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ABSTRACT

This paper presents two decisive factors for Web-based training (WBT) software in the context of E-education. The report focuses on offline education, as real time communication (except chats) is not yet sufficiently reliable due to low bandwidth Internet access in most European rural areas. One of the main advantages of WBT software is being able to study according to one's own schedule. Even if online communication was available, a large offline corpus of knowledge would be required too-just like textbooks are used in today's courses to support traditional in-class teaching. The techniques presented in this paper can help to organize the electronic equivalent of textbooks. Compared to textbooks, correspondence-based distance learning programs and first generation computer-based training software, WBT offers many advantages. Two of them which the authors consider most important constitute the main focus of this paper. First, navigation is no longer limited by serially flipping through pages and second, interactive examples are far more likely to actively involve students while studying. Throughout this paper examples are given of how these features have been successfully implemented in WBT software called Teach/Me. Includes two figures. (Contains 19 references.) (Author/AEF)

The Transition from Computer-Based Training to eEducation

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Abstract: Navigation is one of the key aspects of eLearning environments that can make a difference when comparing new forms of learning to traditional ways of learning. In this paper we elaborate on the experience we gained while developing an eLearning solution and highlight the relevant issues giving screenshots.

1 From Computer-Based Training to E-Education

During the past few years the Web has fundamentally altered many people's work life. Businesses were transformed into e-businesses and the buzzword 'e-commerce' is now ubiquitous. There is, however, an industry that only gradually adopts these new technologies - teaching. Despite the fact that universities have significantly contributed to the development of the Web, it is still not fully used to improve academic teaching.

It was only last year that the term eLearning was defined by Lennox [Lennox 00] as "the use of e-business technologies to speed the flow of business information and knowledge from creator to leamer in a highly personalized, on-demand fashion".

In this paper we will present two decisive factors for Web-based training (WBT) software in the context of e-education. We will focus our report on offline education, as real time communication (except chats) is not yet sufficiently reliable due to low bandwidth Internet access in most European rural areas. Moreover, one of the main advantages of WBT software is being able to study according to one's own schedule. Even if online communication was available, a large offline corpus of knowledge would be required too – just like textbooks are used in today's courses to support traditional in-class teaching. The techniques presented in this paper can help to organize the electronic equivalent of textbooks.

Compared to textbooks, correspondence-based distance learning programs and first generation computer-based training software, WBT offers many advantages. Two of them which we consider most important will constitute the main focus of this paper: First, *navigation* is no longer limited by serially flipping through pages and second, *interactive examples* are far more likely to actively involve students while studying. Throughout this paper we will give examples of how these features have been successfully implemented [Weippl 99] in WBT software called Teach/Me [Lohninger 99].

Dating back to the hype of the term "eCommerce" eLearning is widely used in different ways; for instance, [LineZine] understands eLearning ranging from "the convergence of the Internet and learning, or Internet-enabled learning" to "the use of network technologies to create, foster, deliver, and facilitate learning, anytime and anywhere" or "the delivery of individualized, comprehensive, dynamic learning content in real time, aiding the development of communities of knowledge, linking learners and practitioners with experts."

[ELearners Glossary] defines e-learning as any form of learning that utilizes a network for delivery, interaction, or facilitation.

According to [Learning Circuits Glossary] "E-learning covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, and CD-ROM."

2 Interactive Navigation

Based on the knowledge of how students learn, it seems obvious that the way of presenting knowledge and the options offered to navigate or access it, are essential for successful teaching. It is a commonly known fact that WBT offers the possibility to design teaching material that can be accessed in a non-linear way. However, a brief scan through existing course material reveals that a large number of today's courses are not designed for efficient navigation which is needed for learning. This is why it is essential, that when designing the navigation structure for WBT software one always has to keep in mind that the ultimate goal is to effectively convey knowledge.

In this section we will first discuss theoretical issues that are essential for designing ways to navigate WBT content. We will then continue by discussing various forms of navigation. Finally we will elaborate on the forms of navigation best suited for different targets of learning.

2.1 Learning Process

When studying, people usually create an internal representation of the topic they study. A cognitive map, i.e. a form of visualizing content structure, can aid in this process. Cognitive maps are two-dimensional representations of knowledge structures. They are based on the assumption that the relationships between ideas or concepts can be uncovered due to semantic proximity; that is, semantically related ideas will appear close in geometric representations of cognitive space whereas unrelated concepts will be separated by a greater distance.

Fenker [Fenker 75] states three assumptions about cognitive maps: First, information about a topic is organized and interpreted on the basis of a set of dimensions which represent organizational features of the topic. Second, these dimensions can be represented in n-dimension geometric space. Third, there are many relationships that can exist among concepts. Similarity, degree of association, and the extent to which one concept implies another are examples of these types of relationships. That is, the nature of the semantic relationship is implicit in the relationship but has to be interpreted.

During the learning process cognitive maps can be used to assess how well students have integrated recently acquired knowledge and whether they can position it within existing knowledge. The student draws a concept map representing his current knowledge; areas not well linked to other parts of knowledge may be identified and indicate the necessity of further studies.

Acquiring new knowledge, i.e. transforming external to internal representations preserves certain aspects of the representation, mainly the topology [Steiner 88]. Cognitive maps do not seem to be a full and continuous representation of the information stored in mind. They are fragmented and distorted on an individual basis. Since they change dynamically they cannot be easily copied onto an external representation. Each time an individual tries to output the interior cognitive map containing specific knowledge, it looks different. This implies that there is not only one 'correct' spatial representation of relations between topics.

Although the definition of cognitive maps varies in the literature, there seems to exist an agreement that cognitive maps are an appropriate way to represent relationships between different entities of knowledge [Driver 92], [Gergen 92], [Spiro 92], [Galsersfeld 92].

Some details seem especially important in the context of this paper. Certain points of interest and paths between these points are learned (i.e. external maps are internalized) when studying new concepts. Using those paths, the overall context of the knowledge can be understood easily because students can look at topics in the vicinity of those paths to find related concepts.

The first step in the process of teaching is that the attention is drawn to points of interest, i.e. important topics. Learners perceive these points of interest either because they are highlighted on the cognitive map and can therefore be easily spotted or due to their Importance. In a second step points of interest that are close to each other are used as starting or end points of paths. Knowledge of these paths seems to be more or less knowledge of starting- and endpoints and orientation in the map. This "learning of paths" is what can be achieved by using "Guided Tours" in a Knowledge Landscape, which will be discussed in greater detail in the next section.

2.2 Navigation Metaphors

Initially most CBT programs implemented the behaviorist paradigm. Since the days of behaviorism seem to have passed an increasing number of approaches in CBT try to adopt constructivist methods (overviews can be found in [Jonassen 93], [Brandt 95]).

Freeman [Freeman 96] tried to integrate the constructivist paradigm into a course enabling teachers to use the Internet for distance learning. Having taught the necessary basics, she gave the participants the opportunity "to build up their own internal knowledge base."

The visualization of a given field of knowledge should leave it up to the students how to explore the data, how to structure the contents, where to set priorities and to decide which chapters they consider as related. However, in order to avoid the experience of not knowing what to leam and not being able to structure the presented data, presenting some pre-defined structure to start with is useful.

The modes of navigation offered by Teach/Me [Lohninger 99] go far beyond those of other textbooks.

Pohl et al. [Pohl 95] have identified four main difficulties when creating educational hypertext. First, authors are used to structuring text in a linear or hierarchical way like in printed textbooks. Second, the texts are often too long and do not have enough words highlighted e.g. by bold typesetting. Third, scientific publications as well as textbooks have long argumentative strains that support one final solution for a certain problem. These parts have to be read in a fixed order determined by the author. Fourth, a large number of short texts may be confusing, especially if they are not suitably structured. This can result in the well-known phenomenon of 'Lost-in-Hyperspace'. Two of these issues, i.e. hierarchical text structure and potentially confusing hyperspace navigation can be addressed by providing multiple forms of navigation through WBT content. We will now present four different approaches to navigating hyperlinked textbooks.

2.2.1 Table of Contents

The oldest form of navigation through written information is the table of contents. It is still widely used in today's hyperlinked WBT. This is mainly due to the fact that everyone is familiar with this form of navigation. Most authors think that sequentially structuring content seems to be an efficient way. However, the fact that researchers and authors like a hierarchical-linear structure is to a great extent because it is the structure they have always used.

Despite the advantages offered by the navigation interfaces discussed later in this section, WBT courses should always include a table of contents because everyone expects it and knows how to use it.

2.2.2 Keywords – Indices

Similar to the table of contents, an index is a form of navigational interface commonly found in books. Nonetheless, software may offer a much greater flexibility. First, searches for keywords can be more expressive by using Boolean expressions. Second, by displaying an indexed expression in its context before actually opening the page users can quickly scan through a large number of matches. Compared to paper-based indices that sometimes refer to ten or more different pages for a single keyword the quicker access in a Web-based textbook is certainly an advantage.

2.2.3 Hyperlinks

Hyperlinks are commonly used to navigate through hypertext. Today's Web is linked by only one link type that can represent different forms of how a linked text is related. Rada [Rada 91] distinguishes three fundamentally different forms of links. (1) Sequence links connect pages in a linear sequence. Using 'Next' and 'Back' links helps especially first and second year undergraduate students to access all pages relevant for a lecture. (2) Outline links refer to pages that contain overview. (3) Reference and citation links point to pages that describe topics in greater detail.

When designing WBT software we recommend to clearly indicate (e.g. by a particular icon) the kind of link; this helps students to decide whether they want to follow a link or not. Figure 2, for example, shows two different links; one opens an interactive example to illustrate concepts explained in the HTML page, whereas the other link starts a calculation tool with preloaded exercises so that students can apply their newly acquired knowledge.

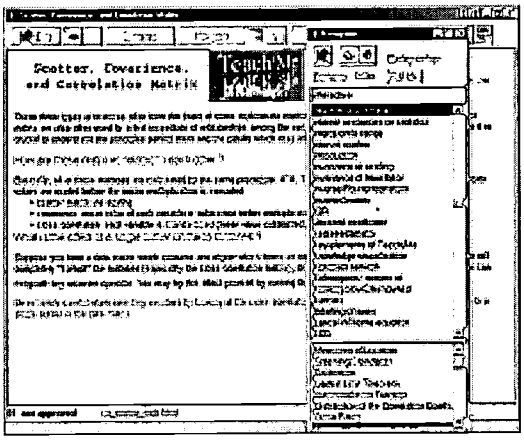

Figure 1: Teach/Me offers a simple but yet efficient index.

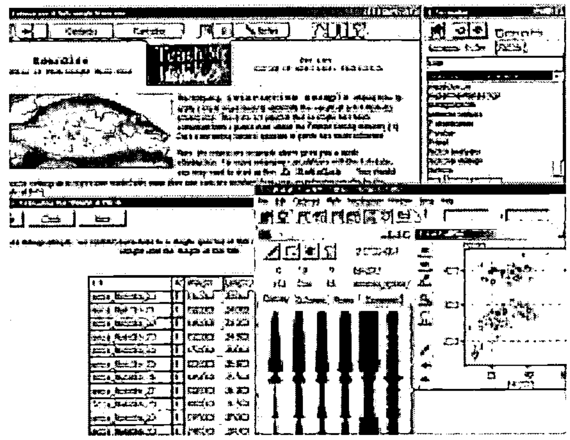

Figure 2: The Web page (top left) contains two different links. One link opens an interactive example (bottom left), whereas the other one starts a calculation program and preloads data for a certain exercise.

2.2.4 Knowledge Landscape

To provide a good overview and easy navigation we have chosen to visualize the textbook with the help of a Knowledge Landscape. A mountain in the landscape represents each page of the underlying textbook. The formation of the Knowledge Landscape is governed by two general rules: (1) In the 3D version, fundamental chapters, explaining basic concepts, are visualized by high mountains, whereas more specific lessons are displayed by smaller mountains. (2) The placement of the mountains is made according to the similarity of the contents of the corresponding lessons. Thus highly related texts are placed next to each other. The positions of the mountains on the 2D surface are computed automatically. This approach allows easy non-linear and non-hierarchical access to originally hierarchically structured documents.

Static objects in a landscape, whether they are real or virtual, have unique fixed positions in the spatial three-dimensional space. We all have experienced the exploration of unknown and the navigation in known territory since early childhood. Thus we are used to remembering the relative positions of objects in our environment and we can easily find objects again, even if they are not in our direct line of sight. Despite the fact that there is not only one 'correct' spatial representation of relations between topics we offer only one Knowledge Landscape as novice users may easily be confused if they are confronted with more than one spatial representation.

2.3 Learning Targets

In this subsection we will have a closer look at five learning targets and we will examine which forms of navigation are best suited for each of them.

2.3.1 Training – Drill and Practice

Drill and Practice training was one of the first applications for computer-based training. The computer was the perfect tool to teach highly standardized procedures such as preflight preparations for an aircraft's cabin crew. A major component of these simple CBT programs is testing the students' knowledge. Objective tests and quizzes are among the most widely used and well-developed tools in higher education. Each question assumes a simple answer that can be evaluated either as correct, incorrect, or partly correct. According to the expected type of answer, questions are often classified into eight types. There are four basic types: (1) yes/no questions, (2) multiple-choice/ single-answer (MC/SA) questions, (3) multiple-choice/multiple-answer (MC/MA) questions, and (4) fill-in questions with a string or numeric answer. More advanced type of questions include (5) matching-pairs questions, (6) ordering-questions, (7) pointing-questions – the answer is one or several areas on a figure – and (8) graphing-questions – the answer is a simple graph. Also, each topic area may have specific types of questions [Brusilovsky 99].

If CBT software is developed for drill and practice, the most important navigation tool is the table of contents. It gives students a clear outline of what will be covered. There is no need to support learning or understanding additional topics as the whole learning process is highly predefined. Referring to the example of training cabin crews, the CBT software does not need to help students understand which preflight checks a pilot would have to make.

2.3.2 Gaining an Overview

Especially in a professional working environment it is very important to be able to quickly gain an overview of a topic and to identify the main concepts. We think that this learning process is best supported by a combination of the Knowledge Landscape and a keyword search. The search results are highlighted in the Knowledge Landscape and one can therefore locate the main concepts and their relation with certain keywords.

2.3.3 Understanding In-depth Knowledge

Teachers generally agree that students must actively process and make sense of available information in order to gain an in-depth understanding of a topic. Therefore, expert teachers use many different techniques to ensure the active involvement of students. For example, classroom teachers rely on a number of visual cues from their students to enhance their delivery of instructional content. A quick glance, for example, reveals who is attentively taking notes, thinking about the lecture or a difficult concept, or trying to make a comment [Willis 93]). In contrast, pupils studying with WBT software may lose attention without anybody noticing.

One way to increase the probability that learners actively process information is to require answers to small quizzes and the use of interactive examples (see Section 3). Another option is to engage them in the process of exploring the knowledge domain. A knowledge landscape can be both motivating to navigate through and convey insight into how concepts are related. As understanding the connections between various topics is essential for gaining in-depth knowledge, the knowledge landscape is an important tool supporting this process.

2.3.4 Reference

Students often keep good textbooks as reference. Mainly because they have spent a considerable amount of time and effort to study the book, they are able to understand concepts they do not remember well very fast again. Therefore it is essential that good learning material is also designed to be used as a reference. Obviously, an index is the most important navigation interface for finding the required information. However, as indices are by definition word-based and not content-based one might miss highly related concepts, particularly if different domain experts use different terms for the same concepts. As the Knowledge Landscape is computed content-based and does not rely on keywords only, it can uncover such relationships.

2.3.5 Adding or Updating Content

The content of WBT software has to be periodically updated to ensure that it meets the demands of a changing syllabus. As most WBT projects are maintained by more than one author it is very difficult to make sure that links to all related topics exist– even if the author is required to set links to topics written by others. The Knowledge Landscape can support authors in finding relevant relations and it helps to ensure that the hypertext navigation structure, i.e. links, is built properly.

3 Conclusion

Navigation can be considered to be one of the decisive factors in determining whether eLearning software really supports the learning process of students. It is no longer limited by serially flipping through pages; we showed how Knowledge Landscapes can be used to provide another (flat) view of hierarchically organized content. The option to interactively manipulate the landscape increases the chance of actively involving students while studying. Throughout this paper we gave examples of how these features have been successfully implemented in existing WBT software.

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