

Exploring Electronic Media and the Human Mind - a Web-Based Training Module

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Abstract: Effective Web-based training (WBT) has a need for adaptation and contextual information, but most WBT modules provide not more than some simple help pages or hypertext facilities with keyword indices. Help pages mostly provide information how to access functions but not how to apply them - and why. Therefore, we designed a generic Web-based Performance Support System (PSS) that can be used as a stand-alone training course about 'Learning in electronic media' or as an integrated help system supporting other WBTs. The PSS provides four modules, a comprehensive glossary, a keyword and a full-text index as well as a graphical overview with brief summaries of all modules. In order to motivate users to apply learning strategies we integrated about fifty so called brain tests: Each test consists of short psychological experiments which can be easily conducted within a few seconds and illustrate important features of human perception and human memory. First experiences ascertained that it is highly motivating for students to test their own perceptions and learn about human cognition.

Introduction

Learning effects of multimedia in education are disappointing, quite frequently. Van den Berg and Watt (1991, pg. 119) compared multimedia in competition to a classroom lecture, multimedia supplementing a lecture and multimedia replacing a lecture. They drew the conclusion: 'Objectively the academic performance of (multimedia) users was not different from those attending classroom lectures [...] Although, positive about (multimedia) technology, they indicated that they would prefer to use it as a supplement to lectures and books.' Meta-analyses support statements like these. Kulik and Kulik (1991) examined 248 research studies about computer-supported learning. 150 studies failed to show any significant effects. The other studies showed only a slight advantage of multimedia over textbooks or lectures. Considering all studies included into the meta-analysis, multimedia produced only a small effect (Hasebrook, 1995). Although, multimedia seems to save some time and reduce simple errors, it has not been found to be very effective as a problem solving tool (Mayer & Anderson, 1992).

There are some promising studies, however, showing that multimedia could potentially facilitate the learning processes. The Software Publishers Association (1995) reviewed the effect of instructional technologies in 133 school studies from 1990 to 1994. It was stated that there were better test results, an increase in self-reliance and a closer interaction between students and teachers. Many other studies have confirmed that multimedia applications enhance learning, only if the individual skills and abilities match the demands of the learning task and the functionality of the multimedia system (e.g. Barba, 1993; Mayer & Sims, 1994). Therefore, it is necessary to teach users strategies and concepts to use multimedia applications. Additionally, it is necessary to adapt the system to individual abilities and the overall learning environment (Schulmeister, 1996; Larkin & Chabay, 1992).

Many vendors and users prefer a stepwise migration from 'old' to 'new' technologies. For instance, Bank Academy has implemented a multimedia CBT in charge of the financial department of an international automobile manufacturer and dealer (cf. figure 1) which was implemented in five different languages and delivered on CD-ROM. One of the challenges of this project was to produce off-line and on-line training courses in a single production process. Therefore, we implemented the different CBT versions using the Hyperwave Information Server (Maurer, 1998) in order to maintain the multimedia elements. Hyperwave directly delivers Web-based training, because it includes a complete Web server, and allows to produce a 'snapshot' of the database which can be delivered on a CD-ROM. Up to now, the training course does not provide more than a traditional multimedia CBT. But in the year 2000 the course will be put on-line and therefore integrate Hyperwave's on-line features, such as note taking, discussion forums and bulletin boards.

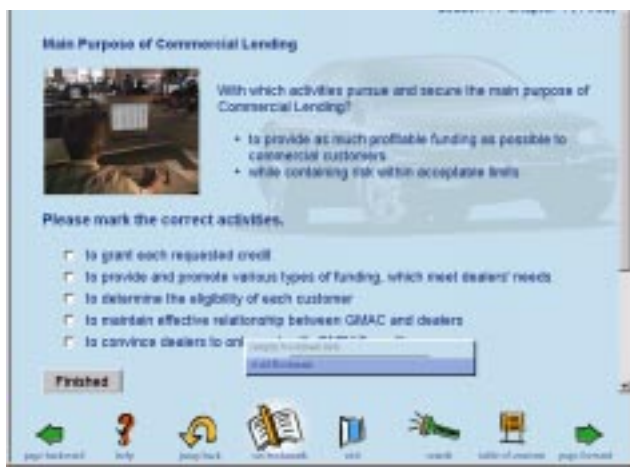


Figure 1: Advanced Web servers like Hyperwave allow to introduce Web-based training starting with off-line multimedia CBTs; this approach has been chosen in a project of Bank Academy in charge of an international automobile manufacturer.

From Help Pages to Performance Support Systems

Duchastel (1992, pg. 69) claims: 'Adaptation is essence of what is known as pedagogical knowledge'. Many researchers aim to make their multimedia systems more adaptive – and therefore more 'pedagogical' (e.g. Cox & Brna, 1995). Expert systems and Intelligent Tutoring Systems (ITS) adapt to the learner's demands, abilities and knowledge – especially in subjects which can be described in formal structures (Bastien, 1992). There is an increasing number of adaptive computer programs which are equipped with media like videos and photographs. As of today, a diverse spectrum of techniques, approaches and philosophies impede the progress in intelligent learning environments (Self, 1992). There are promising results, however, supporting positive effects of intelligent learning environments teaching mathematics and programming (e.g. McGraw, 1994). In general, effects of adaptation and system-controlled tutoring have been small or medium sized, yet (e.g. Schulmeister, 1996).

Despite these insights about the need for adaptation and contextual information many Web-based training modules provide not more than some simple help pages or hypertext facilities with keyword indices. Help pages mostly provide information how to access functions but not how to apply them in different learning contexts - and why to apply them. Effective learning needs a good deal of verbal and visual literacy, whereas computer literacy seems not to be the most influential factor (cf. Mayer & Sims, 1994; Mayer & Anderson, 1992). Thus, most help systems do not support learning strategies to cope with linked multimedia elements, and they do not motivate to use electronic media as a serious learning tool. Effective help systems should support the user to overcome his or her weaknesses and take advantage of her or his strength. We therefore designed a generic Web-based training system that can be used as a stand-alone training course about 'Learning in electronic media' or as an integrated help system supporting other Web applications (cf. figure 2). Thus, it can be used as a Performance Support System (PSS) to enhance utilizing electronic media in a learning and in working environment (McGraw, 1994). The PSS provides four modules, a comprehensive glossary, a keyword and a full-text index as well as a graphical overview with brief summaries of all modules. The table of contents comprises the following topics:

- Learning with multimedia: Advantages and disadvantages of computer-based training - Appropriateness of multiple media - Learning strategies for multimedia - Combining dynamic and static media - Self test 'Multimedia expert'.
- Information from the Internet: Basics about the Internet - Addresses in the Internet - Search engines and search strategies - Self test 'Internet expert'.
- Email and Computer Conferences: Basics about email - Writing emails - Mail and list server - Asynchronous and synchronous computer conferences - Video conferencing - Self test 'Email expert'.
- Learning strategies for CBT: Browsing hypertext and multimedia - Using navigational tools - Using bookmarks and note taking - Graphical browsers, maps and overviews - Strategies for learning and re-learning - Self test 'CBT expert'.

Learning to Learn

Many authors suggest that deeper understanding means that sequential verbal information is highly interconnected with analog pictorial information (e.g. Mayer & Anderson, 1991, 1992). Supporting understanding, then, demands the construction of semantically connected pieces of text and pictures, activating

appropriate pre-knowledge, providing learning strategies for multimedia, and changes of media and learning perspectives to support the construction of comprehensive mental models (Albrecht & O'Brian, 1993). Research (e.g. Mayer & Sims, 1994) support the consideration of individual differences in abilities and interests in order to enhance the understanding processes.

In two studies with 75 subjects we were able to confirm that individually adapted information enhances motivational and learning processes within computer-supported learning environments: Audio-visual media produced only a small effect, individual generated information, however, was very effective and was independent of subject variables like computer experience and usability judgements (Hasebrook & Gremm, in press).

Glowalla and Hasebrook (1995) conducted studies with 52 students which participated in a hypermedia learning course, all of them were novice hypermedia users. In the first lesson they are "unskilled learners", in the last lesson they were "skilled learners". Four month later, 43 of these students attended a relearning course. All students received exactly the same course materials and configuration of features of the hypermedia system as in the learning sessions. Therefore, in the first lesson they were skilled learners, but "unskilled relearners", and in the last lesson, they were "skilled relearners". The results show that browsing tools, such as paging and hypertext links, were used most frequently by skilled relearners, informational tools, such as a glossary and a keyword index, were used more often during learning than during relearning.

In conclusion, multimedia information is first encoded in simple text and image bases; using more sophisticated elaborating and inferencing processes mental models can be generated based on the information in the text and image bases (Hasebrook, 1999). Information selection and encoding from short term memory leads to separated encoding of verbal and pictorial information in the long term memory (Baddely, 1990; Paivio, 1986). There is a tendency to understand pictures 'at a glance' resulting in a simple representation that is not linked to verbal information (Weidenmann, 1994). Deeper processing of images can be elicited by teaching appropriate learning techniques (Drewniak, 1992) and by obvious links between pictures and verbal explanations. These higher levels of processing can help to generate appropriate static and dynamic mental models (Hegarty, 1992).



Figure 2: A content screen of the Web-based training course 'Learning in electronic media' provides brief explanations, interactive exercises (indicated by the mouse icon) and psychological self assessment (indicated by the brain icon).

The role of Meta-Cognition

Self-regulated learners govern a broad variety of cognitive and metacognitive strategies to fulfill their learning tasks. They monitor and - if necessary - modify their learning strategies. They are motivated, independent, and metacognitively active controllers of their own learning processes (Zimmermann, 1990). It is not easy to

acquire knowledge about knowledge acquisition, but it is even more difficult to transfer this knowledge to every-day learning tasks. Therefore, it is essential to practice how to apply study techniques and to motivate the use of sometimes time consuming learning strategies. Otherwise, the learners most likely prefer simple study techniques, such as accessing all pages in sequential order.

Our aim is that is to use 'the computer as a tool for learning through reflection', as Collins and Brown (1988) put it. We tested the correlation of pre-knowledge and acceptance of software tools using an on-line expert system for vocational guidance. There is a positive correlation between the students' judgements about (1) how well the information provided by the system match their interests, (2) how well they know subject, (3) and how well they can imagine important aspects of the subject matter. However, there is a negative correlation between all these variables and the actual state of information: That is, the more information the students have got, the less they are willing to accept system advisory – and the less they have got a notion of knowing. Therefore, information leads to more skepticism and critics (Hasebrook & Nathusius, 1997).



Figure 3: 'Brain tests' enable the user the participate in brief psychological self tests and learn about her or his perceptual and memory system; the screenshot depicts an experiment about the perception of movement.

In order to motivate users to apply learning strategies we integrated about fifty so called brain tests (cf. figure 3): Each brain test consists of short psychological experiments which can be easily conducted within a few seconds and illustrate important features of human perception and human memory. First experiences ascertained that it is amazing and highly motivating for students to test their own perceptions and learn about human cognition. The list of the brain tests comprises the following subjects: Specialization of the brain hemispheres - Grouping visual stimuli - Processing visual features (angles and distances) - Processing three-dimensional scenes - Perceiving colors - Perceiving movements - Acoustical illusions - Short-term and working memory - Memory sets and schemes - Cognitive illusions - Mood and memory - Social influences on cognition - Illusions of awareness and consciousness - (Very) long-term memory - Unconscious and implicit learning. Additionally, self tests for each module help the users to check their expertise on each topic and enables them to review directly the parts of the course which are linked to the questions.

Integrating Performance Support in Learning Systems

Web-based learning systems combine various advantages: access to huge amount of data, up-to-date information, and guidance provided by (self) tests and expert systems. This does not necessarily mean that students enjoy working with electronic media. This is the lesson we learned when comparing four media for vocational guidance (Hasebrook & Wagner, 1997): two of them are multimedia applications and the other two products are printed matter. We measured individual acceptance ratings after having used the four different products with 75 students participating in this study. The results show that printed matter are preferred. This result is statistically independent of sex, education, and experience in using a computer. Thus, the students enjoyed using electronic media, but they rely on printed matter.

Expert advice provided by the system, however, clearly increases acceptance and performance of electronic media: Users pick up more information and they consider this information to be more valuable. The more information they have gathered and elaborated the more they lose their notion of knowing and develop a critical

approach to expert advisory. Multimedia applications should not be designed to provide "something for everyone", but they should provide exactly that piece of information which is needed in a particular stage of the decision making process. The effects were enhanced, if individual preferences were regarded.

A major German bank uses a special version of the PSS 'Learning in electronic media' as a kick-off course and motivational aid to introduce Web-based training in the bank. The aim of the PSS here is not to achieve pre-defined learning objectives but to avoid a 'learning culture shock' by helping the user to become a self-regulated learner. We aim to fully integrate the PSS as a background library and help system for any specific Web-based training course (cf. figure 4). Therefore, we develop an interface that uses keywords from the current HTML pages of the specific course and search terms entered by the user to search the glossary, the keyword and the full-text index of the PSS for relevant explanations and exercises.

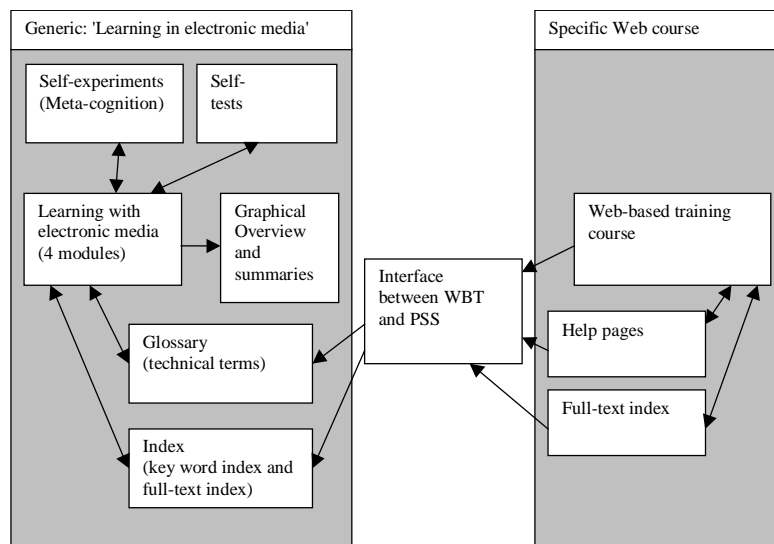


Figure 4: Architecture of the Web-based PSS 'Learning in electronic media' - generic topics and exercises can be linked to specific on-line courses by an interface using the search and the index facilities of the PSS.

The entire system can be stored on an ordinary 'open' Web server, such as Apache. New browser version allows for minor adaptations of colors and fonts using style sheets. Additionally, the system runs on a Hyperwave server which adapts the complete graphical user interface of the PSS to the user interface style of the target system: All buttons of the target system are active, styles guides concerning font, color, and navigational tools such as table of contents, are applied automatically. In this way the PSS becomes an integral part of any specific Web-based training course without re-implementing or modifying its contents.

Conclusion

The learning effect of multimedia has been disappointing, so far. This seems not to be based on a lack of computer literacy but on general deficits in media literacy and in learning strategies that support the integration of knowledge from different sources. Simple help pages are insufficient to cope with these deficits and to strengthen users' ability to become self-regulated learners. We therefore suggest to design and implement generic Web-based Performance Support Systems (PSS) that help the learner to understand and practice appropriate study techniques. Such an PSS has to enable the users to transfer the use of general learning strategies to their actual learning tasks - and it has to motivate this additional learning effort.

The PSS 'Learning in electronic media' comprises explanatory texts, pictures, and animations as well as interactive exercises, self tests, and brief psychological self experiments which give an vivid impression why and how elaborated learning strategies should be applied. Furthermore, the PSS discussed here can be integrated into specific Web-based courses by using style sheets, advanced Web servers, and an interface applet that browses the search facilities of the PSS and automatically points the user to appropriate information.

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