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Designing and Implementing Instruction on the World Wide Web: A Case Study

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This case study describes some tips and lessons learned from a project at St. Cloud State University designed to teach information literacy over the World Wide Web. The information literacy project has two primary components:

1. Under the auspices of LEO: Literacy Education Online (a project to disseminate resources to improve composition and writing skills; URL: http://leo.stcloud.msus.edu), to develop content resources providing guidance in library and internet use and application in research;
2. Under the Center for Information Media, to disseminate self-paced instructional modules on library and internet use and application in research that could be used in credit-generating courses.

As the two components exhibited considerable overlap, it was decided to develop inter-related resources within a single project environment.

For some time, information has been recognized as an important factor in our social and political life. About two hundred years ago, Thomas Jefferson acknowledged that "Information is the currency of democracy," and since then, its importance has never diminished. This has been called the Information Age, and the need for information literacy seems imperative. Information literacy is particularly important as the phenomenal growth of information technologies such as the World Wide Web has made information instantaneously available from around the world. This growth is fueled, in part, by the efforts of many businesses, organizations and governments. Vice President Gore, in a speech about the National Information Infrastructure "challenged his audience to connect every classroom, library, hospital and clinic to the NII by the year 2000 so that all Americans can benefit from the communications revolution" (Gore). Given access to the NII, we can obtain educational, health and economic benefits, as well as the ability, which concerned Jefferson, to become informed citizens. Learning to assess information needs and access appropriate information are important goals to the project, as is the need to critically evaluate the information to determine if it is accurate, current and authoritative.

A second factor contributing to the need for our project is the budgetary constraints being placed on educational institutions as states anticipate federal funding cuts, and more of the state and federal budgets are directed away from education toward entitlement programs and other social needs. Less money is available to purchase books and periodicals to fill student, faculty and community information and research needs, so we are turning to information technology to fill the gap. Our project was designed to address the need for information literacy on the St. Cloud State University campus and potentially the 62 sister institutions within the Minnesota State Colleges and Universities (MnSCU) system. As the need for information literacy grows, the pressure on librarians and information technologists increases, exceeding their capacity to teach each person on-on-one. As academic programs began to add information literacy components, library faculty envisioned the library of the future as one in which the walls "dissolve," and library services are not limited to resources available in the building, but extend throughtout the world.

The latest addition to a long line of instructional (learning) technologies is the World Wide Web, the popular name for Internet sites integrated through the hypertext transfer protocol (HTTP). Faculty on the SCSU campus had already begun using the using the World Wide Web to augment the delivery of live instruction, so they were familiar with the possibilities offered by the Web. At the same time, MnSCU began to emphasize distance education to meet student needs. Given the conjunction of these forces and pressures, delivering information literacy instruction on the World Wide Web seemed to be a logical choice.

Project Overview

The project began in earnest with a needs assessment in the Spring of 1995. Patrons were surveyed and students currently enrolled in library research strategy classes were surveyed and participated in focus groups to determine their content and delivery needs. A design document was created, and the actual instructional development began. Field testing began as component parts were completed, and the portions of the project are expected to be ready for implementation by Fall Quarter 1996. Two complicating developments are slowing portions of the project:

1. The state of Minnesota is establishing an RFP for a new statewide online library system that may be radically different from the system currently in place at St. Cloud State.
2. The PALS system used at St. Cloud State will unveil a new Web-based interface that will be popular but not fully replace the command interface which was incorporated into the project design.

One part of the needs assessment asked students about their "information dream machine." They told us they preferred a seamless interface between learning and searching for information both in the library or around the world. They preferred a graphic environment with the ability to use a mouse or touch screen. They also wanted access to a librarian when they had a question. Many students wanted to access the "dream machine" from home. They wanted a system that was easy to use and employed everyday language. They wanted to be able to print information. The wanted to avoid becoming lost in the system, and preferred topic maps as a way of orienting themselves and making choices. Except for a voice activated system with a built-in taco holder, many of these desires could be realized with a Web environment.

Why the Web?

By its very nature, the Web facilitates the easy distribution of knowledge and instructional resources regionally, globally, or within an enterprise. The current use of the Web in instructional environments is primarily dedicated to distributing course materials (syllabi, assignments, calendars, notes, and in limited but growing instances course readings) to augment traditional classrooms or instructional television. Additionally, many instructors are beginning to incorporate electronic mail, newsgroups, and listservs to further augment instruction and promote limited interaction among students. The real potential of the Web, however, lies in its integration of print, image, video, and audio and the opportunity to build upon the lessons learned from previous technologies and create and pursue new instructional and learner opportunities. Its popularity notwithstanding, hypertext is still emerging from its infancy as an informational and instructional delivery medium.

Advantages & Disadvantages of the Web as an Instructional Environment
The most obvious advantages of hypertext on the Web are its cross platform capabilities (environments

can be accessed from browsers available for almost every configuration of hardware imaginable), the relative ease with which environments can be created, modified, and maintained, and the integration of text, graphics, and interactivity. The ease of creation and modification is particularly useful when distributing current and rapidly changing information and instruction. Recent extensions of HTML and enhancements within Netscape, especially Frames and Java (a programming language from Sun Microsystems) are expanding the level of interactivity and facilitating the inclusion of animation, digital video and audio.

Beyond simple distribution of course syllabi, calendars, and assignments, hypertext can be used for:

- Instructional materials, including access to licensed software applications, PowerPoint presentations, and locally produced full-text supplemental readings and interactive multimedia textbooks;
- One-to-one communication, primarily through Web-integrated email to promote interaction between learners and with instructors;
- Group communication, either asynchronous (primarily Usenet discussion groups) or synchronous ("chat" environments, MUDs (multi-user domains), MOOs (multi-user, object-oriented domains), and especially WOOs (Web-based multi-user, object-oriented domains)) to promote collaborative interaction;
- Evaluation and testing through forms (with associated CGI scripts that can allow for "automated grading") are possible, but there is always the problem of authenticating the identity of remote learners, even in enterprise environments.
- Remote access to all the types of resources included above, plus access to library catalogs and topical databases (that may or may not require authentication for access).

The Internet, and by extension the Web, can deliver textual information, but some have argued whether it is with the same level of readability or comprehension provided by books and periodicals (although readers can control text characteristics like font size that can make reading or "listening" easier); it can deliver video images, but not with the speed or clarity of video tape or cable or broadcast (although better than books or periodicals); it can provide synchronous communication, but without the nuance and inflection found in telephone and video conferencing (although desktop videoconferencing may change this as bandwidth increases). As David Woolley notes, "it's important to be realistic about the strengths and weaknesses of the Web. When you're considering possible solutions to a problem, try not to be dazzled by Web hype." (Woolley 1995)

Hypertext allows instructional designers to create documents with embedded links to provide learners opportunities to follow sequences which can be predetermined or relatively individualized to the needs of the learner. Several researchers (Kearsley 1988,Jonassen 1988) have commented on how hypertext mimics human semantic networks, but creating hypertext pathways along cognitive models is not a task to be dealt with lightly. This linking to external resources and Internet search engines should increase the amount of information a student has available to them seamlessly, without leaving the Web environment. And herein lies the root of one of hypertext's disadvantages in instruction, namely that it is nearly impossible to predetermine with any specificity how or at what point in the sequence a user can and will enter an instructional environment or leave it and enter conceptually related, but different environments. It is possible, through various authentication schemes, to direct the entrance point, but it becomes difficult to control sequences after entry. Navigational problems can arise without adequate visual or textual elements, especially in larger environments. Navigation is impossible to control when links to external resources (especially external directories of links) are included.

The most readily apparent limitations are access to hardware and network connections for users. Many learners may not have access to computers (of sufficient size and configuration) or networks (of adequate bandwidth, either at the enterprise or global level). Requiring students to come to campus to access digital resources defeats some of the spatial distribution inherent in the Web.

There are also inherent limitations in page layout design. There are ways to overcome this, including use of alternative display formats (e.g., Adobe Acrobat's PDF), which frequently require software translators or extensions, and heavier use of graphics, which consumes bandwidth and slows transmission (often making any interaction slower than CD-ROM). Page designers yield control over the appearance of individual pages to users, who determine font styles and sizes. This can create problems, especially how graphic elements appear in relation to the text.

As the Web expands and the capabilities of browser/clients expand, the design team needs to include programmers to develop the specialized scripts to handle authentication, testing, formatting, incorporation of digital video and animation, and improving levels of interaction. Increasing the ways in which information can be delivered, and hence the range of instructional and informational applications, reduces the simplicity of creation, modification, and maintenance. Improving interaction means developing ways to overcome the discrete transactions of client/server architecture.

A concern (rather than a disadvantage), and one that has received little attention, is the psychological impact of extended immersion of learners and instructors in digital environments. Allucquere Rosanne Stone has raised a possible relationship between "digital identities" and multiple personality disorders. (Stone 1996)

The Web is "most useful when used to explore intellectual and verbal knowledge" (McManus 1996) to geographically distributed learners. The geography may be as small as linked classrooms, computer labs, or offices in a single building or a campus, to individuals or classrooms located in small towns within a state or region, or internationally. The asynchronous access and delivery can free both learner and instructor from requirements of time and place, although the primary current application to provide resources that augment instruction does not make use of this advantage. Incorporation of synchronous group discussion (through a MOO or WOO) encourages distributed learners to greater collaboration and interactive problem solving and decision making.

Web instruction could imitate CBI with its interaction and feedback, but one of the strengths of the Web is the ability for students to collaborate with other students or experts. One of our goals is to help students learn deeply, that is learn meaning and develop an understanding of information literacy, so that they become lifelong learners, rather than engage in surface learning, simply to memorize facts. It is our opinion that collaboration could enhance instruction by developing students' ability to analyze and synthesize information, and develop creative thinking and communication skills (Alexander 1995).

We began our project by assuming that there are things that we could not control. For instance, we might intend the user to enter and exit at predetermined points, but users can actually enter at any point on our web. In addition, we have little control over the user's path through the web, although we can design our navigational tools to guide the user. In a similar way, we have little control over the type of browser the user has, or the optional display features chosen by the user, such as font size or color. Finally, we could not control links from other pages on the web to any point within the web. Also, links out of our web to other pages can become stale as those links or pages change. In this case, we needed to assign an information manager to try out the links periodically and update them (p. 688-689, December & Randall 1995). Since navigational tools are built into most web browsers, controlling the student's

progress through the content was not as easy as leaving out choices when we wanted to direct the student's path.

What You Can Control: Standards

In an instructional environment, all standards must support the instructional intent and facilitate learning. There are several issues involving standards. Those affecting delivery performance, such as network cabling and connectivity protocols (Ethernet, fast Ethernet, ATM, and modem baud rate) and size, speed, and operating environment of client computers and servers, are enterprise-wide. These are often beyond the developer control. Hardware platform decisions can be made by individuals, departments, or administration, but are perhaps best made by systems engineers (with adequate user input). While Web software (both browser/clients and HTTP servers) is available for almost every platform (from workstation through mainframe) and operating system (DOS, VMS, UNIX), receiving instructional environments requires high-end desktop computers with wide bandwidth connectivity. In particular, maximizing random memory (RAM) allocation stabilizes performance for expanded multimedia applications.

The information literacy project runs on the departmental Web server (Sun Sparcstation running Solaris and Netscape's HTTP server software) and distributes resources over the campus fiber backbone to departmental AppleTalk, Ethernet and fast Ethernet LANS and a regional T1 line. Workstations on campus include IBM-compatibles (from a few antiquated 8088s and 286s to a majority of 386s and 486s with minimal RAM to high end Pentiums with 24 Mb RAM) and a variety of Apple Macintoshes (from older SE20s to a majority of Performa 636s with 8 Mb RAM to Power PC 8500s with 48 Mb RAM). For off-campus users there are 60 SLIP connections; unfortunately, their use is limited to faculty, staff, and students.

Choice of primary browser/client affects page design flexibility and functional capabilities. The controllable standards are those relating to design elements, environment structure, and editing style. While Netscape incorporates additional functionality and many non-standard HTML tags that allows it to dominate the Web, it should not be assumed that all potential clients will have equal functionality. Nonetheless, the non-standard tags, especially for tables, and expanded functionality provided by Frames and plug-in applications for incorporating multimedia and alternative formats, make Netscape the browser/client environment of choice for publishing and instructional design and dissemination.

Adopting Netscape as the campus-wide browser client was relatively simple: its licensing on campus remains free. Unfortunately, because of the wide array of hardware platforms and lack of staff support, there has been no standardization on software version. There are at least three versions of Netscape available, each with different levels of functionality (and stability). While it is expected that future hardware upgrades (especially expanded RAM) will stabilize the software on campus, there remains the difficulty of distributing informational and instructional resources to external sites having different browser/client software.

Design standards are those most readily within the instructional designer's control. Two qualities are essential: readability and navigability. If content is not presented in a "visually appealing, easy-to-read manner," then learner retention can be significantly reduced (Morgan 1995). Consistent layout and organization of graphic or textual cues (a template including headers, taglines, and identity and

navigational aids (duplicated when and where necessary on longer pages), and stylistics (preferred header and sub-header tags and types of lists, when and where to use tables and graphic diagrams; height, width, and placement of horizontal rules, etc.) create an environmental identity, improves user behavior within the environment, and improves learner retention. Establishing a logical and flexible organizational structure of concept modules based on the anticipated behavior of learners is critical to ease of navigation (and server performance).

Before development began, we established a page template and layout setting the style, size, and placement of identity (logo) and navigational elements (and directory paths for shared common elements), size, spacing, style, and placement of headers and sub-headers, use of horizontal rules, and arrangement of elements in footers (tagline information). The template allows the responsibility for creating modules to be distributed among members of the design team, especially graduate assistants, while maintaining consistency of design; it also speeds the development process. In particular, establishing a standard template for the tagline, incorporating authorship and copyright information and a common email address for information and comments, was necessary to assure ownership and provide credit. At the same time we were creating our environment's "look and feel," the administration, through an ad hoc committee under public relations, began to discuss broader campus coordination; a standard "look" for SCSU administrative and departmental Web sites has been suggested but not adopted. The information literacy project template is sufficiently flexible to accommodate the university's proposed standard "look."

Knowing where one is and getting around the web are important considerations in its design. One drawback of the Web is the possibility of getting disoriented and not knowing where one is, so orientation information was placed at the top and bottom of each page, and visual cues to the type of information on the page were used so that users would be able to answer the following questions: Where am I? What am I doing? What's available? Navigation should be easy, intuitive and consistent. One navigation tool we used is a clickable image map which is a graphic on which a user can "point and click" to choose a content area and go to a a linked document. Image maps can take the form of road maps, timelines, tables, matrices, and other graphical representations of content. One of the most commonly used navigation tools on the Web is a directory or table of contents (TOC) list, which we also used.

Setting a color palette and a grammar for navigational icons and graphic elements (headers, sub-headers, and illustrations), as well as background colors or graphic "wallpaper" and text colors must be done with an understanding of individual file size (page text plus all graphic elements), server storage capacity, and the slowest expected transfer rate. The average "page" of text with HTML tags (in 12 pt font) consumes about 2.5 kilobytes; an average Web "page" occupies 7 to 10 pages of text or 17.5 to 25 kilobytes. Graphic images begin at about 17 kilobytes for small elements (e.g., colored bullets) and can easily range beyond 500 kilobytes depending upon size, format, and numbers of colors. Digital video requires enormous storage capacity; a ten second video clip with audio can consume 2 to 4 megabytes. A standard 14,400 baud modem (while widespread, not as prevalent as 9600 baud modems) can transfer data at about 1000 bytes per second with a good (and clean) phone connection (a good Ethernet connection can average about 10 times faster or 10 kilobytes per second). Large or numerous graphics can make document transfer interminably slow, frustrating users, and interfering with continuity; video and audio often require lengthy transfer times for limited payoff. If either video or audio is essential to the content of the instruction, other mediums (e.g., video or audio tape, CD-ROM, fiber or broadcast ITV) should be considered.

The color palette for this project was established through its participation in LEO. The colors were chosen for their bright, contemporary feel as well as their ability to be easily distinguished when diagraming sentence patterns. In the information literacy project graphic diagrams are used to demonstrate research patterns. A slightly off-white background graphic is used to brighten the page, provide better contrast for

the color palette, and improve readability. The off-white background also serves as a bridge; it is the same background used for Web pages in the Center for Information Media environment (URL: http://lrs.stcloud.msus.edu/cim/cimindex.html). In order to improve transfer rate, the design team is keeping the color palette to nine colors, attempting to minimize the number of diagrams per page, and reducing the information content to one concept (or two interrelated concepts if short) per page or linking portions of a larger concept in a short sequence of pages.

Politics of Chaos

Many academic institutions have fairly structured environments for the development, implementation, and distribution of information technologies. The Web changed what many computer centers had built. Suddenly, almost everyone became empowered, not only because of the ease of creating pages, but because of the simplicity of turning a desktop computer into an Internet server. As a consequence, campus environments, especially for consistency of "look and feel" and integrity of information, have become close to unmanageable.

Public relations departments (and sports information offices) view the Web as a marketing tool, allowing the institution (or enterprise) to boast its accomplishments; admissions departments build on this view and promote the Web as a recruiting tool. Libraries see the Web as a powerful tool for improving access to information, but have yet to develop a method for filtering the flood of pages. Some instructors are beginning to recognize the Web as a means of distributing materials to augment lectures and labs. Legislators and some administrators, enamored with the potential of distance education to reduce overhead costs, see the Web as a solution (often in search of a question). Computer centers too often view the Web as an opportunity to expand their influence on campus. "Ownership" of content often begins to conflict with "ownership of the means of distribution." The chaos resulting from such widespread involvement and competition, leads to disagreement on design and content standards and allocation of resources.

In order to avoid conflict (and possibly to avoid resolving points of conflict) individuals and departments are easily seduced into launching their own servers. However, they soon discover that managing Web servers and environments is more than a part-time job. Student workers are too often hired to solve short-term problems and inadvertently create long-term headaches. While specialized scripts and extensions are available for downloading, they often need to be modified to meet local needs. Other scripts may need to be designed and authored locally. When these and other hardware/software problems arise, programmers in computing centers are called upon to provide solutions or assume operational responsibility.

Like desktop publishing, which made everyone a poor publisher, HTML makes everyone a poor information disseminator. Knowing what happens on the screen when using a particular markup tag does not mean that a particular tag is used properly or with any understanding of the relationship of content and design to communication. The overabundance of uncoordinated graphics and graphical elements (colored bullets and lines) is common, but often does little more than slow the display of pages and confuse the user with their often ambiguous meaning. There is seldom an understanding that coherent environments are more important than individual pages and that environments, once created, cannot remain static. As the number of pages in environments grow, maintenance requirements grow. Again, individuals and departments often turn to other areas of campus to assume maintenance responsibilities.

The information literacy project environment follows the individual department model, although with some caveats. Learning Resources is an umbrella organization incorporating a traditional library, a

degree-granting academic department, an instructional design and media production unit, an academic computing service, and a telecommunications group. Because of slow recognition of Web potential within the computing service and subsequent development of the Web as a public relations media, the other units coordinated acquisition and implementation of a local Web server (Sun Sparcstation). Undaunted by a general absence of adequate programming knowledge, the server was implemented with the assistance of the telecommunications group. While a local server is easily integrated into the campus network, builds upon the distributed client/server model, and places considerable content and design control in local hands, its existence has created maintenance and enhancement dilemmas that remain unresolved.

It is unlikely that the chaos and duplication of effort will be overcome completely. But academic environments can do more to coordinate and promulgate standards (at least in "official" environments) and differentiate areas of responsibility and support. Creating a coordinating team with individuals drawn from constituent areas of responsibility (computing, public relations, graphic design, information organization, content) can lessen entrenched turf wars. The early negotiation of standards within such a group, and the broader acceptance and implementation of standards they develop, can reap enormous savings in development of large-scale environments (and reduce designer/learner frustration) later.

Project Goals and Objectives

Goals and objectives were developed based on our needs assessments, and courses currently being offered. The goals were that leaners would be able to asses their information needs, access information through a variety of sources, demonstrate ethical and legal use of information, evaluate and select information, and organize and communicate the results of their research.

Our primary audience for the instruction is generally young (18-24), academically inexperienced, easily frustrated, and impatient. Most are concerned with class work, efficiency of effort and the general college experience. Their learning style is generally concrete active, that is, they prefer to begin with experience and end with theory. Keeping these things in mind, we designed the instruction to be learner-centered with a task-based organization (Ellis & Laden 1995).

We applied CBT principles as much as possible within the constraints of HTML and browser capabilities to the information structure, navigational tools, and page or screen design. When choosing how to structure and sequence the information, we needed to determine what information would be included, how learners would use the instruction, how each chunk of information was related to each of the others, and how the information would be displayed. We tried to select an information structure which is logical to the user since this would help learner's remember the content, and keep track of where they were.

Pages were designed to be consistent and attractive and to keep cognitive load reasonable by making presentations short, chunking information to avoiding "megapages," and creating spaced practice. Text was written with active language with good mechanics and avoided use of jargon so that meaning and intent was clear and concise. We made an effort to create clear transitions between topics, while keeping in mind that users had considerably more control than in self-contained computer based instruction, and may not necessarily follow the intended path. Creating appropriate transitions and instructions can guide users through the content and increase the likelihood that all instruction is covered adequately.

Like text, the images on our pages were designed to gain the user's interest, explain something or help users remember the lesson content. Images were designed to fit on most computer screens when all options on the browser (such as show location) were toggled to on . When it was necessary to show a large image, it was often done by creating a link from a smaller version (thumbnail). Excessive detail was avoided in images to reduce confusion or overload on the part of the learner. Text and graphics were both

used to cue students to important information, and we attempted to place the graphic and text prompts used to guide students or provide hints near the center of the computer screen where they would be more salient. Because not all browsers are capable of displaying graphics in the display of an HTML page, it is important to label the graphic so the user would know the content of the graphic. In addition, users with slower modem speeds often choose not to automatically load images. They will then be able to read the image label and choose to load the image if they think it will help them understand the content.

We chose not to use audio or digital video since the content was not dependent on moving images or sound. Many of our users were not yet sophisticated Internet users and did not have appropriate application software on their machines (and we are not licensed to distribute appropriate software off-campus). Should we decide at a later date to add more multimedia capabilities, we would be sure that all content was also conveyed in text.

Interactions

Interactions are what set instruction apart from documentation. Positive and corrective feedback is necessary to a successful interaction. The types of interactions are possible on a self-paced lesson: fill-in the blank, multiple choice questions, forms and surveys, information searches, interactive image maps. We chose a variety of interactions based on content requirements. To help students move beyond memorizing information to a deep understanding of the content and develop transferable skills, we wanted to take advantage of the unique aspects of the internet. We considered collaboration between students &/or faculty on web page creation, research or discussion through newsgroups, e-mail or through a MUD/MOO/WOO. We decided to begin with newsgroups and e-mail, and perhaps later use a WOO (selected over a MUD/MOO for seamless integration with the Web environment). Also we provided access to librarian expertise through the Web page email function.

Evaluating the tutorial

We initiated a dry run to check for content accuracy and pedagogical considerations with a subject-matter expert (librarian) and an instructional designer. The a one-to-one evaluation with target population novice library users was conducted to test for usability and learning with a variety of software and hardware. Finally a field test with a larger group of students was conducted to test for usability and learning, timing, and to assess actual on-line field conditions.

Summary

In this article we have attempted to share some tips and lessons learned from an instructional project designed for delivery on the World Wide Web. We embarked on the project to provide information literacy as 1.) a component within the LEO: Literacy Education Online environment to provide guidance on how to use, assess, and apply various library-based research tools and, 2.) to integrate those resources into an instructional program to augment traditional classroom education or to support distance education. The Web was chosen as the delivery vehicle for its platform flexibility and ability to seemlessly provide instruction and access to resources. This strength, we felt, outweighed weaknesses such as potential for learner disorientation. Campus chaos needed to be addressed if not resolved for the project to proceed. Applying the principles of instructional design we assessed student content and delivery needs, determined our goals and objectives, and began development. We adopted a task-based learner-centered model for the instruction. Applying and adapting principles of CBI to the Web, we developed templates and designed interactions and assessment tools appropriate to the content. The project is currently under development and a formative evaluation is being conducted on component parts as they are completed.

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