

Creating Effective Instructional Materials for the World Wide Web

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Keywords: WorldWideWeb, Multimedia, Tertiary Education, Instructional Design, Teaching, Learning

Introduction

The World Wide Web is a popular and useful instructional medium for a number of reasons. It is easily accessible, it supports flexible storage and display options, it provides a simple yet powerful publishing format and a means to incorporate multiple media elements. Interestingly, instructional effectiveness is not a proven characteristic for World Wide Web courseware and in many instances delivery via the WWW can impede rather than enhance learning when compared to conventional publishing forms. The purpose of this paper is to consider design aspects that can help to improve the instructional effectiveness of teaching and learning through the WWW.

Learning through the WWW

The hypermedia format used by the WWW has received wide acclaim and its potential as a learning tool is derived from the nature of the learning that it supports. It facilitates student-centred approaches creating a motivating and active learning environment (Becker & Dwyer, 1994). It supports and encourages browsing and exploration, learner behaviours that are frequently associated with higher-order learning (Thuring, Mannemann & Haake, 1995). The nature of information organisation in hypermedia appears to closely mimic human memory, and retrieval methods closely resemble human thought processes. Hypermedia facilitates a very natural and efficient form for information retrieval (Dimitroff & Wolfram, 1995). These and other advantages offered by the medium have created considerable enthusiasm among learning theorists and teachers, towards the WWW and hypermedia as a learning tool. But as with all instructional technologies, potential and reality are frequently not synonymous.

Hypermedia materials themselves do not teach but provide a medium that with appropriate use can support learning (eg. [Eklund, 1995 \[HREF 3\]](#) ; [Alexander, 1995 \[HREF 4\]](#)). Learning is achieved through a process of constructing knowledge. When a learner is confronted with new knowledge, the learner's intentions, previous experiences, and metacognitive strategies are all essential elements in determining what becomes of the knowledge (Reeves, 1993). The effectiveness in any learning environment is based upon the types and levels of cognitive and metacognitive activity engendered in the learners. It is now widely accepted that learning is enhanced by active environments in which students have cause to be engaged in processing personally relevant content and to be reflective during the learning process (Jonassen, 1994). How this can be achieved through the WWW is the focus of this paper.

Factors influencing the effectiveness of the WWW as an instructional tool

Learning is a process that is influenced by, and results from, the interaction of three areas of influence: agent, activity, and world (Lave & Wenger, 1991) Other writers, for example, Brofenbrenner (1979) provides similar descriptions for these influences such as person, process and context approach (as cited in Ceci & Ruiz, 1993). In terms of the instructional design for interactive multimedia programs, we have found a framework of three mutually constitutive elements: the learner, the implementation and the interactive multimedia program to be useful in describing the roles and responsibilities within the learning process. The three elements correspond to the role of the teacher, learner and the materials themselves, in the instructional setting. When this framework is applied to the design of WWW multimedia materials, key factors and strategies for each of the elements can be identified (Figure 1). While the factors for learner and implementation are quite consistent with other interactive media, within the WWW materials there are a number of important and unique attributes that can be considered.



Figure 1: *Constitutive elements of effective WWW learning environments*

Designing WWW Documents

Print-based instructional materials have served well in the past in support of student-centred independent learning. In recent times, the move to computer-based learning environments has been taken to improve the perceived interactivity of the materials. There are unique advantages among print and computer-based materials and the WWW appears to provide a means to make the most of the opportunities afforded by each. Some critical considerations in designing electronic instructional and informational materials include organisation, orientation, navigation, presentation and interactivity.

Organisation

A problem facing the WWW designer is choice of the strategy that should be employed to organise the material. While hypermedia describes a particular type of learning environment, there are several forms of exposition that assume this title (Gillingham, 1993). The different forms of hypermedia can be described through a continuum describing the nature of the linking involved. At one end of the continuum, the links are minimal and simply act to connect nodes in a specified sequence. This form of hypermedia closely resembles conventional text and is referred to as linear. In its use, the learner is encouraged and in most cases compelled to follow an instructional sequence planned by the instructor. In hypermedia environments, there is potential to create materials with varying degrees of linearity. Further along the continuum, the links tend to form a hierarchical structure, giving learners more freedom in the choice of path through the materials. At the extreme, hypermedia can provide a totally unstructured learning environment with multiple links between associated nodes. In this environment, learners are free to move between associated nodes through referential links and very little structure is imposed and in evidence.

The choice of information organisation for WWW materials depends on the nature of the intended learning outcomes. Jonassen, Mayes & McAleese (1993) provide a useful guide for selecting the form of hypermedia most suited to the nature of intended learning outcomes by suggesting instructional strategies against knowledge acquisition aims (Figure 2). When the instructional forms of the different forms of hypermedia are matched against the continuum describing

instructional strategies, it is evident that when the materials seek to develop students' initial knowledge, for example, facts, procedures and rules of discourse, linear linking is an appropriate hypermedia form. For this type of learning, it is appropriate to create materials with a strong structure that present information in a planned and considered fashion. In using these materials, learners are required to follow an instructional sequence set by the teacher. For higher levels of knowledge, for example, developing an understanding of concepts and principles, the less structured hierarchical and referential linking are more appropriate. In such instances, students are guided by such factors as their prior knowledge and readiness to assimilate new material. When building on an existing knowledge base, learners can benefit from the freedom to browse and explore, to inquire and seek responses to their own questions rather than following a pre-determined path of instruction.

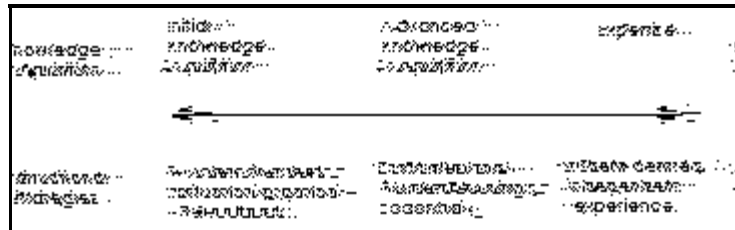


Figure 2: *A continuum of knowledge acquisition and facilitative instructional strategies.*

Orientation

One of the major problems reported with the use of hypermedia as an instructional form when compared to print materials, is the orientation of the learner within the learning environment. Orientation describes the means by which users are able to identify their current position in the system, how they achieved that position and how to return to a previous position. Disorientation is a problem which is frequently observed in studies of hypermedia users and a problem which significantly limits instructional outcomes (eg. Gay & Mazur, 1989; Collis, 1991). Electronic learning materials can easily conceal much of the information they contain and it is important in the design process to provide the learner with a means to orient and move freely within the information space.

A number of strategies are available to the WWW developer to aid orientation within learning materials. These include:

- **Placement cues** In linear sequences, the use of bars or graphs are commonly used to indicate the distance and placement of the learner in the instructional sequence. These bars are created as graphical elements and are interspersed within the text to provide visual cues. An example of visual cues to aid orientation can be found in WWW documents where information layers are provided for navigation purposes, for example, documents from our [Foundation Courses \[HREF 5\]](#).
- **Hierarchies and Indices** These structures provide access to the information nodes within a system together with an overall structure for the learner that is reinforced as nodes are selected and viewed. The use of frames and targetable windows provide a means for materials to continually display these structures as content is selected and accessed. A number of tutorial guides on the WWW provide good examples of this feature, for example [the Javascript Authoring Guide\[HREF 6\]](#).
- **Semantic Nets** Learning can be enhanced when connections and associations between related information are recognised and made specific. The use of image maps as tools by which information nodes can be accessed and selected provide a linking structure and reinforce associations and connections between the contained information as well supporting learner orientation. The [CNN Newsroom \[HREF 7\]](#) uses a concept map as alternative means to seek links.

Navigation

It is important when designing for the WWW to employ standard and intuitive ways to move between nodes. Conventional instructional materials require few operational skills on the part of the learner while WWW materials employ many functions and features that can distract learner from the task at hand. It is important in designing

materials to minimise the negative impact of poor interface design. When learners are compelled to think and consider how an interface operates when undertaking a learning task, their attention is split and the mental effort required to attend to information from multiple sources lessens that which can be applied to the actual learning task (Chandler & Sweller, 1991). At the same time, if learners are not comfortable with the system, its instructional advantages can be lost (Gray & Sasha, 1989).

There are a number of guidelines suggested by authors which can act to minimise the amount of mental and cognitive activity associated with controlling the interface. Brooks (1993) suggests a need for simplicity and consistency in design. When screens change, the only things that change should be the information to which the learner is being directed. Buttons and controlling features should remain in the same place and should be intuitive rather than clever in their design. Typographic clues, colour changes and unnecessary graphics all have the potential to distract and should be used sparingly. In terms of text display, distinct guidelines exist to guide hypermedia development (eg. Hartley, 1987; Wynn & Herrington, 1995).

Presentation

Critical aspects in WWW content presentation are the text structure and its readability. Coherence in text is assisted by the use of a well-defined structure and appropriate cues (van Dijk & Kintsch, 1983). Readers find coherent and well-structured text easier to read than that which is ill-structured (Gillingham, 1993). Structured text provides information in a sequential fashion with elements such as overviews, and a consistent format to which subsequent text can be added. The following paragraphs describe some useful strategies that can be used in developing hypermedia that lead to well structured, coherent and readable texts.

- **Text Structure** Text structure can be aided by the use of cues and overviews (Thuring, Mannemann & Haake, 1995). The use of indices and tables showing the structure and relationship between nodes is a useful strategy for this (Dee-Lucas & Larkin, 1995). Many systems use nets to demonstrate the structure and organisation of information and to aid learners in gaining a sense of global structure.
- **Readability** The readability of a document is a measure of the ease with which a reader is able to comprehend what is being read. There are a number of ways to increase readability of the printed text. At the surface level, difficult terms can be linked to nodes that provide further explanation and description, for example, clicking on a word to find its meaning. As an aid to increasing understanding of deeper meaning structures, literal and inferential questions can be placed with paragraph summaries to help the learners to reflect and consider what has been read. While these forms of cues can also be provided in some ways with conventional materials, they can form a natural part of a hypermedia system readily available to those students who seek to employ them while providing no distraction to those who do not need them (Higgins & Boone, 1990).
- **Fragmentation** A number of studies have revealed that fragmentation of information and learning material occurs when it is presented as discrete elements. Fragmentation results in a lack of associative and interpretative contexts and can create a document that appears to the user as a series of discrete rather than coherent information elements. There are several ways to overcome the possibility of learners perceiving fragmentation in a hypermedia system. Most links in hypermedia serve two purposes: to show a relationship exists between two nodes and to provide a path between them. Horney (1993) suggests there should be some distinction made in these two tasks. When links show the form of association they represent as well as providing the means to traverse, navigation is enhanced as an associative context for linked nodes. New nodes can be shown in concert with their predecessors thus establishing a coherence and semantic relationship enabling a common mental representation by the learner (Thuring, Mannemann and Haake, 1995). Paraphrases and summaries also enhance learning by helping to reduce the fragmentation caused by the division of the content into hypertext nodes (Blohm, 1982). The [Contents Page from the Third Interactive Multimedia Symposium \[HREF 8\]](#) demonstrates how fragmentation can be controlled by appropriate indexing methods.

Interactivity

The term, interactivity, describes the forms of communication that a medium supports enabling dialogue between the learner and the instructor (Jonassen, 1988) and is an important attribute of technology-supported educational

environments. With computer-based learning environments, communication between instructor and students are constrained by the technology. The intelligence of the technology is used in place of the instructor and exchanges are made between the learner and the programmed instructional system. The interactions in electronic learning environments are able to enhance learning through the feedback they provide and the context and purpose they are able to encourage support.

Most writers agree that clicking on paths and navigating through a WWW instructional sequence is not representative of interactivity. Until recently, interactivity has been difficult to achieve with WWW documents with most attempts making creative use of limited opportunities. Some strategies that have been used successfully to create the essence of interactivity in WWW learning materials include the provision of model answers and e-mail communications. More recently, other forms of interactivity have come to be supported by WWW documents. The use of Common Gateway Interface (CGI) scripts at the server enables designers to create forms within documents by which learners can enter responses and receive programmed feedback. This feature has been used widely in the creation of multiple choice and short answer tests which can be automatically marked and has the capacity to support record-keeping for more advanced student diagnostics.

New developments in client-side processing applications have led to enhanced interactive capabilities for the WWW . The advantage of client-side processing is that learners can receive immediate feedback to interactions. For example, the Java application supports many forms of interactivity and the continual release of plug-ins such as Shockwave (for Director) now support quite sophisticated processing of learner actions and responses. Our own home page [the infob@Rn \[HREF 9\]](#) demonstrates use of Shockwave as a navigation aid.

Designing Learner Roles

There are many ways in which the role of the learner can be varied within an instructional setting to influence and enhance learning outcomes. Critical dimensions drawn from our previous work with situated learning in multimedia environments appear to have direct relevance in this area (eg. Herrington & Oliver, 1996; Herrington & Oliver, 1995). The following list describes student behaviours that can be considered and planned in the process of designing the WWW materials.

Collaboration

A majority of contemporary computer-based learning reflect the belief that the interactions will, and should be, made by a single user. However research studies (eg. Del Marie Rysavy & Sales, 1991) have shown that there are clear educational advantages to be derived from collaborative activities among students. The implications of this for WWW materials are that interactions and activities that engage higher-order thinking and critical reflection need to be included and opportunities presented to enable group and team work. The communications component of the WWW provides unique opportunities to enable forms of communicative and collaborative activities among networked learners.

Reflection

Computer-based learning programs frequently subdivide skills into small sections which are then taught systematically in a logical order. This often results in the processes requiring little thought as the students can deduce the answers correctly from the preceding section without a real understanding of the subject. Students know information must be relevant because it is in the same section. There is no need for reflection. More effective environments require students to reflect upon a much broader base of knowledge to solve their problem. The simple fact of being adjacent to a particular topic would be no guarantee that the information is relevant to the problem. In order to solve the problem or complete the task, the student would be required to reflect upon the whole resource by predicting, hypothesising, and experimenting to produce a solution. The increased use of hierarchical and referential links and associations in documents reduces the linearity of the instructional pathway. Activities that encourage reflection and metacognition through increased levels of learner control can assist students to focus more attention onto their own thought processes

(Collins & Brown, 1988).

Articulation

Most computer-based learning programs are designed to be used quietly with the learner selecting, pointing and clicking in silence. Being able to speak the vocabulary and tell the stories of a culture of practice is fundamental to learning (Lave and Wenger, 1991) and yet the use of many WWW documents allows the knowledge to remain tacit. More effective learning environments ensure that the resources are used within a social context with students working in groups, discussing the issues, reporting back, presenting findings, interviewing and debating the issues to ensure that students have the opportunity to articulate, negotiate and defend their knowledge. The use of e-mail and other communicative activities supported by the WWW provide opportunities for articulation enabling tacit knowledge to be made explicit (Bransford, et al., 1990; Collins, 1988; Collins, et al., 1989).

Planning Implementation strategies

The third constitutive element of an effective WWW learning environment is the role of the teacher and the procedures by which the learning materials are implemented. Our previous work with situated learning environments in interactive multimedia suggests the following strategies as powerful adjuncts to enhancing teaching and learning with the WWW:

Coaching and scaffolding

Coaching describes the action of the teacher in providing guidance and help in a learning setting while scaffolding represents the support provided in the form of skills, strategies and links that the students are unable to provide to complete the task. Enhanced achievement is obtained when the strong support is provided initially (the scaffolding) and then gradually removed as the student becomes able to stand alone (Collins, et al., 1989; Griffin, 1995; Harley, 1993; Collins, 1988; Young, 1993). Many designers of WWW instructional materials attempt to create documents that are self-contained resources that include everything the student needs to learn a particular topic. However, there are many individual learner characteristics that cannot be accommodated in a single WWW document.

There have been some attempts to create intelligent systems for the WWW, for example, adaptive hypermedia ([Eklund, 1995 \[HREF 3\]](#)), but currently this role is still best performed by the teacher. The teacher's role in coaching, observing students, offering hints and reminders, providing feedback, scaffolding and fading, modeling, and so on, are powerful enhancements to any learning situation. The implication for the instructional design of WWW materials is that the teacher's coaching role needs to be acknowledged and addressed, with suggestions and strategies planned and taken for implementation with students. Much of this planning is independent of the actual development of the WWW materials

Integrated assessment

Measures and assessments of achievement and outcomes from instructional settings play an important part in the teaching and learning process. Frequently with computer-based learning, assessment measures bear little semblance to the environment in which the learning has taken place. Young (1993) suggests that 'assessment can no longer be viewed as an add-on to an instructional design or simply as separate stages in a linear process of pre-test, instruction, posttest; rather assessment must become an integrated, ongoing, and seamless part of the learning environment' (p. 48). The implications of this for instructional design are that some thought should be given to designing assessment which is concerned with the process as well as the product of involvement with the learning program.

The enhanced interactive capabilities of the WWW provides the means for assessment of student learning to extend beyond conventional essays and examinations. McLellan (1993) points out that more reliable assessments can take the form of evaluation measures such as portfolios, summary statistics of learners' paths through instructional materials, diagnosis, and reflection and self-assessment. Much of this can be achieved and supported through appropriate design of WWW documents and learning materials.

Summary and Conclusions

There are many factors which influence the learning that will be achieved from the use of computer-based learning materials such as CD-ROM based multimedia and materials designed for the WWW. Currently most attention in the design of WWW learning materials, and multimedia, seems to be in the planning and development of the materials themselves. While this is an important activity, it must be accompanied by consideration of two other factors in the learning process, the learners themselves and how the materials will be implemented.

The purpose of this paper has been to demonstrate that the learning achieved through use of the WWW depends not only on the quality of the learning materials but also on the ways they are used by the learners and are implemented by the instructor. We cannot judge potential learning by the consideration of any of these factors in isolation. The best WWW materials can be completely ineffective when used in the wrong contexts and with inappropriate implementation. Potentially poor materials from a design perspective can be greatly enhanced through clever and innovative use.

At Edith Cowan University, we are employed in a number of WWW courseware delivery projects. In the development stages of our WWW instructional materials, we try to consider not only the content to be delivered but also appropriate learner activities and support and implementation strategies. We are building on the experience gained through many years of CD-ROM based multimedia development. We believe that in the future most multimedia used in higher education will be delivered through networks and platforms such as the WWW and that research and development in this area is very important. We hope next year to be able to present some papers describing in detail WWW materials designed and delivered using the principles discussed in this paper.

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HREF 1

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HREF 2

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HREF 6

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HREF 7

<http://www.nmis.org/NewsInteractive/CNN/Newsroom/contents.html> - CNN Newsroom

HREF 8

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HREF 9

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