Sales and	sales@acme.com

Marketing -----------------
Coordinator phone ext. 301

back to top
Harold Hanes
Accounting hhanes@acme.com
Deparment -----------------
Manager phone ext. 350

back to top

Note: Lessons 5-8 do not implement concept mastery quizzes as they are not prerequisites to any other lessons in the learn html modules.

Lesson #7

The Navigation Bar

Navigation Bars

| Point 1 | Point 2 | Point 3 |

here is the html for a simple navigation bar...
| < a href= "#point1" > Point1 < /a >
| < a href= "#point2" > Point2 < /a >

| < a href= "#point3" > Point3 < /a > |

1. Point #1- The Pipe key (|) is a common keystroke used to separate links in a navigation bar.

2. Point #2- The text based navigation bar is faster to construct than an image map.

3. Point #3- The HTML for a text based navigation bar, outlined above is easy to create once you know how to build internal and external links. Just separate your link html with the pipe key.

For Concept Mastery Quizzes in Lessons 1-4, IF Concept Mastery was shown… the following text appeared in browser.

Your answer was correct.

The lesson index will now show new links for you to explore.

Click here to return to the lesson index.

IF Concept Mastery was not shown in lessons 1-4… the following text appeared…

Your answer was incorrect.

The lesson index will remain the same.
Please try again.

E. Conditional Entities facilitate Adaptive Presentation Techniques

Notes: In the example below, a special built-in entity of Interaction/IP- visitor.track, which tracks all of the nodes that the student has visited, is used to check and see if the user has yet to go to the quizmaster node. If so, then the text from the lesson index will be included, if not, then another piece of text will be activated which will tell the student that should take the quiz first before working on the lessons. Text adaptation using the same technique can also be used to show more elaborate instructions on a particular node to beginning students, while more advanced students could be presented less detailed information. (Brusilovsky, 1998 p. 71)

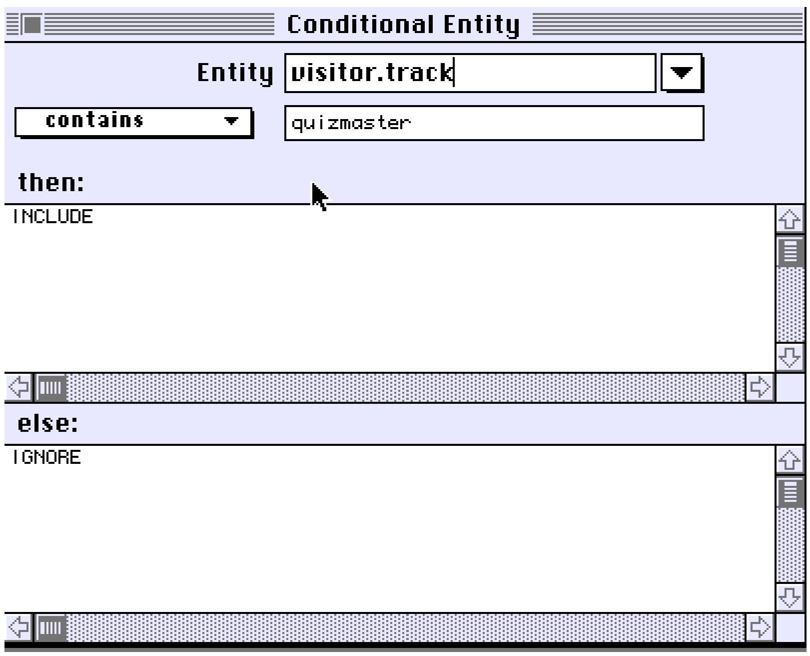

Figure 4. Conditional Entity Screenshot

F. IRB Consent Form

VITA

Mark Mann
Candidate for the Degree of
Doctor of Education

Thesis: USING THE ADAPTIVE NAVIGATION SUPPORT TECHNIQUE OF LINK HIDING IN AN EDUCATIONAL HYPERMEDIA SYSTEM: AN EXPERIMENTAL STUDY

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Houston, Texas, On October 14, 1963, the son of James Scott Mann and Dene Hofheinz Anton.

Education: Graduated from Anderson High School, Austin, Texas in May, 1981. Bachelor of Arts degree from Southwestern University in American Studies in May of 1987. Received Master of Arts degree from Southern Nazarene University in Religion in May of 1992. Completed the requirements for the Doctor of Education degree with a emphasis in Education Technology at Oklahoma State University in May of 1999.

Experience: Worked for three years (1996- 1999) for MicroAge of Oklahoma City as a network engineer and Microsoft Certified Professional Trainer. Also taught courses for ComputerSmart Training Centers, Inc.. Courses taught include HTML programming, Internet Information Server Administration, and Windows NT Server Administration.

Professional Memberships: Microsoft Certified Professional Trainer, HTML Writers Guild.