

RUNNING HEAD: Web-Enhanced Instruction

A Theory-Driven Model for the Web-Enhanced Educational Psychology Class

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Abstract

This paper begins with a review of literature relevant to the use of the World Wide Web for class enhancement. A number of themes are discussed that can be derived from published anecdotal accounts from web designers and other experts. What little controlled research that has been conducted indicates that there is not any significant difference between traditional lecture, and web-based courses on measures of learning. Related literature on self-contained hypertext environments is also discussed. The literature review is followed by a summary of educational theory relevant to web-enhanced instruction. Cognitive flexibility, situated action, guided discovery, and spatial-verbal processing theories are discussed, and design principles derived from these theories are presented. Lastly, examples from a web enhanced undergraduate educational psychology class are presented. Components of the class discussed are web-lecture supplements, interactive web activities, and US news briefs group activities.

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The World Wide Web and Education

There is no question that the world wide web has already had a large impact on the way that educational delivery is viewed, as Ron Owston (1997) puts it in a recent article on the World Wide Web in the *Educational Researcher*, “Nothing before has captured the imagination and interest of educators simultaneously around the globe more than the World Wide Web” (p. 27). The use of the web in the classroom, and the growing number of classes offered completely over the web have exploded in during its very short history (e.g., Anderson & Joerg, 1996; Dodge, 1995; Kinzie, Larsen, Burch, & Baker, 1996; Logan, 1996; Mounts, 1996; Shotsberger, 1996; Weiler, 1996.) Unfortunately, despite the popularity of the web in education, there have been few controlled empirical investigations of the effectiveness of this medium. However, an examination of the existing published anecdotal accounts and experiences of educational web designers yields some fairly consistent principles:

1. Symmetry/Simplicity

- ◆ A potential educational web site designer should suppress the normal tendency to demonstrate their skills and abilities to use multiple graphics and other complex multi-media. Experienced site designers recommend that the developer create “sensible, clear and clutter free navigation” (Everhart, 1997, p 24); to avoid flashing text (Cotrell & Eisenberg, 1997); and to think small (Schwier & Misanchuk, 1996). In general, non-textual graphic and other multi-media components should only be included if they serve a clear purpose (Cotrell & Eisenberg, 1997; Everhart, 1977)

2. Consistency

- ◆ The design of individual pages should be consistent within a web site, and, in general the site should have an over-riding consistency/commonality (Cotrell & Eisenberg, 1997; Everhart, 1997; Shotsberger, 1996; Young & Watkins, 1997)

3. Minimize Download Time

- ◆ An effort should be made to minimize the number of large graphics, and other multi-media materials that increase the time it takes for the page to download (Cotrell & Eisenberg, 1997). The designer should keep in mind that there’s a good chance that some users will be using slow modems.

4. Pre-organizer

- ◆ The designer should make an effort to provide the learners with some sort of pre-organizational tools, to provide him or her with some idea as to the organizational

structure of the site. With the ideal site, a learner should be able to tell at first glance what the scope and organization of the site is (Cotrell & Eisenberg, 1997; Everhart, 1997) and the prototypical navigation path should be made obvious (Goldberg, 1997). Some suggest that a concept map may serve this purpose (Dodge, 1995)

5. Flexibility

- ◆ Although designers agree that providing learner guidance is a crucial part of an effective educational web site, the ideal site also allows for flexibility in navigation (Goldberg, 1997).

6. Minimize Scrolling

- ◆ Most designers agree that one of the advantages of the hypertext format is that the site can be more than just a series of pages of notes hooked together in one long window. The pages should be presented in manageable sizes, and the need for scrolling should be minimized (Cotrell & Eisenberg, 1997), and, consistent with the need for structure and symmetry, the pages may be displayed most effectively as a hierarchy of short pages (Young & Watkins, 1997).

7. No dead ends

- ◆ A web site should exhibit “circularity” (Young & Watkins, 1997, p. 2), in that the learner should be able to easily find their way back to previous pages, when going on side excursions in navigation. Some suggest that the learner should always be able to get back to the start in one click (Cotrell & Eisenberg, 1997).

All of these suggestions should be considered and implemented with a degree of caution. They are based on the experience that web designers have developed in the first few years that the web has existed, and, almost none of these principles have been tested via rigorous-controlled research. Nonetheless, there does seem to be some consistency among designers with respect to the above principles.

A noted exception to the anecdotal data described above is an experiment conducted by Murray Goldberg (1997). A very elaborate and thoughtful web site was developed for the delivery of a computer science class. The site included interactive exercises, learner feedback, and required no special plug ins. A number of design principles were considered in the creation of this site. During one semester of the class students volunteered for this experiment. The volunteers were randomly assigned to a lecture, web+lecture, or web group. In the former they were taught via a traditional lecture approach, and were not allowed access to the web site; in the second case they were taught via lecture and were also allowed access to the web site; and, in the latter group they were not allowed to attend lectures, and took the class completely via the web site. There were not significant differences among groups on class test scores, though there was a trend for those in the lecture+web group to do better, while the other two

were largely equivalent. Other interesting findings that emerged from questionnaire data: a) the lecture-only group was the least satisfied with the method of class delivery; b) the web only group reported spending less time on the class; and c) those in the web only group said they would prefer lectures in conjunction with the web.

Interestingly, the finding that the mode of delivery (lecture, web+lecture, and web) did not significantly effect class performance, is also consist with related research involving self contained hypertext environments. In two experiments a self contained hypertext program was created to deliver class materials to replace lecture. In each case, lecture, lecture+hypertext, and hypertext only groups were compared, and, in each case, no significant differences in class performance were found (Forrester, 1995; Vandenberg & Watt, 1991).

Also, from research on self contained hypertext environments, comes empirical evidence that providing learner guidance is important in determining the effectiveness of such an environment (Jacobson, Maouri, Mishra, & Kolar 1995; Jacobson & Spiro, 1995; Large, 1995). This finding is particularly applicable to web-based hypertext environments since there is more potential for confusion and unguided discovery learning.

Educational Theory and the Web Enhanced Classroom

I have identified four theoretical models that I believe are particularly relevant to the use of the world wide to enhance a traditional class. A summary description of each of these follow:

Cognitive Flexibility. Cognitive flexibility theory is a theory of complex knowledge learning (Feltovich, Spiro, Coulson, 1989; Jacobson & Spiro, 1995; Jacobson et al., 1995; Spiro, Vispoes, Schmitz, Samarapungavan, & Boerger, 1987). It is based on the metaphor that the learning of complex knowledge is analogous to criss-crossing a conceptual landscape. The theory has been applied effectively in self-contained hypermedia learning environments (Jacobson et al., 1995; Jacobson & Spiro, 1995.), so it extends readily to the world wide web. Some of the basic principles of the theory that are relevant in the design of a web enhanced class are: a) Introduce the learner to multiple representations of the knowledge domain; b) Introduce the learner to the complexity of the to be-learned domain up front; c) Create an active learning environment; and d) Tie the information to be learned to case examples.

Situated Action. The term “situated action” is often used to describe a general educational model as laid out by a number of researchers (e.g., Brown, Collins, & Duguid, 1989; Collins, Brown, & Holme, 1991; Greeno & Moore, 1993). The fundamental principle of this theory, which in many ways has become the over-riding metaphor for educational research and theory, is that all learning is strongly imbedded in a given context, and this context should be meaningful, practical, and relevant to "real life" (Brown et al., 1989; Jacobson et al, 1995). The Web certainly has the potential to provide such a context. The foundational information the instructor is attempting to

convey in the class can be greatly enriched by the information available via the World Wide Web.

Guided Discovery. During the 1960s, discovery learning, a term introduced by Jerome Bruner (1960) became a popular educational practice. In general, the fundamental idea behind discovery learning, was that learners should be left on their own, with the appropriate tools, so that they would eventually "discover" the appropriate answer/method, and this discovery would constitute much more long lasting and meaningful learning than traditional direct instruction techniques. While research has born out Bruner's basic notion that active learning is much more effective than passive, studies that have examined discovery learning indicate that the technique is often ineffective. It is important that the instructor strike some sort of balance between giving the learner the freedom to actively engage the material, while also providing the learner with enough guidance and feedback that he or she learns efficiently and effectively (Gagne & Brown, 1961; Mayer, 1987). Many students' experience with the World Wide Web is analogous to an episode in discovery learning, in that there is so much information available, yet finding relevant information, and knowing what to do with it, is often far less obvious (Anderson & Joerg, 1996).

Spatial-Verbal Processing. A fourth theoretical model that is particularly relevant to web page design is a set of related theories that I refer to as spatial-verbal processing ("contiguity theory" Mayer, 1997; Mayer & Anderson, 1992; "spatial-verbal processing model" Dansereau, 1989; Lambiotte, Dansereau, Cross & Reynolds, 1989; and "conjoint retention" Kulhavy, Lee, & Caterino, 1985). All of these theories borrow heavily from Paivio's dual-coding model (Paivio, 1971). Paivio suggests that some types of information are learned much more quickly and readily since they lend themselves to a dual verbal/abstract and imagic/concrete code, so that the information is stored diffusely/redundantly. A host of research has, since that time, supported Paivio's theory (e.g., Clark & Paivio, 1991; Mayer, Bove, Bryman, Mars & Tapangco, 1996; Paivio, 1986; Schwartz & Kulhavey, 1981). The spatial-verbal processing theories extend dual-coding, in that they apply not just to verbal information that lends itself to verbal and imagic storage, but to pictorial/spatial and verbal (i.e., multi-media) displays. The combination of pictorial/spatial and verbal information constitute the typical web page.

Specific recommendations based on these models are displayed in Table 1.

Cognitive Flexibility	<ul style="list-style-type: none"> • Include multiple sites and activities for the same complex materials • Include elements that emphasize the overall organization, and elements of connectedness • Include interactive activities • Tie foundational material to cases, represented by given web sites
Situated Action	<ul style="list-style-type: none"> • provide for flexibility of access time and place • include relevant external sites that provide “real world” relevant context for foundational materials
Guided Discovery	<ul style="list-style-type: none"> • Include navigational guides • Include structured web activities
Spatial-Verbal Processing	<ul style="list-style-type: none"> • Use graphics as support for textual material

Table 1. Web Applications based on Theory

Example from an Educational Psychology Class

During the fall of 1997, I taught an Educational Psychology class in which I use the World Wide Web extensively. The components of this class which involved the WWW follow:

Web-Lecture Supplements. For all lectures I created a lecture outline, and supplemented this with related figures, pictures, and graphics. This was displayed on the web as two side-by-side frames, one representing the outline, and the other the graphics. Clicking on a component of the outline would bring up the associated graphic. I used these displays for my lectures in class, and this was also available for students over the web for viewing outside of class. Examples are presented in Figures 1 - 3.

These supplements were consistent with the theories presented above in that I made an effort to explicitly tie the verbal information contained in the outline with the figures/pictures/graphs (i.e., spatial/verbal processing). In addition, the outline provided the learner with an overall structural representation of the domain, consistent with cognitive flexibility theory. Further, the fact that the displays were available outside of class for any computer that had an internet connection and a web browser added allowed for the focus to be more on the student than the instructor, thus consistent with situated action theories.

Interactive Web Activities. Four times during the class, students were required to carry out interactive web activities, in which they were required to go to an external web site and answer questions relevant to that site. I made an effort to select sites that were

relevant to the information that was currently being discussed in class, and which emphasized the application of that information. For example, on the last project I had students visit the Titan (Andrius, 1998) web site, after I had contacted the author of the web site. The introductory page of the project read as follows:

To complete this project, you will be required to visit one section of one of the modules of the Teachers in Training Education Network project (TITAN). This module, which covers tips on teaching, is a part of the section on classroom management. When you click "here" below you will go to that module and you should explore/study at least three of the tips. After this, click on the "questions" button which will be in a small frame at the bottom of the page. You will be required to respond to the following items:

1. Which of the "teaching tips" did you explore/study?
2. Summarize what you learned about teaching from your examination of these tips.
3. Describe a hypothetical scenario from a classroom full of students of any age group you choose, in which you are the instructor, and which relates to one or more of the tips that you read about. (Do not use an example that was used with the tips.)
4. Please provide some constructive comments on the TITAN module that you studied for this project, to aid the author in further development.

Please keep these items in mind as you study the "Teaching Tips" portion of the "TITAN" module on "Classroom Management". The TITAN site is being developed by John Andrius as part of his Ph.D. work at the University of Tasmania. Your responses to these items, in addition to serving as your fourth web project, will also be sent to John Andrius to aid him in evaluating this site. When your responses are sent, your name and email will NOT be included. However, when you are finished with the project, you will have the option of helping John further with his development of the project, by sending him your name and email, but this is completely up to you and will in no way influence your grade on the project. Directions for doing so will be displayed after you submit your answers. As always, you can do some of the questions, submit them, and then do the rest later, just be sure and **INCLUDE YOUR NAME AND EMAIL EACH TIME YOU SUBMIT ANSWERS!** To begin the project click here.

The inclusion of interactive activities such as these is consistent with the active learning and tying information to case examples principles of cognitive flexibility theory; provides a meaningful context for learning, consistent with situated action theory; and provides a structured learning activity, consistent with guided discovery theory.

US News Briefs Group Activities. Once every two weeks students met in small groups and discussed information included in *US News Briefs* from the *EdNet* Web Site (Simpson Communications, 1998). These briefs presented stories currently in the news involving education. Students were asked to read selected briefs before class, and then answer application questions about these timely stories within their group, after which one group member summarized the groups' views with the class. Questions were aimed at stimulating critical thinking about issues. Students were also responsible for the information contained in the assigned briefs for the class tests.

For example, one of the news briefs (Henry, 1997):

CLINTON WANTS NATIONAL READING AND MATH EXAMS
 Battles over President Clinton's goal of national reading and math tests for fourth and eighth grades are expected to erupt when Congress returns on September 3. Clinton wants to create tests as challenging as any currently available. Critics of his plan see federal influence creeping into local control of schools. Civil rights groups, including the NAACP, fear the tests being misused to track, or retain, students. During the congressional recess, the U.S. Education Department awarded a \$13 million contract to begin development of the tests, scheduled to start in March 1999. Education Secretary Richard Riley hosted briefings for officials from 47 states. 15 urban public school systems will participate.

Students were asked to respond to the following with respect to this story.

Pretend your group is a congressional committee who is in charge of passing or not passing this law. a) Each group member should express his or her opinion. The group should then come to a consensus and pass or not pass the law.

These activities are also consistent with the active learning, and case examples principles of cognitive flexibility theory; and provide a meaningful context for learning, as specified by situated action theory.

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