Planned Adaptive Coherence Experiments

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Abstract

In knowledge gain theories the acquisition of a coherent mental model is assumed to be the key to adequate comprehension of the to-be-learned content. Through growing use of linked and thus modularized texts in virtual learning environments these texts can lack of linear learning sequence and the learner could only develop an incoherent mental model. On the basis of a modified process model of text comprehension we make assumptions about the usefulness of additional adaptive coherent information to prevent coherence lacks in the learner. We propose controlled experiments to evaluate these hypotheses.

1. Introduction

Since the 70ies of the last century research was intensely concerned with the cognitive processes dealing with knowledge acquisition. Some of the results of this research area were theories on the process of knowledge acquisition. Different personal and environmental factors were postulated to have an influence on the learning process.

Some models include learner facilities, learners' activities, special features of the learning material, and the kind of the given or chosen task. In addition, an interaction between these factors was postulated. Fischer and Mandl [1990] developed a tetraedic model of text comprehension especially for the context of learning with modern media on the basis of the four factors mentioned above. The interaction between the learner, the knowledge base (the learning material) and the learning task is especially interesting for our studies.

Schnotz [1994] developed a text comprehension theory including three levels of text processing. Schnotz explicitly developed his model for knowledge acquisition with conventional linear text as it is in books. Virtual systems, however, often do not use a linear learning text concept but a more modular kind of text structures which is known as hypertext.

Through the partly intransparently linked structure of hypertexts the reader does not always know how the requested page is linked with the last page after following a link. In this case, the text might lose global coherence for the reader, i.e. the connection of the already visited pages with the overall topic. With adaptive mechanisms we want to close those gaps by supporting the user with individual information.

To describe the effect of coherence reduction in hypertext the text processing model of Schnotz [1994] can be adapted. The user leaves the required linearity of the processed text when he or she jumps to pages which he does not have the required prerequisites for. Adaptive additional links to that required content might be used to give the user the opportunity to look it up.

2. Text Comprehension

As found by Kintsch [1994, 1996], learners with little prior knowledge profit from linear text where learners with high prior knowledge can deal even with incoherent texts. Those results let user adaptation seem to be an appropriate way of user centered coherence addition.

Foltz [1992] presented his users additional summaries by adding short sentences which were page summaries. For the summary presentation he did not take into account the user's individual prior knowledge but presented additional information of those pages, which were between the last visited and the requested page. This additional information did not show any effect on learning success.

For Naumann et al. [2003] the approach of coherence adaptation is assumed to be optimal for giving learners the best context to learn effectively. Storrer [2002] recommended an adaptive coherence approach as a facilitation of the reader's text comprehension.

On the basis of Fischer and Mandl [1990] we developed a Cyclic Learning Model (CLM) to describe the process of recursive learning with adaptive learning material. Figure 1 shows the simpler form of the model, where the learning task as influencing factor is left out.

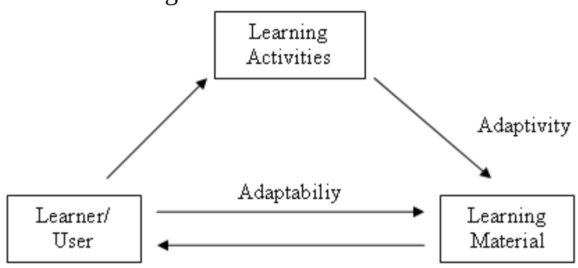

Figure 1: Simple Cyclic Learning Model (CLM)

The simple CLM assumes a learning process to be effective when it takes into account the user's navigation behavior and exercise performance to adapt the presentation of texts. The process is called to be cyclic because of its feedback nature. Based on responses to exercises the system gets information on the user's knowledge on the different pages. The system adapts links and annotations in a way that helps the user to proceed with the text successfully.In Figure 2 this cycle is added by a learning task.

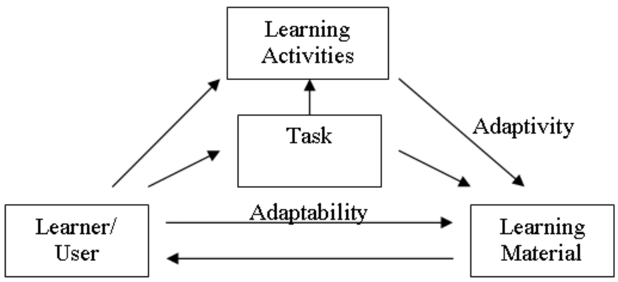

Figure 2: added Cyclic Learning Model (aCLM)

Here the learning task or goal is added. The goal can influence the learning behaviour and the learning material itself e.g., by presenting only relevant pages. In the planned experiments the learners' characteristics will consist of the users' prior knowledge, the aspect of learning material will be given by the presentation of additional links, the learner activity will be the user navigation and his or her exercise performance, and the learning task be represented by learning goal. The learning material will be adapted to the prior knowledge by giving the learner links to the required but not yet learned pages.

In two pilot studies we conducted online experiments [Lippitsch, 2003; Lippitsch & Weber, 2003]. These experiments revealed the amount of help links presentation. I.e., if users jumped to pages for which they were not prepared and therefore navigated incoherently. Sufficient preparation would have been the learning of prerequisite pages. The studies showed that as well expert users as novice users jumped through the presented course in this manner. A second result of these pilot studies was the influence of the learning goal on the navigation behavior. Users with general learning goals more seldom navigated incoherently compared to users with specific goals.

3. Planned Experiments

The planned experiments should reveal the usefulness of the presented adaptive coherence information. To reach this goal, we want to conduct two supplemental rows of experiments. In row A, the coherence of the visited pages will be assigned to the users, where in row B the users get free access to the pages and can produce coherence or incoherence by themselves. In row B, a separation into two groups will be undertaken by the occurrence of incoherent navigation. In row A the page order will be set beforehand, in row B free navigation will be possible. This differentiation should allow a comparison between more artificial but experimental conditions on the one hand and more ecologically valid conditions of real live navigation behaviour on the other hand.

For the planned experiments we want to use an online learning course on the topic of Linux basics. To reduce the subjectivity within the prerequisite structure of the course, two independent raters will rate the prerequisite status of each page. The course would be accepted if the corresponding judges on the prerequisite structure will be sufficient.

3.1. Experiments Ia and Ib

With the first pair of experiments we want to investigate the usage of the additional links under experimental conditions. We want to see whether using added links will result in better learning performance. As well the kind of additional information as the page coherence will be assigned experimentally. This results in two fully crossed factors and a complete experimental design. Table 3 gives the factors and their combinations.

Table 1: Cells of the planned experiments Ia and Ib

		Kind of Additional Links		
		No Links	Chapter Links	Coherent Links
Page Order	Coherent	L_{11}	L_{12}	L_{13}
	Incoherent	L_{21}	L_{22}	L_{23}

The first factor (named "Kind of Additional Links") will differentiate between different kinds of additional links. "No links at all" will be compared to "additional but not coherent links" and to "additional coherent links". The links can not be adapted to the user in the experiment of row A, because the page order is given.

The source of variance in user navigation will be minimized for experimental reasons. That means, differences in user navigation will be simulated by giving different page orders. There will be one coherent and one incoherent page order.

We assume that the usage of the additional information will consume time. So we consider two measurements of exercise performance. At T1, we want to define a break for all learners at the same time to measure their exercise performance with unknown items. Learners who have used additional links will be likely to perform less than those to whom no additional information was presented. Only learners with incoherent page order could profit from additional information at this stage by getting at least some information to fill occurred knowledge gaps. After this first measurement the readers will have any required time to complete the course. Thus, the second performance test will start individually. The time between T1 and T2 will also be an interesting dependant variable. We assume that readers with additional information will spend more time in the course following the presented links and learning on the linked pages. Those users will only profit from this additional information if it adds to the coherence of their mental models. Learners with an incoherent learning material but coherent additional information will perform better at T2 than those without additional links or with not helpful additional information. Learners with coherent learning material will get confused by additional coherent information and will perform worse than users without links.

3.2. Experiments IIa and IIb

In the second pair of experiments, the learning goal will be taken into account as a third factor representing the learning task in the CLM. Two different goals (specific vs. general) will be included as levels of the third factor „learning goal“. Having the general goal, the user should aim for a general overview of the course. Users with the specific goal should aim for a complete knowledge on a specific area of the course. Both groups have to complete the same sequence of tests as introduced above.

Table 2: Experimental design of experiments IIa and IIb

		Kind of Additional Links		
		No Links	Chapter Links	Coherent Links
General Goal	Coherent Pages	L_{11}	L_{12}	L_{13}
	Incoherent Pages	L_{21}	L_{22}	L_{23}
Special Goal	Coherent Pages	L_{31}	L_{32}	L_{33}
	Incoherent Pages	L_{41}	L_{42}	L_{43}

Table 2: Experimental design of experiments IIa and IIb

Adding the learning goal to the factorial design leads to a more complex hypotheses structure. We assume that the learning goal will influence the learners' need to look up specific pages. Learners with a general goal more likely will try to build a mental model of the whole topic, where learners with a specific goal will more likely reduce their interests on those pages which they assume to be directly related to the given goal. Thus, learners with the specific goal and an incoherent page order will profit from the additional information in terms of exercises dealing with their specific goal. This will be measurable in performance at T2 where this group will perform better than learners without the additional information. Learners with the general goal will profit from the adaptive links by being able to build a more coherent mental model of the course topic and thus be able to perform better at T2 on exercises on the whole course. Thus, the learner's goal will not directly influence the usefulness of adaptive coherence support but the user's need to get more information on specific topics or not.

Outline of Experiments

With these four experiments we want to achieve some knowledge on the possibilities of adaptive coherence links, which will be given to the user according to his or her knowledge on prerequisite pages. The additional adaptive coherent links consume time while being read. For this reason, we cannot assume that using coherent links will yield effective learning results within the same time as users without additional links will need. But we assume coherent links to be explicitly more useful in performance matters when combined with incoherent navigation.

All planned experiments will base on a learning environment which enables the experimentator to give experimental conditions experimentally or does so automatically on itself and fulfils all other required conditions. The software NetCoach fulfils all these requirements as well as from author view as from user view [Weber et al., 2001; Weber and Brusilovsky, 2001].

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