Design guidelines for WWW-based course environments

BY ANKE EKMA AND BETTY COLLIS

WWW-based course environments are rapidly appearing, before there has been time for much theoretical development with respect to guidelines for their design. In this article we describe a set of 20 guidelines which we think would be a contribution to this development. The guidelines are illustrated through their application to a particular case, the redesign of a WWW-based course "Environmental Management", now in operation, with more than 120 learners in six countries.

Guideline 1: Be consistent in designing an interface, especially when using text, pictures or icons to instruct the learner.

Guideline 2: Use metaphors that correspond to the user's daily life, so that he has concrete expectations about the result of an action.

Guideline 3: Set as few headings of subheadings as are necessary to organise the content, then use the chosen style consistently.

Guideline 4: Many basic hypertext principles for on-screen layout design apply also to designing text for computer displays, not just on-screen, so make a structured pattern on the page.

Guideline 5: Consider carefully what information is used in which situation.

Guideline 6: Because objects and virtual metaphors are not unambiguously understood across all computer interfaces and international borders, they should be investigated before put into a page.

Guideline 7: Do not confuse the user by putting more than seven (Navigational) icons on a page. The preferred number of icons on a page is five, plus or minus two.

WWW-based course environments

WWW technology is increasingly being used to support course delivery, for both face-to-face and distance learners (see [3] for an inventory and analysis). In some cases, the support is a new feature of an existing course, outside of the course itself. For example, the WWW is being used as an information system for courses, with both one-way broadcast-type communication from institution and instructor to students as well as integrated access to information related to the specific learner. The WWW is already familiar in the role of "virtual library", providing hyperlinked access to course resources, including those specific to the study material of a course; those involving multimedia databases of images, text and even audio; those located external to the course but linked to the course by the course designer; and those found by the learner himself with the use of embedded search tools. In addition, the WWW can now integrate various forms of communication support to course information and resources, where the communication can take many forms and modalities. Continual technical developments in the WWW now allow integration of other digital materials, such as tutorial and simulation programs as well as various forms of interactivity via CGI scripting and Java applets. Groupwork and collaboration, both in real and deferred time, are also now supported by WWW-based tools. Furthermore, many courses are now being entirely offered through WWW environments (for examples, see [4]).

Instructional design for WWW-based courses

Given all these possibilities, it is not surprising that an increasing number of courses are including some combination of these WWW functionalities, and as the combination increases the WWW site becomes more and more the central medium for the course. Through one WWW-based user interface, the learner can access a wide range of resources and be able to carry out a wide range of activities. However, the rapid development of the WWW technology and the ideas being put into practice via the technology have not yet been supported by cohesive sets of instructional-design principles to guide their form and logic when they are to be applied to course design. Such prin-
policies need to reflect at least four streams of considerations: traditional instructional-design insights relating to how learning takes place and can best be organized; design insights from human-computer interface and human-computer interaction research relating to principles relating to the usability of systems, including design considerations relating to layout and presentation on computer screens; design considerations specific to hyperlinked learning environments; and design aspects unique to the WWW environment itself.

Design guidelines for WWW-based courses

We have responded to this need for a cohesive set of design guidelines for WWW-based courses through a careful literature review of the various design aspects noted above [7], and have developed a set of 20 design guidelines as a contribution to this need [6]. We are now applying these guidelines in a number of ways, to test their applicability and to supply insights for their on-going revision. The guidelines themselves can be grouped into four categories: presentation, hypertext, pedagogy, and technology. We present them briefly here.

Presentation aspects

Presentation aspects relate primarily to the user interface of WWW-based courses, how the course is presented to the learner (and instructor). Guidelines in this context are strongly influenced by HCI and user-interface design experience, and relate not only to specific considerations such as typography, colour, and the use of images, but also to overall aspects of interface design, such as the application of metaphors. From relevant literature, (see for example [12]), we have extracted the following seven presentation guidelines as particularly relevant for WWW-based course environments (Figure 1).

Design guidelines for hypertext-related aspects of WWW-based courses

From the literature relating to hypertext systems, (see for example [11] and [10]), particularly the problems that users may encounter when navigating such systems and the problems that learners may face in using such systems as learning environments, we know that making the structure of a hyperlinked system clear to the

Guideline 15: Enable the learner to study whenever and wherever he wants by making the learning material accessible at any time and anywhere.

Guideline 16: Learner commitment and motivation can be increased by integrating questions into the instructional material.

Guideline 17: The learner should be able to answer questions within the learning material. The answers to the questions must be available for the learner, preferably after he has answered them.

Guideline 18: The learner should be able to get in contact with other learners, in the form of co-operative working or discussion as well as informal contact.

Guideline 19: The learner should be able to get some form of (local) tutoring.

Guideline 20: Both the learner and the tutor should have access to support services to help with technology-related aspects of the course experience.

Figure 3 Design guidelines for WWW-based course environments from the educational perspective

Figure 4 Design guideline for WWW-based courses related to implementation support

Figure 5 Map of the design guidelines for an individual learning environment

Figure 6 Index of the course materials

Index Course Materials

Module 1: Environmental Management
Module 2: EU Environmental Law
Module 3: Evaluation of Environmental Management
Module 4: Environmental Assessment Method
Module 5: Life Cycle Assessment
Module 6: Environmental Impact Statements
Module 7: Environmental Auditing
Module 8: Economic Assessment
Module 9: Related Issues
Module 10: Environmental Design
Module 11: Case Studies
Module 12: Summary

See the comments on the contents and questions.

> means that the discussion for this module has been started

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Guideline 6: Because icons and virtual metaphors are not unambiguously understood across all computer interfaces and international borders, they should be investigated before put into a page.

Guideline 8: The user should get a clear overview of the structure of the Web site. This can be accomplished by adding navigational buttons which link to the previous and the next page in the same sequence, as well as a link to a local homepage.

Guideline 16: Learner commitment and motivation can be increased by integrating questions into the instructional materials.

Guideline 2: Use metaphors that correspond to the user's daily life, so that he has concrete expectations about the result of an action.

Guideline 18: The learner should be able to get in contact with other learners, in the form of co-operative working or discussion as well as informal contact.

user is a key consideration. From this and other insights (9) is particularly recommended, we derived the following seven design guidelines as particularly relevant to WWW-based courses (Figure 2).

Design aspects relating to pedagogical aspects

The educational literature offers many different insights into what can be obtained relating to the design of WWW-based course environments even though the insights were developed before WWW environments existed. Some of these insights relate to the individual's interaction with learning materials in themselves; others (particularly from the distance education literature; see for example (8)), relate to the support of adult learners who are studying at a distance from their instructor and classmates. The following design guidelines were extracted as particularly important for WWW-based course environments (Figure 3).

Design guidelines relating to use of the WWW technology itself

Finally, WWW environments are a new form of technology for all concerned. From decades of experience with the implementation of technological innovations in education, we know that instructors and learners alike predictably encounter confusion and frustration when confronted with a technology that is new to them (a review of this appears in [3], Chapter 7). Unless appropriate help is available, many never go past this frustration in order to continue with the new technology. Thus, the last of our design guidelines relates particularly to this important aspect of WWW-based course design, an aspect that may be outside of the course itself but critical to it (Figure 4).

We find it convenient to represent all the design guidelines in one graphic. Figure 5 shows this representation.

Applying the guidelines to the redesign of the “Environmental Management” course

An important way to validate and improve design guidelines is to apply them in practice. From the designer's perspective, the usefulness of the guidelines during the design process can be
evaluated. From the learners' perspective, the influence of the design guidelines within a course developed around those guidelines can be indirectly evaluated based on the learner's reactions to the overall course and its component aspects. Both of these perspectives were employed during the application and validation of the design guidelines with respect to a WWW-based course called "Environmental Management" (Version 2). In the following sections, we briefly describe the course, illustrate a few of the ways that the design guidelines were applied to its redesign, and give a summary of learner reaction to the course.

The Environmental Management course

Version 1 of the Environmental Management course was developed in 1995 as part of the TeleScopia Project, for trans-European delivery of courses making use of a variety of technical platforms (see [1], [5]). One of the course deliverers in TeleScopia was the UETP-EEE (University-Enterprise Training Partnership in Environmental Management Engineering), a network of European universities, enterprises and professional organisations involved in environmental engineering. The Environmental Management course was especially designed for the TeleScopia Project [13], and was the only WWW-based course in that project.

Various evaluations were carried out of the first version of the course, and a second version, for a cohort of approximately 120 learners participating during the period October 1996 and March 1997, was designed [6]. Learners access the course via a WWW environment (http://www.dipoli.hut.fi/EEE; note that a password is needed to enter, contact the first author for a guest password) via a

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1 The second version of the course was developed and is used within the scope of the ATLAS (Atlantic Mobility for Academic Studies in Engineering and Environment) Project funded by the European Union. The Lifelong Learning Institute Dipoli at the Helsinki University of Technology, working together with the University-Enterprise Training Partnership in Environment Management Engineering (UETP- EEE), is responsible for the re-design of the course.

3. Evolution of Environmental Management

"We travel together passengers on a little spaceship, dependent on its valuable reserves of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work, and I will say the love we give a fragile craft".
- Ambassador Adolfo Stevenson to the 39th session of the UN Economic and Social Council, July 9, 1965.

3.1 Objectives
3.2 Introduction
3.3 Economic Growth
3.4 The 1950s: an Awakens
3.5 International Initiatives

Figure 7 Index page of a module

planning and decision making affecting the quality of the environment.

NEPA established a Council on Environmental Quality to oversee its implementation and to report to the President annually on environmental quality. It also addressed research, training, monitoring, and forecasting, all essential and often neglected aspects of environmental management.

Questions:

At intervals throughout the text, "boxes" like this will appear with questions. Please register your responses to the materials by replying to the questions, and checking the answers provided at the end of each Module.

Questions are intended to make the materials more interesting, and to reinforce points made in the text. You can note answers in the spaces provided, or on separate sheets.

Figure 8 Example of a question integrated in the learning materials

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modem or ISDN connection. Through the course environment, learners access not only the course materials and information about the organisation of the course, but also a variety of forms of communication among themselves, and between themselves and local tutors and others involved with the overall delivery of the course. Local face-to-face tutoring sessions are also available. In addition, the course includes three international video-conferencing sessions which currently are not integrated technically within the WWW environment. The language used in the course is English.

Application of the design guidelines in the design of Version 2

The design guidelines were applied to every aspect of re-design of the Environmental Management course, Version 2.0 (see [6] for a detailed summary). Because of space constraints here, we can only give a sample of how this application occurred.

For example, the original course did not use many graphics. In the materials section of the new EM course, use has been made of graphics, although they have been kept as simple as possible, and small in size (in kilobytes) because of the long loading time that can occur when using sophisticated graphics. Figure 6 shows an example of the presentation design of the course, in this case, the menu from the “Materials Index” component.

Guideline 6 was thus taken into account in this design decision; icons should be investigated before put into a page.

Arrows are used in many user interfaces, perhaps the most universally understood ones relate to the interface of a radio-cassette player, with play, fast-forward and rewind buttons. Arrows suggest movement; an arrow that points to the left is interpreted as going back, an arrow pointing to the right usually refers to moving forward. An arrow pointing to top means usually “up”. Figure 7 shows the index of Module 3 of the course. The double arrows that point to the top refer to the “material index”: the double arrows pointing to the left take the learner to the index of the previous module; and the double arrows pointing to the right bring him to the index of the next module. These decisions were made in reference to Guideline 8, the user should
get a clear overview of the structure of the Web site.

Arrows are in this case navigational buttons which link to the previous and the next page in the same sequence. This at least helps the user to have a sense of his immediate location in the site.

Questions integrated in the learning materials can increase motivation and interactivity (Guideline 16). The EM Course integrated several questions into the learning materials. Figure 8 gives an example.

In addition to the video-conferencing portion of the EM Course, Guideline 18 is also applicable to a WWW-based two-way interactive element of the course, namely the Discussion component. From the discussion page, the learner can join two newsgroups (see Figure 9). In the design of this part of the course, Guideline 2, the use of metaphors was particularly important.

On the screen two buttons are visible that each link to a different newsgroup. In the first newsgroup, learners can discuss the content of the course with other learners, with tutors, and with experts, as recommended in Guideline 18.

Since it is impossible to send the learners in the EM course all over the world to meet their fellow learners, an introduction via video-conferencing has been added to the course. But the video-conferences are only short, and not all the learners get the chance to talk to each other. This is the reason that the Class of '96 pages have been integrated in the course (see Figure 10). These pages are based on the idea of the "yearbook" or "almanac", where pictures and small biographies about the learners are presented. At the Class of '96 site, the learner is free to look around in the pages of the tutors, to get a glimpse of the tutors, the experts, and of course the other learners, if they have added their own "homepages".

In the virtual workshop, associated with the "Class of '96" component, the learner can easily create his own Web page. This activity is not compulsory, and does not have any impact on the learner's study results. In the virtual workshop, the learner can fill in a standard COI-based form, displayed in Figure 11.

As can be seen in Figure 11, the learner is restricted in the amount of text and

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**Figure 11** Form for adding a "personal homepage"

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**Figure 12** Guidelines used in the design of the new EM Course
pictures he can add to his own page. This is done because the pages are mainly meant for introduction, but also because there should be some consistency between the learners’ homepages.

The above are just a sampling of examples of how the design guidelines were used to inform the many decisions that were taken in the re-design of the WWW-based EM course. Figure 12 shows a general summary of how often the design guidelines were applied to Version 2 of the EM course.

Learner validation of the guidelines

The EM course is in session from October 1996 through March 1997; thus, at the time of writing of this report (November 1996), only a first impression of the course could be obtained from the learners. A survey returned by the learners after their first experiences with the WWW-based course shows very positive responses: the learners feel they have a clear understanding of the structure of the course environment and particularly value the easily-made personal home pages within the course. These and a variety of other comments from the WWW-based learner evaluation are given in detail in [6]; the important conclusion to date is that the WWW-based course environment appears to be well received by its distributed learners. This in turn implicitly supports the design guidelines on which the course is based.

Other validation approaches for the design guidelines

Certainly more than one experience of application of the design guidelines is needed for their validation and refinement. Another type of validation is also taking place: the use of the design guidelines within a course focused on the specific topic of the design of WWW-based learning materials themselves. Such a course (WWW-based itself) is in operation at the University of Twente [2], and the design guidelines have been integrated into the Study Materials for the course. In addition, they are being used as the criteria for the learners’ formative evaluation of their self-designed WWW materials, and will be used as the criteria used by the course instructors for summative evaluation of the learners’ WWW-based products. The course site, integrating study materials discussing the design guidelines and various instruments for formative evaluation of WWW sites based on the guidelines, is open for inspection, so that this aspect of the validation process for the design guidelines can be seen in operation [2].

In conclusion, to date it appears that the design guidelines form a valuable contribution to support the design process for WWW-based course environments. However, it is also clear that the guidelines should be continually evaluated and revised, to refine their usefulness and test their applicability in a variety of contexts.

References


2. Collis, B. The course ISM 1. 1996. [WWW-based course, Faculty of Educational Science and Technology, University of Twente: see http://www.to.utwente.nl/ism/ism1-96/home.html]


