Exploring Issues for Information Architecture of Web-based Learning in South Africa

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Web-based learning (WBL) can be defined as any form of learning that is partly or fully based on material, applications or communication that is delivered over the World Wide Web (WWW). WBL tools provide integrated environments of various technologies to support diverse educators’ and learners’ needs via the Internet. One of the biggest challenges facing WBL environments is the organization, communication and presentation of information in a logical and usable manner via the WWW. A good information architecture design can increase the usability of a website. Information architecture is concerned with the design of organization, labeling, navigation and searching systems to help users find and manage information. Several Higher Education (HE) institutions in South Africa have developed their own WBL tools some of these, however, exhibit usability problems with respect to information architecture (IA). The goal of this paper is to investigate and discuss the issues involved with the IA of WBL tools developed in South Africa.

Categories and Subject Descriptors: K.3, K.3.1, H.1, H.5
General Terms: Design, Human Factors
Additional Key Words and Phrases: Web-based Learning, Information Architecture, Evaluation

1. INTRODUCTION

The emergence of the World Wide Web and networking technologies have made it possible to connect learners, separated by time and space, with distributed instructional resources (Report, 1999). These instructional resources include teachers, other learners, subject matter experts, reference materials, simulations, and interactive practice exercises. There are many design approaches, technological capabilities and development tools for WBL delivery. Although these differ in required bandwidth, user interface, and degree of interactivity, online technologies share a common strategy, which is to deliver learning to audiences at disparate locations. There are, however, several critical factors for the success of WBL. These include technical issues such as speed, visual layout and navigation as well as educational issues such as accuracy of content, interactivity and active participation.

This paper discusses issues involved with the information architecture of WBL. A discussion of WBL in South Africa is given together with an overview of WBL and WBL tools. Information architecture is defined, followed by a discussion of the components and general principles of IA and how these relate to WBL. The typical components of WBL tools are discussed together with an expert review of two of the WBL tools that have been developed and implemented in South Africa. The paper concludes with a discussion of research issues for IA of WBL in South Africa.

2. WEB-BASED LEARNING

2.1 Definition

There are many terms for online education. Some of these include web-based learning (WBL), Internet-based education and education via computer-mediated communication (Paulsen, 2002). Web-based learning (a major subcomponent of the broader term "e-learning") is one of the tools with which education is delivered (Jackson, 2004). E-learning covers a wide set of applications and process such as WBL, computer-based and digital collaboration (Paulsen, 2002). The term E-learning is often used as a more generic term and as a synonym for online education. WBL can be defined as learning materials which are delivered in a Web browser and can include materials which are packaged on CD-ROM or other media (Tsai and Machado, 2003). Further definitions include using the WWW to create a meaningful learning environment through the use of instructional strategies (Khan, 1997), (Hall, 1999).
2.2 WBL Tools
A typical WBL tool such as WebCT is a sophisticated tool that can be used to create Web-based educational environments (WebCT, 2004). WBL tools can be used to create entire on-line courses, or to simply publish materials that supplement existing courses. WBL tools provide integrated environments of various technologies to support diverse educators’ and learners’ needs via the Internet (Storey et al., 2002). The goal of these tools is to enhance face-to-face instruction and to deliver distance-learning courses. These tools usually offer three types of functions - server administration, course design and student access. Typical components offered to students include course note posting, assignment submissions, quizzes and communication features.

2.3 Designing WBL Environments
Designing WBL environments is a combination of pedagogical design and usability (Minocha and Sharp, 2004). WBL environments need intuitive interfaces and clear information design that will allow users to focus on the learning process (Nielsen, 1997).

Several frameworks exist for analyzing WBL from pedagogical and institutional perspectives (Khan, 2001). Such frameworks provide guidance on which factors to consider when implementing WBL. What is often overlooked in these frameworks is the design and usability of the WBL environment and how to determine this (Storey et al., 2002). Today, there is a large amount of theoretical and practical knowledge relating to software usability evaluation in general and educational software in particular (Squires and Preece, 1999). Developing usable WBL environments requires an in-depth knowledge of more than just the technologies involved. According to several web design experts, including Nielsen and Spool, “Usability is often the most neglected aspect of web sites, yet in many respects it is the most important” (Nielsen, 2001). To ensure usability requires a user-centered design approach together with an understanding of design principles and guidelines.

There are many usability considerations to consider when designing user interfaces for WBL (Storey et al., 2002). First, the important elements of a web page must be visible. The content of web pages should be formatted and displayed such that users can easily see or access the important elements and navigational aids. Second, the user interface must also provide appropriate feedback to users. For every action a user performs, the system should provide some feedback allowing the user to evaluate the effect(s) of their action. Third, the system should be consistent. Consistency can take many forms, such as consistent sequences of actions, consistent labeling of links and buttons, and a consistent navigation format.

According to Hall (1999), a number of themes emerge from an examination of the existing literature relating to instructional web site design. One common theme is the importance of thoughtful site organization. Nielsen (Nielsen, 1997) suggests that the site designer must be careful to provide the learner with an environment which consists of short informational units, consisting of text, directly supported by useful graphical representations, linked in a structured intuitive fashion for the learner. He furthermore advises that the designer should take advantage of the unique flexibility of the environment by allowing for flexibility and learner control, including interactive activities which encourage, “real life” activities. The designer should also make use of the unique collaborative learning activities that are possible with the WWW.

The next section discusses IA and how this can be used to assist with website design.

3. INFORMATION ARCHITECTURE

3.1 Definition
There is no common definition of information architecture (IA). IA typically refers to the organization of a website's structure and content, the labeling and categorizing of information and the design of navigation and search systems (Toub, 2000). Information Architects are the librarians of web development. The aim of IA is to help users find information and accomplish their task. According to Wurman (Wurman, 1997), an Information Architect is an individual who organises data in order to clarify the complexities. Such an individual is furthermore a person who creates the structure or map of the information path. IA can also be defined as the organisation, labeling and navigation of information to facilitate task completion and intuitive access to content (Rosenfeld and Morville, 2002). From the above definitions, one can conclude that IA can be divided into four components:

- **Organisation**: How to categorize information.
- **Labeling**: How to represent information.
- **Navigation**: How to browse or move through information
- **Searching**: How to search information.

The next section discusses general IA principles and how these can be applied to designing WBL environments.

3.2 Principles
Technological advances and new developments provide opportunities to create well-designed WBL environments. The development of such environments requires consideration of the instructional design principles and how these relate to each of the IA components, namely, organization, labeling, navigation and searching. Wodtke (2002) makes a
distinction between principles and guidelines. Principles are defined as high-level guidelines which are not specific solutions to problems. Guidelines are described as shortcuts or heuristics which have worked before and that can be used again. No specific IA principles for WBL currently exist. Dong and Agogino (2001) have however, formulated IA principles that can be used to support the instructional process. These principles are primarily based on the constructivist theories of learning and were used to determine the specifications for the IA and visual design of a digital library. These IA principles for instructional design are discussed in more detail below.

3.2.1 Information Organisation
This principle involves how to organise information in a manner that will provide opportunities for users to create, synthesize, manipulate or debate content rather than merely passively receiving instruction. According to Rosenfeld and Morville (2002), information organization is fairly complex. A variety of organisation schemes have to be considered to ensure that users can navigate through the information. In order to have an effective organisation scheme, it is necessary to break the content into groups of homogeneous content. This will aid the decision-making process when selecting the organisation schemes to be used. Distinction should be made between which schemes are the best to use when the user knows exactly what they are looking for. Ambiguous schemes on the other hand, are used for browsing and associative learning. Rosenfeld and Morville (2002) recommend that, where possible, both schemes must be used. This will also assist with the challenge of providing multiple ways of accessing information by a diverse user population group on the web.

3.2.2 Labeling Information
This principle involves how to label information resources with appropriate educational identifiers. Rosenfeld and Morville (2002) state that labels represent a relationship between the users and the content. As the relationship could change on a regular basis, the labeling system will have to be adjusted accordingly. To avoid ambiguous labels, Rosenfeld and Morville recommend that labels be kept simple and focused on the content of the site. It is furthermore recommended that instead of developing labels, labeling systems should be developed. Such labeling systems benefit users in the sense that they are consistent which makes labeling easy to learn and easy to use.

3.2.3 Navigating Information
This principle describes how to allow the user to navigate information in a way that will support individual learning goals. Navigation systems are composed of several elements which can broadly be divided into embedded and supplemental navigations systems (Rosenfeld and Morville, 2002). Embedded navigation systems are typically found within the content of the site. These help the users understand where they are and where they can go. Supplemental navigation systems provide different ways of accessing the same information by making use of sitemaps, indexes and step-by-step guides. Supplemental navigation serves a specific purpose and fits into the framework of searching and browsing.

3.2.4 Searching Information
This principle enables the users to optimise information searches to meet their interests, knowledge, understanding, abilities and experiences. Rosenfeld and Morville (2002) warn against the inclusion of searching without careful consideration. They maintain that most users want to browse a site rather than search the site. Searching should only be implemented when the site has too much information to browse. Search systems can be divided into two variants. The first allows the user to enter a query in a search interface which is then matched against an index that represents the site content. This query results in the presentation of a set of matching documents with the most relevant documents listed first. The second variant displays records containing metadata to represent each document. As searching is a complex activity, it is necessary to consider the option which will offer most benefit to the user.

These IA principles are focused on users and their needs. The reason why the user comes to a site is to find information. Ultimately, well-designed IA improves “findability” (Rosenfeld and Morville, 2002), usability and understandability (Wodtke, 2002). The aim of IA is to ensure that the users’ needs are met. It is important therefore to consider who the site is aimed at and what the purpose of the site is. It is also necessary to consider the different skills levels of the intended users. It can therefore be said that the primary goal of IA for WBL is to facilitate a better way in which the learning process can take place (Dong and Agogino, 2001).

3.3 Evaluation
Conventional usability evaluation techniques such as heuristic evaluation, user-based observation, and user testing can be used to identify usability problems with WBL environments (Minocha and Sharp, 2004). Cognitive walkthroughs can be used to evaluate the learnability of the user interface. Toub (2002) maintains that a single usability evaluation technique cannot provide adequate information about the IA and suggests that IA evaluations should be both quantitative and qualitative and that different evaluation techniques be used to evaluate the different components of IA. Toub also maintains that IA should mainly be evaluated in terms of site structure, grouping and labeling of site content.
He acknowledges that IA may include areas such as navigation design and indexing but suggests that these aspects be evaluated using some form of heuristic evaluation. He does, however, state that the bad news is that few heuristics exist specifically for site structure.

4. WBL IN SOUTH AFRICA

4.1 Overview

Many tertiary institutions in South Africa have shifted their attention from investing in educational courseware to investing in WBL environments. This shift did not happen without some challenges and difficulties. One such challenge is the cost of implementing commercial WBL tools such as WebCT and Blackboard at South African tertiary institutions. A further challenge is that of commercial WBL tools which are designed for primarily English first language speakers. These factors have led to the development of several South African WBL tools such as Knowledge Environment for Web-based Learning (KEWL), which was developed at the University of the Western Cape. Another such tool is Open Learning System (OLS), currently in use at the University of Natal. Both of these tools are used to not only supplement traditional teaching-and-learning, but also to facilitate online learning for distance students.

International research has shown that many commercial WBL tools are unusable or badly designed (Storey et al., 2002). Many guidelines for designing online learning exist but such guidelines are primarily focused on users with a strong technological background and English as first language. Despite the fact that many such design guidelines exist no evidence exists as to whether these have been used in practice in South Africa. In addition, the usability of locally developed WBL tools, such as KEWL and OLS, has not been widely researched in South Africa.

The next section will discuss the results of a heuristic evaluation of the IA of KEWL and OLS.

4.2 Heuristic Evaluation

A preliminary heuristic evaluation was conducted on KEWL and OLS, which highlighted several issues that could impact directly on the usability of the WBL environments developed using these tools. General web design guidelines as well as Rosenfeld and Morville’s IA principles formed the basis of the heuristic evaluation. Figure 1 shows the homepage of Marine Botany in KEWL. Finding information on this page as well as navigating the page is problematic. The non-standard navigation toolbar consists of icons with no description of the purpose of each of these icons. Limited feedback is provided, making it difficult to know how to proceed beyond the first screen.

Figure 2 displays the opening screen of the UNIN Symposium module in OLS. Although this environment is also web-based, the user interface design differs significantly from KEWL. As the interface is based on an MS Outlook metaphor, navigation is more intuitive than KEWL, but should the user not be familiar with MS Outlook, navigation could be problematic.
Usability problems identified in KEWL | Usability problems identified in OLS
---|---
**Organisation**
- Scrolling is required to read the contents of page.
- There is no clear indication of goals on the page.
- No breakdown of course content or shortcuts to specific sections is provided.
- Large amounts of text have to be read.
- Daily activities are listed in the bottom left corner of screen. The use of this menu is not obvious.
- Scrolling is required to read the contents of the page.

**Labeling**
- The pages are incorrectly labeled.
- The page titles are not updated when navigating through the site.
- The labels are not clear and concise to explain the purpose of the pages.

**Navigation**
- A non-standard bar of icons appears on the screen. No explanation is offered as to what these represent.
- Tooltips are available on mouse over, but appear underneath icon toolbar.
- In order to proceed to the next page, the user has to click on the last icon, namely ➤.
- No indication is given as to how the user can return to previous page.
- Navigation is based on the MS Outlook metaphor.
- At times it is not clear where to go next.
- Tabs are available at top of the page to utilities such as email and different course modules.

**Searching**
- No search facility is provided.
- No search facility is provided.

Table 1: Usability problems identified in KEWL and OLS

Table 1 lists the results of the preliminary heuristic evaluation performed on both KEWL and OLS. The key usability problems that were identified are directly related to IA issues, namely organisation, labeling, navigation and searching. The next section identifies and discusses several research issues relating to IA of WBL in South Africa.

5. RESEARCH ISSUES

Several research issues still need to be investigated with respect to IA of WBL tools developed in South Africa. Students at South African universities come from educationally, linguistically and culturally diverse backgrounds. Many of these undergraduate students are introduced to computers for the first time at university, and for the majority English is a second or even third language. More research is needed in South Africa to determine how to design flexible WBL environments that can accommodate a wide range of users.
The IA principles discussed in Section 3.2 need to be expanded and refined to produce a specific set of guidelines for IA of WBL. These guidelines could be used to assist with the design and evaluation of the IA of WBL tools developed in South Africa specifically for South African users. Based on the research in Section 4.2, several preliminary heuristics have been identified which are presented in Table 2. Several of these heuristics can be applied specifically to the South African context. These heuristics refer to the presentation of course content to accommodate individual learner differences; the language and terminology used for labeling; and the suitability and flexibility of the navigation scheme (Table 2).

<table>
<thead>
<tr>
<th>Organisation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>How well is the course information grouped together on the page?</td>
<td></td>
</tr>
<tr>
<td>Is the course content presented in an efficient and effective manner?</td>
<td></td>
</tr>
<tr>
<td>Is the course content presented in a variety of ways to meet individual learner differences?</td>
<td></td>
</tr>
<tr>
<td>Does the organisation of the site support the learners’ tasks?</td>
<td></td>
</tr>
<tr>
<td>Can important information content be viewed without extensive scrolling?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Labeling</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the predictability of a label?</td>
<td></td>
</tr>
<tr>
<td>What is the effectiveness of a label?</td>
<td></td>
</tr>
<tr>
<td>Is there a consistent theme or labeling system used throughout the site?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Navigation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the course home page have effective navigation (for example, menu, index)?</td>
<td></td>
</tr>
<tr>
<td>Are the course pages easy to navigate?</td>
<td></td>
</tr>
<tr>
<td>Is the navigation between the different pages efficient (for example, menus and return to previous page)?</td>
<td></td>
</tr>
<tr>
<td>Is the navigation within pages effective (for example, overviews, lists, headings)?</td>
<td></td>
</tr>
<tr>
<td>Are information retrieval tools such as course site maps provided?</td>
<td></td>
</tr>
<tr>
<td>Is the navigation appropriate for the intended learner group?</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Searching</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Is a search facility provided on the course home page?</td>
<td></td>
</tr>
<tr>
<td>Is a query facility provided on the course pages?</td>
<td></td>
</tr>
<tr>
<td>Is browsing of the content of the course pages supported?</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Preliminary heuristics for IA of WBL in South Africa

6. CONCLUSION AND FUTURE WORK

The objective of this paper was to investigate issues for IA of WBL in South Africa. Several HE institutions in South Africa are currently using some form of WBL for teaching. Existing frameworks for WBL focus primarily on pedagogical and institutional issues and do not include usability and user satisfaction issues. IA can provide strong support for the instructional goals of WBL environments by identifying and proposing optimal ways for organising and presenting course information. The primary components of IA are information organization, labeling, navigation and searching. This paper has proposed a preliminary set of heuristics which can be used to evaluate the IA of WBL. These heuristics will have to be refined and expanded to produce a specific set of guidelines for IA of WBL in South Africa.

REFERENCES

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