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PANELS

Analysis of Hypermedia Browsing Processes in Order to Reduce Disorientation

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Abstract: Difficulties with orientation are common in hyperdocuments. This paper describes an exploratory study to research the role of a navigation map, as help tool, during browsing processes. We try to establish the influence of this navigational tool, provided by a hypermedia prototype, in retrieval tasks. Twenty-two students tested this prototype and some data were collected: scores obtained in a task-test and a record of the path followed by the subjects. With these data we define a set of ratios as an attempt to understand the subjects' browsing processes. Findings suggest that the map was not effective in the ameliorative role. Perhaps it is not wise to assume that a map that helps performance in a spatial context also form an aid to a hypermedia environment.

Introduction

Hypermedia environments are complex systems based in the non linear organisation of the information. This conceptual assumption introduces new problems as the design of the hypertext structure, the organisation of the content supported by the hypertext structure and the navigation in the system. Our present concern is addressed to browsing/navigation process, a major problem in hypermedia systems, that results from the explosive ability of the system to develop complex networks of information, with direct implications in the user interaction process as the disorientation. Identified as *being lost in hyperspace* [Edwards & Hardman, 1989], this is the main concern to the present study: how and what tools should be used to manage the system; how users deal with reference tools, as maps. We assume that these information systems are quite different from the textual ones, and the mental representation from the information system should be another than the one from the sequential process that has reached us from the printing techniques. Even when the expert reader of a printing text uses a non sequential process he has a static reference, from the book, the page, the paragraph, the word and the graphic layout of the textual interface. In a hypertext environment this reference is dynamic and probably the user will need to deal with a virtual reference model.

Problems associated with the navigation suggest controversial approaches: the spatial and the conceptual [Stanton et al., 1992]. Generally, hypertext systems are conceived as spatial ones, these are central conceptions of the interface metaphor development and the browsing tools, as maps. [Edwards & Hardman, 1989] suggest that the representation provided by navigational tools should be similar to the representation formed by the users, and the same authors identify three distinct situations when the users *feel lost* : i) not knowing where to go next; ii) knowing where to go but not knowing how to get there; and iii) not knowing the current position relative to the overall hypermedia structure.

The analogy between navigation in physical environments and information ones was proposed also by [Canter, Rivers & Storrs, 1985] that stress the analogy of the psychological processes involved in both domains. Thus, users should develop a spatial cognitive representation from the information environment. However [Stanton et al., 1992:432] suggest that a cognitive map "indicate that there is some long-term semantic memory representation of the environment, but that is more like a network map than a survey map..." and stress the interaction between a cognitive map formation under the spatial map reference.

As a result of user's behaviour in high complex hypermedia environments, the designs of these systems have been object of particular development and several approaches, to help users to avoid disorientation problems while browsing hypermedia systems. The establishment of conventions, as metaphors, and the design of browsing tools, as maps, is some of them [Kim & Hirtle, 1995]. Conceived as spatial metaphors of the information network, as the metaphors of the real world are to the interface design [Mountford,1995], spatial maps could be cognitive aids to improve the cognitive mapping of the hypertext structure and reduce users' disorientation.

Our study examines specially the last situation related to navigational aids, and analyse a particular tool: a navigation map. [Nielsen, 1990] argues that the use of the tourist metaphor tries to provide some of the same assistance to hypermedia users as that one that is given to the tourists. According to this, we would expect that navigation maps give the user an overview of the content organisation that will be appropriate to the navigation during the learning process in a hypermedia environment.

Method and procedure

For the present study we develop a hypermedia prototype concerning the theory of tectonic Plates (a global theory of Geology) that was used with a group of 22 high schools students randomly selected. The hypertext structure to organise the information in the prototype was the web model proposed by [Brockmann, Horton & Brock, 1989]. This particular model of organisation is potentially confusing and unpredictable as is suggested by the same authors, and that was assumed as a condition to the empirical study.

Information was presented in nodes-pages and the users can have access to several tools from any screen page by clicking on icons, as a notecard to individual comments, animation and, in a high level of the interaction, the navigation tools. In this prototype the aim was on a specific tool: the navigation map. This is a content index with the representation of the path followed by the student and the stages remaining. With the map we provide a global overview of the network but we exempted the representation of the multiple links among screen pages because it tends to be space intensive and consuming.

From the tool map the student could have access to any wanted screen page. The research design also includes a task-test to gather data from the instructional session with the hypermedia prototype, that was organised in 12 task-questions that students should answer during the work session.

Its goal was to lead students to search for requested information and write it down. Each task presented would imply that students were able to find the right pathway, into the hypermedia network, to get the information requested. The task given had the role of a stimulus to activate the users information-seeking process. To accomplish the task students should develop an oriented browsing style based or not in the map tool.

When testing the prototype we intend to explore the relationships between student's performance in searching information in a non linear database and the use of the navigation map presented by the prototype. This research includes two different moments: a drill and practice session with a special prototype made for it, and a major session with the application described above. During the first session (that we designate as short session) participants get familiar with the hypermedia environment and receive a brief explanation of the researchers purposes. During the second session students had a maximum of 45 minutes (time of regular class) for participating in the study. They worked through the hypermedia prototype at an individual computer. Necessary instructions were given in the begin of the session concerning the main aspects of the prototype interface and about the aims of the task-test.

The prototype includes a general function of identification of the user that generates a permanent file of each student's use of it. This program records the path followed by each student during the session time with the hypermedia application. The data recorded includes:

code, sex, age and frequency of computers use of each student;
name of the visited page;
the objects clicked in each page that were important to solve the test;
time spent in each page (seconds);

frequency of visit to each page.

Data Analysis

The data analysis was based in the score obtained in the task-test, the time spent in each page visited, the frequency of visit to each information node and to the frequency of visit and time spending in the navigation map. Students could obtain a score in the task-test ranging from 0 (any question was correct) to 100 (all questions was correct). The remaining data were gathered in a traversal path record that took the form of a list of nodes selected by the student. Each student traversal path list could be compared to an ideal path, predefined by the authors, that referred only to important information nodes to the task-test. In order to deal with this data, we use ratios, that we intend as a measurement to the student behaviour, in the information network, oriented by specific parameters: *searching*, *orientation*, *access* and *time*.

Ratios used in present study were developed by the authors for the web model followed in the hyperdocument and adapted from previous research in the domain [Marchionini & Shneiderman, 1988; Stanton, Taylor & Tweedie, 1992; Gillingham, 1993; Canter, Rivers & Storrs, 1985].

In order to identify users performance in the experimental hypermedia application we define the following ratios: Search, (RSe) Orientation(ROr), Access (RAc) and Time (RTi). A brief description of these are: RSe = nº nodes of the predefined path visited / total nº of nodes of the predefined path; ROr = nº nodes of the predefined path visited / total nº of nodes visited; RAc = nº of nodes of the predefined path / (nº of the nodes of the predefined path) + (nº of unnecessary nodes accessed); RTi = time spent in nodes from the predefined path / total time spent in nodes of the web.

Statistical comparisons were made to analyse data from the users' browsing processes in the hyperdocument. Nonparametrics statistics with the Kruskal-Wallis test ($n < 30$), were made in order to analyse the significance of the frequency of the visit and time spent in the map with estimated ratios and results from the task-test for the 3 groups of performance identified.

Results

Data obtained from the task-test shows a medium result of resolution for the subjects, based in the modal score that was 50, with a mean score of 57.7 (SD = 18.1). Analysing individual performance for the task-test, we identify that 5 / 22 subjects (23%) had a score below 50 and 17 / 22 subjects (77%) had a score above or equal to 50.

From the analyses of the frequency of visit to the map tool in the hyperdocument we identify, among the subjects, three modes of use. The first group has 10 / 22 subjects (45%) that visited the map very rarely (below or equal to five times) during the session; the second group with 5 /22 subjects (23%) visited the map less rarely (between six and ten times) during the session; and the third group with 7 / 22 subjects (32%) visited the map tool more often (above or equal to eleven times)[see table 1].

% of subjects	nº of visits
45	≤ 5
23	6 to 10
32	≥ 11

Table 1: Frequency of visit to the map tool.

Time spent by the subjects in the map tool leads us to identify again three groups of performance during the session. From the data, the first group has 9 / 22 subjects (41%) that spent a short time (below or equal to 100 seconds); the second group has 7 / 22 subjects (32%) that spent a moderate time (among 101 and 250 seconds); and the third group with 6 / 22 subjects (27%) spent a longer time (above or equal to 251 seconds) [see table 2].

% of subjects	time in seconds
41	≤ 100
32	101 to 250
27	≥ 251

Table 2: Time of visit to the map tool.

Correlation analysis between data variables were done. Only the more relevant results will be reported here.

Using Pearson correlation coefficient between data variables: frequency of visit to the map, time spent in the map, ratios of orientation, access, search and time, and task-test we had the following results [see table 3].

Frequency of visit to the map	*vs.*	Ratio of Orientation	0.576
Frequency of visit to the map	*vs.*	Ratio of Access	0.616
Frequency of visit to the map	*vs.*	Time spent in the map	0.928
Time spent in the map	*vs.*	Ratio of Orientation	0.701
Time spent in the map	*vs.*	Ratio of Access	0.728
Ratio of Access	*vs.*	Ratio of Orientation	0.973
Ratio of Time	*vs.*	Task-test	0.575

Table 3: Variables correlation

Analysis of statistical significance for the three groups identified concerning frequency of visit to the map and the ratios in addition to task-test score show significative differences to the ratio of Orientation 0.007, and to the ratio of Access 0.003, with $p < 0.05$. We found also a value of 0.062 to the variable task-test, with $p < 0.05$. Although not significant the present value could be interpreted as a weak relation between the frequency of map visiting and the score obtained in the task-test. To the time spent in the map for the three groups identified there is a significative difference to the variables' ratio of Orientation 0.033, and ratio of Access 0.007, with $p < 0.05$.

Conclusions

Results do not show a significant difference in the performance of the groups related to frequency to the map with the Search ratio. This ratio indicates clearly the necessary effort to follow the nodes of information that subjects will need to answer to the task-test. Correlation analysis between data variables frequency/time and Search ratio shows an inverse effort. More visits to the map, less relevant search. More time spent in it, less search effort. We stress that Search ratio measures the amount of information accessed by the user that is relevant to the task. Thus, the Search ratio indicates the formation of a mental representation of the relevant information accessed by the user.

However, there is a significant difference between groups of frequency/time and ratios of Orientation and Access. The presence of the map tool was used as an anchor by the subjects. This indicates a long cycle navigation within the web, determined by the map and not by the relevance of the information to the individual performance. Correlation data between frequency and time in the map (the highest score 0.928 from the data), showed no evidence to the task resolution and could be interpreted as an indication of the cognitive overhead to the groups of the highest frequency. Subjects in this condition attribute the control of their performance to the system, as we may conclude by the results to the task-test, which had no significant difference to the three groups of frequency and time in the map. We may conclude that the amount of frequency of visiting the map and time spent in it does not mean orientation in the process of organising and acquiring relevant information.

These findings are consistent with the suggestions of [Stanton et al., 1992], who argue that the provision of a map result in poorer performance, less use of the system, lower perceived control and poorer development of cognitive maps, when compared to a condition with no map present. Nevertheless, we used another research design that not includes the representation of cognitive maps. Perhaps it is not wise to assume that a map that helps performance in a spatial context also form an aid to a hypermedia environment.

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