Adaptive Coherence Information as an Approach to facilitate the Comprehension of Online Learning Courses

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Abstract

Knowledge acquisition with online learning courses is mostly a matter of reading texts on a display. Understanding the text might be more problematic than in a book because of the possible gaps which could be produced by jumps to remote pages. Building an inadequate mental model might be a more probable danger for readers with little or no background knowledge because they do not have sufficient substitutions for lacking actual coherent information. This situation could be prevented by an adaptive feature that supports the user with additional information. We plan to examine the effectiveness and efficiency of an additional adaptive coherence information.

1 Introduction

According to Storrer [2002], authors of online learning courses have to design the structure of the underlying domain knowledge in a way to facilitate the user's comprehension by facilitation of his or her coherence-building. The crucial point to an adequate domain model of a course would be to examine and define topics containing prerequisite knowledge necessary to understand other topics. In our approach we follow this suggestion by providing the user with a system of adaptive coherent information.

1.1 The Process of Comprehension

To examine the process of comprehension, Storrer suggests a model of Schnotz [1994]. He designed his model to explain the processes of comprehension in linear text only. But it is especially adaptable for the use in knowledge transfer with hypertext. The central assumption is the building of a mental model. The product of a comprehension process is a coherent and adequate mental model which represents all information in more or less detail. The user builds his or her mental model through an interaction between the already acquired background knowledge and the actually processed text information.

One of the main features of hypertext are the links even between remote pages. They allow the user to jump to different pages even within another context. Thus, the user may get confused by following links. His imagination of coherence or matching between the already processed text and the actual page may be inadequate if he or she has no background knowledge to fill the knowledge gaps which are not provided by the text. The level of background knowledge seems to be crucial for text comprehension: A novice user is more endangered of building an inadequate mental model than a user with a higher level of background knowledge.

1.2 An Adaptive Coherence Approach

In our approach, we try to provide the user with additional adaptive coherence information from within the course to give him or her the opportunity to learn more about recommended pages which should be known before the actual page should be visited. With this help, novice users who navigated through the course in a nonlinear way should be able to build a more coherent mental model of the course subject. To linearly navigating users no hint texts would be presented at all, because they should not need any additional coherence information on the course structure to comprehend its content.

2 Project Description

Our approach is based on the adaptation of the page presentation to the user's knowledge acquired within the course. A later step will include the adjustment of the user model to the background knowledge the user acquired before. We distinguish between two knowledge sources: 'prior knowledge' is acquired within the course, whereas 'background knowledge' means the topic related knowledge which is acquired before the user enters the actual course.

In this approach, adaptive coherence information is assumed to facilitate the comprehension of online learning courses. Users who had not learned prerequisite pages within the course are provided with a short notice and a link to the referring pages.

2.1 Hint Texts as Adaptive Coherence Information

The first realization of comprehension facilitation with additional short summaries was done by Foltz [1992]. The insertion rule of his system presented some additional coherence information if the user followed a link to a remote page. In that case, the user got additional coherence information on top of the actual page. They consisted of short summaries of those pages he or she just skipped. No summaries were presented on close pages.

Kintsch [1994] found that users with a higher level of prior knowledge may get distracted by additional

information and possibly get a disadvantage in comprehension. Therefore, in our approach hint texts should only be presented to users with little prior knowledge adaptively. We assume hint texts only to be helpful if the user's knowledge about prerequisite concepts is taken into account to decide their presentation.

In his experiment, Foltz used a course on the economic market to be learned by undergraduate psychology students. Those students could possibly have been novice users in such a knowledge domain. This may have been the reason for the participants' lack of nonlinear navigation behavior which rarely produced any summaries at all.

To prevent such a setting, we chose to use a course on HTML-programming. We expected that even novice users would navigate through the course in a nonlinear way so that they would produce hint texts. This course has two convincing advantages: First, HTML-programming is a more modular domain than a course on a social content (e.g. economic market or psychology) and second, many users are interested in it.

2.2 Application of Adaptive Coherence in NetCoach

We use NetCoach [Weber *et al.*, 2001] as authoring system and online server. Besides other concepts prerequisites are one important element of the domain model in NetCoach. The prerequisites of pages within a course have to be set up by the course author. He can define, if one page (A) is recommended to be learned before another page (B) should be visited. Then A is called a prerequisite for B. The user is still free to navigate through the course in any way he likes.

During the user's progress the system stores his navigation behavior and exercise performance on pages with test groups in a so called user model. The system compares the user model with the domain model and checks if there are some prerequisites which are not fulfilled to comprehend the actual page.

NetCoach provides the author and user with some adaptivity features one of which is adaptive hint text presentation. Each hint text is a short sentences representing the basic topic of one not yet learned prerequisite page. The user is supposed to follow the link next to the hint text to learn more about background pages. Then an extra window will pop up with the content of the requested page. Now he can decide whether he will read on at that page or an the page he visited before on which the hint texts were presented. In summary, hint texts and their neighbored links are meant to improve the coherence of the user's mental model of the course subject. Not the hint text itself but the page the hint text hints to is to be read and learned to provide the user with sufficient background knowledge.

3 Field Study

In a field study we tried to find evidence that on the one hand even novice users navigate through the course in a nonlinear way and on the other hand that the use of hint texts would produce better results for users with little background knowledge.

For experimental reasons we provided NetCoach with a special feature which assigns new users randomly to the experimental groups. The two user groups were either to provided with the possibility to get hint texts or not. The actual presentation of the hint texts depended on the navigation behavior of the individual user. Next to each hint text a link was implemented to allow the user to access the referred page. The system logged each user action within the system to enable the researcher to analyze the user's behavior and performance. At the beginning of the first session a questionnaire was given to the users containing questions on their gender, the age, the goal of the work with the course, and the subjective proficiency level of HTML programming.

3.1 Sample Description

Between February and May 2003 we conducted the data of 642 interested users of the mentioned HTML-course[1]. Of these new logins just 603 People really used their login. That means, users with no time spent in the course or without navigation activity were excluded from the analysis.

The resulting sample of 603 participants included 417 men (valid 75.1%) and 138 women (valid 24.9%). 48 persons did not give any information on their gender. The mean age was about 30.3 years with an standard deviation of 12.8 years. The mean working duration was 20 minutes and 33 seconds with a standard deviation of 45 minutes and 26 seconds.

69.4% of the sample said that they had little or no theoretical knowledge on HTML programming, 30.6% said to have at least moderate knowledge. For further analyses we divided the group into two subgroups using the median split method. So, 69.4% of the group were users with low background knowledge and the remaining 30.6% were users with high background knowledge.

3.2 Navigation Behavior

We expected that novice users would profit from the additional coherence information resulting in a better exercise performance than those novice users without the additional information. In addition, users with high background knowledge should not profit from the presented hint texts or even get distracted by them which could result in a reduced exercise performance.

The total sample of 603 users was divided into two subgroups randomly (see fig. 1). The first group could produce hint texts (50.9%) the second could not (49.1%).

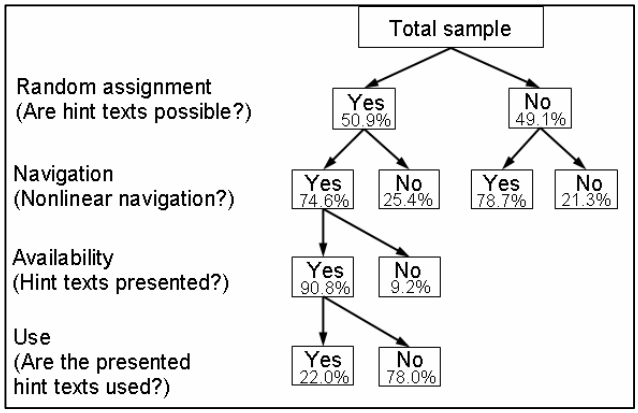

Figure 1: Subgroups of the total sample

[1] http://art.ph-freiburg.de/html-tutor

As to be expected, the random assignment worked properly and thus produced subgroups of nearly the same size. The next step is much more interesting: Would the enabled users navigate in a nonlinear way and thus produce hint texts? We found that in each group about 75.0% of these users navigated through the course in an incoherent way at least once. Hint texts were presented to users at such occasions.

The last separation in Figure 1 represents the question if those users who navigated through the course in a nonlinear way and got hint texts actually used the links next to the hint texts and looked up the referred pages. Just 22.0% of these users did so.

Figure 2 shows the navigation behavior and the use of hint texts by users with low or high background knowledge.

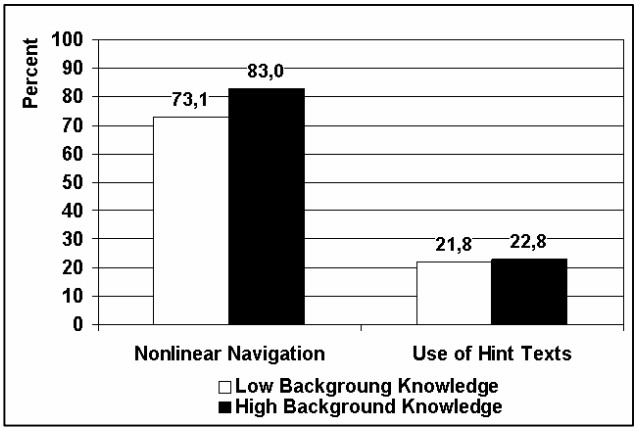

Figure 2: Navigation behavior and use on hint texts depending on the background knowledge

73.1% of the users with low background knowledge navigate through the course in a nonlinear way at least once. The respective percentage of users with high background knowledge is just a bit higher (83.0%). The percentage of users who use the presented hint texts by following the link is nearly the same for both groups.

3.3 Exercise Performance

We measured the exercise performance by logging the users' answers to exercise questions within the course. We took into account the different working durations by taking the percentage of correct answers as the dependent variable. In Figure 3 the mean percentages of correct answers of the interesting groups are displayed.

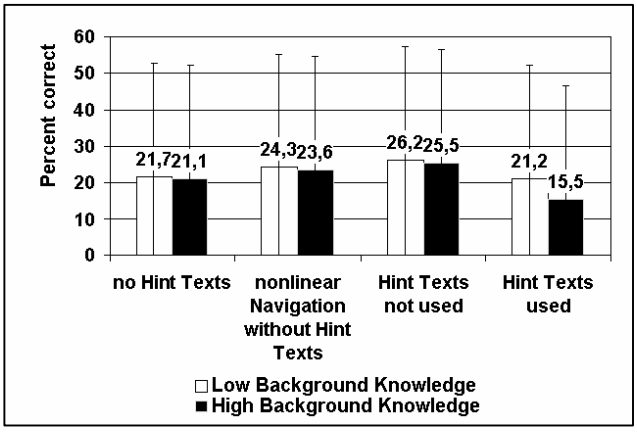

Figure 3: Mean percentages of correct answers

The presented differences are not at all significant because the standard deviation is very high. Nevertheless, we want to discuss our interpretation.

The overall mean of users with low background knowledge tends to be slightly better than the performance of users with high background knowledge. The greatest difference between those two user groups is found when the users followed the links next to the presented hint texts.

The mean differences could be caused by some confounding variables. I.e., users with low background knowledge worked longer within the course and had a more general goal like to gain an overview on HTML. Users with high background knowledge rather wanted to work with the course to acquire detailed knowledge on a specific HTML problem or question.

4 Conclusions and Future Perspectives

Results show that even novice users navigate through the course in a nonlinear way at least occasionally. But the percentage of users who do so does not mean that these users do that every time when following a link. The overall frequency of nonlinear navigation is quite low (about 5%).

The greatest difference between novice and advanced users regarding the percentage of correct answers was to be found when the users followed the presented hint texts. The findings may lead to the assumption that novice users have s better exercise performance but the examined outcome may be confounded with variables, such as the working duration and different user goals. E.g., we found a significant increase in working duration for the novice users. A random assignment of those confounding variables would be a solution to prevent undesired effects. In a real world setting like our field study, we could not assign the user's goals randomly because every user uses the course in an individual way and wants to get an answer to his or her specific question. Additionally, the huge variance of the percentage of correct answers may blur the average effects.

To establish real experimental conditions, the next step will be an offline laboratory setting. The advantage of such a setting would be the reduction of the variance of possibly confounding variables such as working duration and working goals and thus to be able to attribute a difference in exercise performance directly to the different hint text presentations.

An additional option of adaptivity will be the integration of a pretest to determine not only the user's prior knowledge acquired within the course but also his or her background knowledge acquired with other sources beforehand the system does not know about. In the presented study the user's background knowledge was not measured but asked through a questionnaire at the beginning of the course. A pretest would help to gather information about the real background knowledge of the user. The individual user model could be triggered by this information. The user would not have to learn those pages he or she already showed proficiency of.

Another future option of the adaptive coherence feature could be the opportunity to mark the background pages manually as already learned. This information could substitute the pretest because it provides the sys-

tem with information about the user's background knowledge without testing him or her. The user has to decide on his or her own if his or her knowledge is sufficient to mark these pages as known. The system may then update the respective user model and would no longer present hint texts of these pages.

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