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Instructional Web Site Design Principles:

A Literature Review and Synthesis

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### Abstract

The purpose of this review is to summarize the present literature relevant to web-based-instructional site design, with the goal of delineating general principles and practices that are associated with effective site design. The literature reviewed consists of published accounts of web designers, trainers, and instructors, as well as research in basic education, hypertext, and web based training and instruction. The review is organized around a basic framework, which is based on the individual web page as a starting point for web design, consisting of textual and imagic components. The links and the site structural system is then considered, in terms of internal links (i.e., other pages and interactive activities); and external links (i.e., external sites, and communication activities). Literature and principles derived from this literature is presented with respect to each component of this framework. Among the basic themes to emerge are: a) the potential effectiveness of web-based training compared to on-site training; b) the importance of providing structural guidance for the learner; c) the importance of including interactive, learner centered, activities; d) the potential effectiveness of utilizing the vast resources available on the web; and e) the potential effectiveness of collaborative web-based learning.

## Instructional Web Site Design Principles: A Literature Review and Synthesis

### Introduction

#### Focus of review

The purpose of this paper is to review the existing literature relevant to web based instruction site design, with the aim of deriving general principles and specific applications useful to the web-based instruction site designer. The review was specifically carried out to derive generic principles for site design, as opposed to presenting multiple models based on various learner, content, and outcome variables. It is my view that such a focus can serve an important function as a starting point, and as a foundation during this early phase of research and theory applicable to web-based instruction and training. Others have also espoused this view. For example, Bannen & Milhelm (1997) suggest that "...there is also a significant need to describe these Web-based courses in terms of their over-all instructional design characteristics, rather than defining each course only by the specific content it provides". However, I certainly recognize the fact that no one set of design principles will be satisfactory for all conditions (Smith, Newman, & Parks, 1997). Further it is important that the reader know that the World Wide Web, like all instructional and training media, is simply a means for providing effective instruction, not an end in itself (Reeves & Reeves, 1997).

#### Present State of Research

It is also important to note that the assessment and delineation of effective web based training methods is in its infancy. As such, there are few systematic, controlled studies of specific aspects of web site design as it applies to instruction or training. As a

result, there has been a call for more controlled, systematic research examining web-based training & instruction (Butler, 1997; Landauer, 1995; Oweston, 1997; Reeves & Reeves, 1997). In any case, in this review I will include many published accounts, which are more anecdotal than experimental, based on the experiences of the early developers and innovators in the area of web based instruction and training. I believe it is important to point this out so that the reader can consider this review in the proper context, however, I still believe much valuable insight can be gained for the web-based instruction designer from a review of the literature as it now stands.

There is a surprising amount of consistency and agreement among those who have been designing instructional web sites, and many important lessons have already been learned and expressed in “real world” accounts. Further, there are a number of controlled usability and learning studies that have been conducted with self-contained hypertext environments, which are certainly relevant to instructional web-site design, since the web is essentially an open hypertext and hypermedia environment (Smith, Newman, & Parks, 1997). Finally, there are some noted exceptions to the lack of controlled, empirical research, and studies of this nature are appearing at the time of this writing.

#### Overall Effectiveness

Before considering specific components of web site design it is important to note that some experiments which directly compare web based learning with traditional instruction have been conducted within academic settings in recent years. These experiments consistently indicate that students can learn via the web just as effectively, or in some cases more effectively, than those in the traditional classroom (Gerhing, 1997; Goldberg, 1997; McCollum, 1997; Russell, 1996; Witherspoon, 1996). This research is

somewhat misleading, in that these studies always involve a comparison with an instructor using direct instruction (lecture), and in some cases the web group is required to do more work (McCollum, 1997). However, these studies are an important starting point for our review of literature relevant to web based instruction, especially for the instructor who is reluctant to teach via the web, in that the available evidence indicates that the learner can learn just as effectively in the web-based environment. Most importantly, good versus poor instruction is a consequence of design and delivery, not the medium by which it's delivered (Clark 1983; 1994). Thus, the issue now becomes, what differentiates an effective web course site design, versus a poor one? The rest of the review is dedicated to this issue.

### Organizational Framework

This review and the principles which emerged will be couched within the framework displayed in figure 1. As you can see from the figure, the basic starting point of web site design is the page, which is fundamentally a textual and image display. Links make up the other basic component of the page, and it is these associative links which make the web site fundamentally different from traditional text. Further, the links are the beginning point for determining the overall structure of the web site. I have also differentiated between the self-contained site controlled and created by a given designer, and the external web, as represented by the area outside the box. Without the latter, the web-based instruction is no different than a self-contained hypertext/hypermedia program. I will begin with the individual page.

## Page Design

### Text

The most consistent principal across the present literature on web site instructional design, is that the text presented on a given page should be limited (Cotrell & Eisenberg, 1997; DeBra, 1997; Jones & Farquhar, 1997), and that scrolling should be avoided (Shotsberger, 1996). This position is supported by most designers, and there is also evidence from traditional instruction that breaking instructional units into smaller parts can enhance learning, and increase motivation (Cornell & Martins, 1997; Keller & Burkman, 1993). Breaking the text into individual pages should not consist of simply taking a large, linear page of text, and breaking it into a sequential series of pages (DeBra, 1997; Nielson, 1997), rather the linking should be used to allow the learner to have more control in reading than would be the case with traditional text. In this sense hypertext reading is fundamentally different from traditional reading in that the learner becomes an active participant (Kolosseus, Bauer, & Bernhardt, 1995), and the distinction between learning and authoring breaks down (Burbules & Callister, 1996). In fact, hypertext reading has been likened to a dance (Dowling, 1997). (Although, as I'll discuss below, learner control can be a two-edged sword.)

Not only should the text segments be small, but the author should write less in general than would be the case with traditional text (DeBra, 1997; Nielson, 1997). Reading information from a computer screen can be as much as thirty percent slower than reading from paper (DeBra, 1996; Wright & Lickorish, 1983). Although this problem can be largely overcome with greater screen resolution and anti-aliasing text (DeBra, 1996), learners still report frustration with reading text from a screen (Bostock, 1997).

For this reason, those presenting training materials via text should make a concerted effort to be succinct. Nielson (1997) suggests that instructional text on the computer should be about 50% as long as would be the case if the same text was presented as hard copy.

Another important aspect of web page design, which differs from traditional text presentations, is that many designers advocate an “inverse pyramid” design, with important information clearly demarcated at the top of the page (Cotrell & Eisenberg, 1997; Jones & Farquhar, 1997; Nielson, 1997). This aids the learner in being able to more clearly discern the overall structure of the information, a crucial factor in effective web training design, as we’ll discuss below.

One aspect of traditional text, which should be imitated on the computer, is the shape of the traditional text page, taller than it is wide. Newspapers, of course, even create multiple columns to exaggerate the short line length. Unfortunately, most computer screens are designed in the exact opposite fashion. This creates more strain on the users in the effort required to move their eyes back across long lines to the next line, and can be confusing, especially if some of the lines begin with the same words. There is research which indicates that learning is more effective with more shorter lines, than with fewer long lines (Hansen & Haas, 1988). For this reason DeBra (1996) suggests that the designer use multiple columns on the screen, and/or break up the text with graphics to make the line length more manageable.

### Images

There are a number of related theories which are applicable to the display of text and image combinations, which were not developed specifically for the World Wide

Web, but which certainly apply (i.e., “conjoint retention”, Kulhavy, Lee, & Caterino, 1985; “spatial-verbal processing”, Dansereau, 1989; Lambiotte, Dansereau, Cross & Reynolds, 1989; and “contiguity theory”, Mayer, 1997; Mayer & Anderson, 1991). All of these theories are extensions of Paivio’s dual coding theory (Paivio, 1971), and all are based on the fundamental premise that pictorial/spatial representations, in combination with text, can serve to produce a more robust "dual-code" than text by itself. There is a great deal of research which supports this (Abel & Kulhavy, 1986; Hall, Dansereau, & Skaggs, 1992; Mayer & Anderson, 1991; Mayer, 1997; Rewey, Dansereau, Skaggs, Hall, & Pitre, 1989). The inclusion of graphics, in combination with text is common practice in web displays, and the web is certainly different from traditional text, in that the images can be dynamic, involving movement, or even some type of video image. The above mentioned theories can all be seen as support for the effectiveness of combining text with graphical representations, but it’s important to note that the assumption is that the graphical representation directly supports the text to be displayed. While these theories would seem to suggest that images should be used liberally, there is a consistent message in the existing web-instruction literature, which is that graphics, especially dynamic ones, should be used carefully.

Developers are in agreement that graphics, and multimedia in general, should be used only when they directly support the materials (Cotrell & Eisenberg, 1997; DeBra, 1996), when they serve a “clear instructional purpose” (Everhart, 1997). The hypertext environment on the web is inherently complex on the face of it, so the designer should be especially careful about adding to this complexity. In addition, including too much graphical information is inconsistent with the theme developed above, that the site should

consist of small instructional units. Moreover, download time is a very real issue with respect to web documents as anyone knows who has used a relatively slow modem to download an elaborate page, rich with multimedia. For this reason, the designer should make an attempt to minimize download time as much as possible (Cotrell & Eisenberg, 1997). Although it is certainly true that there is much evidence that images can greatly enhance the power of text, images should be used carefully and only when necessary. In general, "...the single page should not be cluttered and contain too much information" (DeBra, 1996).

### Hyperlinks/Site organization

Hyperlinks are the basic building blocks, and determinants of the overall structure of the site. Therefore in this section I will begin with specific issues about links and individual pages, and I will follow this with basic issues of overall page structure, in addition to specific issues about links.

#### Links on the Page

Just as was the case with images, and other multimedia, designers are in agreement that links should be included on a page only if they serve a clear purpose (DeBra, 1996; Shneiderman & Kearsley, 1989). In one experiment, a negative correlation was found between the number of links on a page and learners' comprehension of the information contained in a site (User Interface Engineering, 1998). Another consistent suggestion is that links should be clearly labeled (Berners-Lee, 1995; DeBra, 1996; Jones & Farquhar, 1997; User Interface Engineering, 1998). This not only lets the learners make a more informed decision as to whether or not they should click on the link, but it also gives the learner more clear information about the overall

organization of the site, which is an issue I will develop further below. For the same reason, the over-all layout of links on the page should have some organization/structural meaning (Jones & Farquhar, 1997; Nielson, 1997), and there is some agreement that links on one page to other places within the same page is confusing to learners (User Interface Engineering, 1998), and should, consequently, be avoided (Jones & Farquhar, 1997).

### Organizational Structure

One of the fundamental advantages of hypertext is the potential for representing complex knowledge via multiple associative links (Frick, Corry, & Bray, 1997; Reeves & Reeves, 1997). The World Wide Web certainly represents such a complex structure, and represents an infinitely large complex, ill-structured domain. Unfortunately, such a structure is ideal for facilitating browsing and exploring, but is not well suited for searching (Smith, Newman, & Parks, 1997). More importantly, the large amount of freedom and control that this allows the learner may be particularly detrimental for the novice learner (Large, 1995; Niemiec, Sikorski, & Walberg, 1996). In fact, there is a surprising amount of research with hypertext systems that indicates that including too much learner control can, contrary to expectations, decrease learning effectiveness (Large, 1995; Niemiec, Sikorski, & Walberg, 1996). This is not so surprising when one considers how complex, and novel, is the hyperspace for the average learner. This phenomena has lead to the term, “lost in hyperspace” (Burbules & Callister, 1996; Hill, 1997; Nielson & Lyngbaek, 1990). For this reason, one of the most important design principles, which is supported both by web-designer published experiences, and by research on hypertext learning environments, is that the learner should be provided with guidance (Jacobson, Maouri, Mishra, Kolar, 1995; Smith, Newman, & Parks, 1997).

There are a number of ways that the web-based-training designer can combat the “lost in hyperspace” problem, and provide the learner with some guidance. The first method is to create a clear, and systematic organization scheme for the learning site (DeBra, 1996; Schneiderman & Kersley, 1989). For example, Everhart (1997) suggests that the site should be “sensible, clear, and clutter free” (Everhart, 1997). Such a clear organizational scheme can increase learner motivation in addition to enhancing learning (Cornell & Martins, 1997; Keller & Burkman, 1993). The usual/prototypical path through the pages should be obvious (Goldberg, 1997), and the information should be in a modular fashion within a well structured hierarchy (Smith, Newman, & Parks; Young & Watkins, 1997). In this same vein the main points should be obvious to the learner (Shotsberger, 1996). In fact, a consistent theme in the literature is that some sort of advance organizer should be included in the site design so that the learner can easily get an overview of the site organization (Burbules & Callister, 1996; Cornell & Martins, 1997; Cotrell & Eisenberg, 1997; Dodge, 1995; Everhart, 1997). A clear organization also includes consistency in design across all the pages of a site (Cotrell & Eisenberg, 1997; Everhart, 1997; Shotsberger, 1996; Young & Watkins, 1997). There is evidence that learners have a great deal of difficulty comparing and contrasting information across different sites due to a lack of design consistency (User Interface Engineering, 1998).

Although the importance of providing a clear organization and learner guidance is of fundamental importance, it is also important to take advantage of the flexibility of hypertext. For this reason web designers, and learning theorists, have also emphasized the importance of creating a flexible site design, which accommodates the more inquisitive or expert learner whose goal is to explore (Goldberg, 1997; Reeves & Reeves,

1997; Siegel & Kirkley, 1997). While this may seem to be inconsistent with the organization and guidance themes presented above, hypertext environments are flexible enough to provide guidance and flexibility simultaneously. In order to do this, the organizational structure should provide a clear route back to the starting point (Goldberg, 1997; Hardman, 1989), to allow the site “explorer” to find their way back. For this reason, designers emphasize that a site should not include dead ends (Young & Watkins, 1997; Shotsberger, 1996).

### Internal Links

The most basic type of link is from one page in a site to another page within the same site. By "same site" I am referring to pages created and/or controlled by the site developer normally located on the same server. Such a linking system would be analogous to a self-contained hypertext environment which does not have to be located on the world wide web. Such links would be subject to the discussion above about site structure principles, and the pages linked to would be subject to the discussion about page design. In addition, these within-site links can include interactive activities, created using program techniques such as CGI scripts or Java Script. Such activities require the learner to respond to some type of question or exercise provided by the instructor. The learner's response can be sent to some external location (see discussion on communication below), or the program can create some sort of instant feedback for the learner.

Such an activity constitutes one of the most powerful learning tools that instructional web-based designers have at their disposal. Such a system can be used to provide the learner with information about their comprehension of the material (Nichols, 1997). Such activities act to enhance metacognitive awareness and active learning, two

of the most important factors in learning of all kinds (Reeves & Reeves, 1997). It is not surprising then that instructional web designers emphasize the importance of such activities (Ritchie & Hoffman, 1996; Gillani & Relan, 1997). The nature of these activities can differ a great deal, but one common theme that web instructional designers and educational researchers advocate is the inclusion of learner centered activities (Siegel & Kirkley, 1997), which encourage the learner to actively create their own learning, and to relate the information to “real world” problems (National Research Council, 1997; Siegel & Kirkley, 1997). For example, writing activities in which learners are required to relate class information to their own lives can serve as powerful learning tools within a web-based environment (Bonk & Reynolds, 1997; Rankin, 1997)

### External Resources

#### External sites

Siegel & Davis (1986) defined “computer imaginative designs” as “those that exploit the strengths of the computer by creating possibilities that were not readily feasible in any other medium.” One genuinely unique strength of web-based-instruction is the potential to use the vast store of resources available on the World Wide Web (Butler, 1997). The use of external sites as support materials is not only important, because it is a unique advantage of the web, but it can serve as a powerful tool for providing a meaningful, “real world” context (Jonassen et al., 1997), in that the foundational information included in the internal site can be linked to case examples from around the world (Jonassen et al., 1997). These can, of course, also be utilized into a fairly direct interactive task such as those discussed above, in which the learner responds to specific questions or problems provided by the instructor, about some external site (Hall, 1998). Or the learner can also

simply be directed to explore a site or group of sites, and to provide some sort of analysis, comparison, and/or synthesis (Dodge, 1997; Ritchie & Hoffman, 1996). Such exploratory activities, in which the learner is allowed to make the materials relevant to their own needs, can act to increase motivation (Cornell & Martins, 1997; Duchastel, 1997; Keller & Burkman, 1993). In either case, it is important to link the exploration of the site to some specific activity, to encourage the learner to actively process the information (Butler, 1997; Duchastel, 1997; Duchastel & Turcotte, 1996). Further, it is important that the external site and training activities associated with it fit into the basic goals of the instructional module (Butler, 1997).

### Communication

I have included the important topic of web communication within the external resources portion of the framework, in that communication on the web involves a connection between a single learner and another learner, instructor, or expert external to that learner. Although I recognize that, mechanically, such communication can take place within a self-contained environment, it seemed appropriate to consider this an “external” event in that it is usually beyond the direct control of the web developer.

Communication activities carried out among learners on the web also constitute one of the most powerful tools that web-based-instructors have at their disposal. Once again, we can look to decades of educational research, which point to the effectiveness of collaborative/cooperative learning (Johnson & Johnson, 1994; Slavin, 1995). In web based training this is particularly important since there is sometimes a tendency for the learner to feel isolated (Hill, 1997). The use of web-based collaborative activities has proven to be one of the most rich and promising areas of web-based instruction (Bonk &

Reynolds, 1997; Eklund & Eklund, 1997; Harasim, 1990; Harasim, Calvert, & Groeneboer, 1997; Malikowski, 1997; Riel, 1990; 1993; Rheingold, 1995). There are some unique advantages of the web with respect to collaborative interactions. First, these interactions can be structured and guided to a greater degree than they can in face to face interactions (Harasim, 1996), and providing structure in face to face cooperative learning is an important factor in determining its effectiveness (Hall, et al. 1988; O'Donnell, 1996; Patterson, Dansereau, & Newborn, 1992). Second, the conversations among learners are available for the learners and instructors to view, increasing metacognitive awareness. Third, the anonymity of web based collaboration can encourage learners who wouldn't otherwise participate to do so (McCollum, 1997).

Some important criteria have been identified that account for the effectiveness of cooperative learning via the web. Consistent with a theme, which runs through this review, the activity needs to be guided and structured to some degree (Jones & Okey, 1995; Jones & Farquhar, 1997). Just giving learners the opportunity to use email will not guarantee productive interactive discussion (Sherry & Wilson, 1997). For this reason instructors and designers have suggested that it is a good idea to require a minimum number of postings each week (Harasim, 1996; Malikowski, 1997; Paulsen, 1995). Another effective method is for the trainer to post messages to the learner to stimulate discussion, and encourage interaction (Eastmond, 1995; Harasim, 1993). Also, learners can be assigned different roles for the completion of a group project (Bonk & Reynolds, 1997; Shotsberger, 1997). Bonk & Reynolds (1997) provide an extensive list of other creative conferencing activities, which encourage active, student centered learning.

Another important factor is that the conferencing activity should be fully integrated with the class materials, as is the case with other interactive activities (Harasim, 1996).

### Conclusions

A number of themes emerge from an examination of the existing literature which are relevant to instructional web site design. One common theme, which emerges, is the importance of thoughtful site organization. The site designer must be careful to provide the learner with a modular environment consisting of short informational units, consisting of text, directly supported by useful graphical representations, linked in a structured intuitive fashion for the learner. At the same time, the designer should take advantage of the unique flexibility of the hyperspace environment by allowing for flexibility and learner control, including interactive activities which encourage, “real life”, activities. Further, the designer should make use of the vast resources available on the web to enrich the basic instructional materials with case examples. Finally, the designer should make use of the unique collaborative learning activities that are possible with the World Wide Web. Through the application of the of the principles delineated above, and careful and thoughtful planning, there is no reason that the instructional web-based designer can not create a learning environment on the World Wide Web as effective as any that can be created at a specific physical training site.

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Figures

Figure 1. Instructional Web Site Design Model

