Evaluation of Navigational Behavior in a Hypertext Learning System

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Abstract: We conducted an empirical study with nine subjects to investigate the navigational behavior. Particularly, we tested our hypotheses whether overview maps are used extensively and whether interactive examples engage users attention. The analysis of navigation patterns indicates that there might be two different navigation strategies. We collected the relevant data by the use of a monitoring tool, thinking aloud protocols and videos. First results seem to validate our hypotheses.

1. Introduction

Hypertext learning systems are being used increasingly in all areas of education. Nevertheless, it is still not absolutely clear what advantages hypertext can offer (Schulmeister 1997). Comprehensive evaluation studies of learning technologies have been conducted in the past few years (see e.g. Allen et al 1996) and broad range evaluation frameworks have been developed (see e.g. Hallett & Essex 2001, Hedberg et al 2001). The focus of our study is more specific. We have tried to test whether novel features of hypertext learning systems are accepted and used by learners. Novel in this context means that these features cannot be found in traditional textbooks. We concentrate on (clickable) overview maps (compare Fig. 1) and interactive examples. Both features cannot be offered by books.
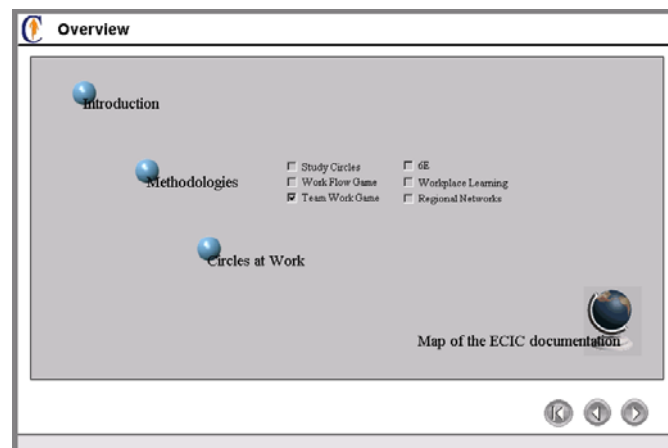

Fig 1: ECIC overview map

Overview maps are a typical feature of hypertext systems. They reflect the distributed character of knowledge representation in hypertext (Pohl 2003). Interactive examples are supposed to convey more realistic information about the topic to be learned and to give them something similar to hands-on experience (Kommers et al 1996). It can be argued theoretically that both of these features offer advantages in the learning process. Nevertheless, it is an open question whether learners make use of these novel features and how these features should be designed. The study described in the following text relates some results concerning these questions.

The learning program we used to investigate these issues was the electronic manual developed in the course of the ECIC (European Continuous Improvement Circles) project. The aim of this project was the dissemination of participative methods of organizational development in small and medium sized companies all over Europe. This program is described in more detail in Lanzenberger and Pohl (2001).

2. Evaluation Methods

The main question we are interested in is whether learners use novel features of hypertext learning systems. This can be investigated in several ways. We developed a monitoring tool, which recorded the relevant user activities when they navigated the learning system. In addition, we also used thinking aloud protocols and filmed how users interacted with the program. These two methodologies correspond to two approaches in HCI: usability testing and field studies (Preece et al 2002). In the following, we will concentrate on usability testing.

Basically, the monitoring tool records which pages in the hypertext document the learners visit, how long they look at these pages and where they go next. These data enable us to analyze various variables. First, it is possible to derive navigational patterns from these data. Second, it is possible to find out how often learners visit specific pages, for example whether they visit the various overview maps considerably more often than the other pages. This would indicate that overview maps are essential for navigation and that sequential navigation is not popular among learners. Third, the time learners spend looking at one page or interacting with this page can give us an indication whether learners found this page interesting. Specifically, we would assume that learners spend more time on pages with interactive examples than on other pages containing only text.

So far we tested nine people, four of them were men and five women. They were between 20 and 40 years of age. Most of them had an academic background and some experience with computers. Each of the subjects worked with the system for one hour. They were encouraged to think aloud during their interaction with the system. All relevant activities of the learners were recorded by a monitoring tool. The log-files produced by the monitoring tool are the basis for the results described in the following section. The results of the data derived from the videos, the thinking aloud protocols and the learners' comments regarding their work with the system will be analyzed in the near future.

4. Results

Before we started the tests we formulated several hypotheses about the behavior of the learners. Our first hypothesis was that learners would use overview maps (compare Fig 1) to a great extent. In this context, we distinguish global and local overview maps. Global overview maps give an overview over the whole system whereas local maps only refer to a certain chapter of the learning system. Table 1 shows how often single pages were visited by all the nine subjects, that is, how often pages were visited during the whole experiment. Table 1 refers to those seven pages of the learning system, which were visited most frequently. Among these pages are two different global overview maps (one of them is more general and one is more detailed), four different local overview maps and an introductory page. The introductory page is one of several which contain diagrams and text and give learners a first idea of the topic of the learning system. Most other pages were visited approximately nine times in all, that is, every one of the nine subjects visited it once. In contrast one global overview map was visited approximately twenty times by every subject, as Table 1 indicates. Table 1 indicates that global overview maps play an important role for the learners. Moreover, local overview maps are also used extensively.

Some of the pages were not visited at all or only by a few subjects. We assume that this is due to design errors. One part of the system contained a more or less linear subsection which contained only text. The last pages of this subsection were not visited at all because learners apparently found these pages boring. It might be argued that large pieces of linear text contradict the intrinsic logic of the medium and are, therefore, avoided by the learners.

category of page	no. of times visited
1. global overview map	197
2. global overview map	161
3. local overview map	97
4. local overview map	78
5. introductory page	77
6. local overview map	51
7. local overview map	44

Table 1: Frequency of visits to single pages (sum of all subjects)

Another hypothesis concerned the duration of the visits. We assumed that the learners would visit pages with interactive examples less often than overview maps but that they would spend more time on these pages. The results are shown in table 2. This table contains two different measures. " Σ" is the duration of all visits of all subjects during the whole experiment. " Ø" shows the average time subjects spent on a page during one visit.

category of page	duration of visit (Σ)	duration of visit (Ø)
global overview map	0:49:25 (hours/mins/secs)	18,4 secs
global overview map	0:36:53	11,23 secs
introductory page	0:24:09	18,82 secs
introductory page	0:22:35	37,7 secs
introductory page	0:20:32	35,3 secs
interactive example	0:13:15	61,2 secs
interactive example	0:12:23	74,3 secs
local overview map	0:12:19	7,6 sec

Table 2: Duration of visits (sum, average)

Table 2 shows that subjects spent quite a lot of time looking at the global overview maps. This is not only due to the fact that they came there very often. They also studied the information presented there quite intensively but they spent even more time (on average) on the introductory pages. As we expected, the subjects did not visit the pages with the interactive examples very often but when they went there they interacted with these pages considerably longer than with any other page. It must be mentioned, however, that these results are not unequivocal. In one section of the system, there were several rather similar interactive examples. Most subjects visited only the first two or three of these and skipped the rest because they probably found them boring.
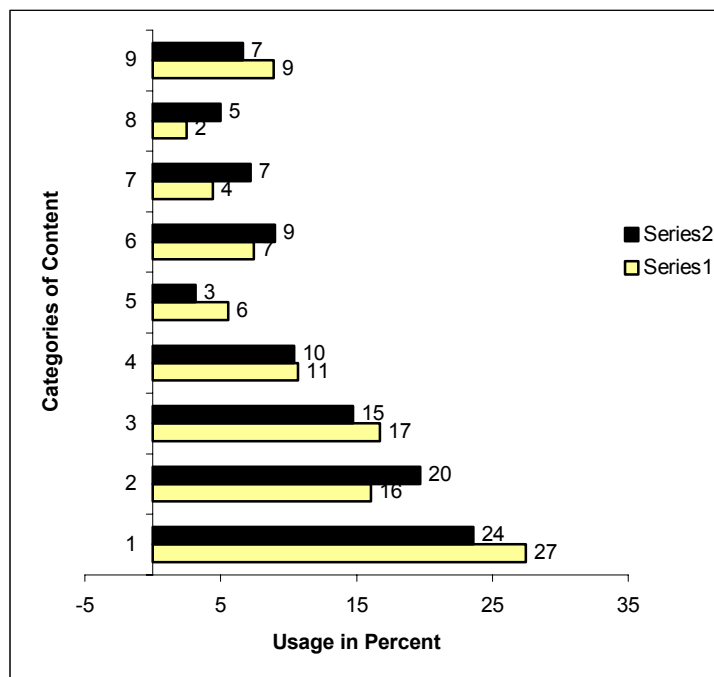

Figure 2: X Axis: Usage in Percent: Series 1: Duration of Usage, Series 2: Number of Pages visited;
Y Axis: Categories of Content (subsections of the system):
1: Global Overview Maps; 2: Study Circles, main topic of the system (some interactive parts); 3: 6E Certificate (highly interactive); 4: Teamwork Game (highly interactive); 5: Examples of Study Circles in a rural zone of Austria (highly interactive); 6: Workplace Learning (some interactive parts); 7: Regional Networks; 8: Example of a Study Circle of Spain; 9: Workflow Game

Figure 2 shows two important results. First, the global overview maps were used very often (24 % of all clicks done during the investigations opened a global overview map) and the subjects spent a lot of time with this pages (27 % of the overall time). Study Circles are the most important topic of this learning system, therefore, the users navigated this topic thoroughly. However, the users preferred content including highly interactive parts. Second, the ratio of the duration of usage and the number of pages visited points out the average time used per page. If the average time is high, the user had more time to study content and functionality of the page. It is not clear whether a page characterized by a long average time is very interesting or very confusing. However, content with a very short average time indicates that the user did not find what he or she was looking for.

The relation between the number of pages visited and the duration of usage shown in Figure 2 as relation between the dark and the light bars seems to be an interesting variable. There seem to be categories of pages which motivate users to a long duration of usage and others to short visits to many pages. As indicated in Table 2 the pages with the interactive examples engaged useres' attention for a long time. Thus subsections which include interactive examples might have longer durations of visits. This can be seen in Figure 2. In addition, this phenomen can also be seen in graphical overview maps and in subsections with a large text fields, e.g. section 9.

5. Conclusion

The main question of this study was whether students use novel features of hypertext learning systems or not. We were especially interested in the use of graphical overview maps and interactive examples. In general, the subjects of our study appreciated these features and spent a lot of time with the interactive examples although the design and the context of use play an important role. Not all local overview maps were used intensively and interactive examples were only studied if they presented new material. The tracking of the navigational path indicated that the subjects used two different strategies of navigation. One group visited the overview maps very often, the other group preferred sequential navigation. Both tended to use the graphical overview map more often in the beginning of the session. It is, of course, difficult to generalise the results from such a small sample. Still, we think that our study gives some insights into learning with hypertexts.

We think that the analysis of the thinking aloud protocols and the videos will give us more detailed information about these processes. In addition, we intend to investigate whether there are different styles of navigation or gender differences.

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