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## **An empirical study on the recall of site map of home pages on the World Wide Web**

KASHIF HUSSAIN\* \*\*, SHAZIA YASIN MUGHAL\*, FRANCOISE ANCEAUX\*\*, SYLVIE LELEU-MERVIEL\*

Laboratory of Communication Sciences\*, DREAM,  
Cognitive Psychology & Ergonomics\*\*, LAMIH, UMR 8530,  
The University of Valenciennes & Hainaut de Cambésis, Valenciennes,  
FRANCE

<http://www.univ-valenciennes.fr/LAMIH>

*Abstract: - In this article we describe an integrated view of home page structure for recall of information being a powerful concept for the users in information retrieval. We present the results of an experiment investigating the role of structured information in the recall of titles and sub-titles of the site map. We compare the recall of text information of the home page in terms of their hierarchical order at different levels, ascending / descending order, total number of headings recall and total number of levels recall and total possible hierarchical order pages using two types of the Web pages differing in structure of the site map only (structured vs. unstructured) and two types of users (high knowledge vs. low knowledge). All groups were asked to recall the site map of the Web site. The subjects showed improved recall performance for structured information site map page as compared to reduced recall for unstructured one. We argue that structured pages can lead to the construction of better recall process. We believe that the usability of Web tools must allow cognitive resources for navigation planning. The findings from this study indicate that Website developers should construct and provide a conceptual map, which gives a clear insight into the organizational structure of the whole Web site. The findings suggest that the structured site map is importance for both high and low prior knowledge subjects to know that how the ideas of the different document relate to one another.*

*Key-Words: - Navigation, World Wide Web, Site Map, Comprehension, Web Structure.*

### **1 Introduction**

In the cluster of huge amount of heterogeneous information available on the World Wide Web, we face many problems while accessing, and navigating through the existing information that is interweaved on the Web from various distributed sources. The WWW was originally designed to both read and write documents. Currently, however, the major use of the WWW is reading only [1]. But even reading is a complex mix of several paths and track that seems not easy for user in the shared information space. The user has to go through several decisions to visit the most relevant link, to avoid completely irrelevant link, broken link, or dead link, etc.

A lot of work is available to support designers in terms of norms, guidelines, to fit themselves into the new dimension of information sciences. Nevertheless, the companies with large structure, the creation of a user-friendly intranet, extranet structure can be a big challenge. The challenge is to better define the structure and categorize information, which can be helpful in getting the required piece of information in minimum possible time.

This is evident from experiments of [2], [3], [4], [5], [6], [7], [8] who measured different navigation characteristics, as measured by time spent for information retrieval. Structuring information helps one to understand the different pieces of information in a better way. Thus comprehension also increases through the enriched context that comes from sophisticated navigation support and supplemental relationships [9], [10]. The research showed that it would be beneficial for the information-seeking process to have a clear organization of the information and try to convey it to the user. Thüring proposed some cognitive guidelines to represent better ways of organizing (grouping, categorizing, and clustering) to increase coherence and to reduce cognitive overhead [10]. These include:

- Equivalencies between information units are necessary according to their importance level: Headings could have the same size but larger than the size used for the next level subheading, and so on.
- Context of information units should be maintained: The overall context of actual node

should be displayed together with its related nodes to help user see the overall space.

- Higher-order information should be employed: This enables users to identify important portions of the document and their relationships.
- Enable the user to visualize the structure of the document: A clear site map providing all the major pieces of information of the Web site can do this.

Design and usability guidelines suggested that a site map is necessary for every Web site [11] [12]. There are various possible structures to categorize the information element related to each other in order to create an overall structure. A site map that mirrors the site structure well can help the user to reduce the feeling of being lost during navigation [13]. Chen performed a meta-analysis that showed that a graphical map, a visualization of the organization of hypertext, is of significant importance in hypertext [14]. A structured site map can be useful in terms of information retrieval because we look for a specific piece of information with the help of key words described in the site map in order to reach the desired page. A site map during navigation provides shortcuts to the important pages of a site with just a single click visited [11]. Our research supports the structured site map, which can be useful for all type of users that navigate in order to get their desired Web page.

To carry out our research we used the hierarchical structure in which information is categorized in super and sub-ordered headings which provides a clear image of space and helps to know how things are organized and linked in the space. However, the article addresses one of the "non-technical" aspects of site map structure. Moreover, we will limit our study to text-based pages. The Home Page designing should lead to better comprehension regardless of whether the home page is primarily text-based or graphics based [4]. In this study, we focus on our previous work to verify the site map structure recall by the subjects after each navigation session for information retrieval [15]. The result reveals some interesting facts that may be helpful in providing users with immediate and relevant information. The remainder of the paper is organized as follows: First, we commence with background theory that derives the hypotheses of our experiment, which are followed by a description of experimental methodology. Then, we present the results and discussion. Finally, we lead towards our conclusion.

## **2 Background Theory**

The comprehension and navigation of a hypertext document depends on the reader's ability to construct a coherent mental representation [16]. Web Content Accessibility Guidelines strongly recommend providing clear and consistent navigation mechanisms to increase the likelihood that a person will find what he is looking for at a Web site.

Disorientation represents one of the most common problems faced by the Web users, "lost in hyperspace" the term commonly used [17] [18] [19] [20] [21]. According to Conklin, two major challenging problems that ultimately limit the usefulness of hypertext are disorientation and cognitive overhead [17]. Conklin defines disorientation as "the tendency to lose one's sense of location and direction in a non-linear document," using the expression "lost in space" to describe it. He defines cognitive overhead as "the additional effort and concentration necessary to maintain several tasks or trails at one time". Disorientation, or the tendency to lose one's sense of location, can cause users to become frustrated, lose interest, and experience a measurable decline in efficiency [3].

Nielsen investigated the homogeneity problem of an information space. On-line text always looks the same [22]. Thus, places and sense of location were not easily recognized or understood, which is part of the disorientation problem.

## **3 Research**

The current investigation attempts to make a modest contribution in this direction by examining - along multiple dimensions- how people make recall of site map information on the Web designed to have varying level of structure.

### **3.1 Research Question and Hypotheses**

Based on the above theory, we lead to derive our basic research question: does the hierarchical structured home page influence the subjects in information recall of the site map?

The set of hypotheses related to this research question was built after the literature research:

H1: Cognitively designed representations lead to better recall of headings and subheadings as compared to non-cognitively designed home pages.

H2: Cognitively designed representations lead to structured and organized recall of headings and subheadings as compared to non-cognitively designed home pages.

H3: Cognitively designed representations may help more low prior knowledge subjects organize their information as compare to high prior knowledge subjects.

H4: High prior knowledge subjects can recall better than low prior knowledge subjects.

The empirical research that we proposed was actually prepared after our previous research on structured home pages, followed by the exploratory phase.

**Figure 1: A part of structured home page on the left side while unstructured home page on the right side (In French)**

<p><b>LA FRANCE</b></p> <p><b>GEOGRAPHIE PHYSIQUE</b></p> <ul style="list-style-type: none"> <li>La Carte de la France</li> <li>Un Relief Diversifié</li> <li>Les Hautes Montagnes             <ul style="list-style-type: none"> <li>Alpes</li> <li>Pyrénées</li> </ul> </li> <li>Des Climats Tempérés             <ul style="list-style-type: none"> <li>Statistiques Météorologiques</li> <li>Statistiques Météorologiques du Paris</li> <li>Statistiques Météorologiques du Marseille</li> <li>Statistiques Météorologiques du Lyon</li> </ul> </li> <li>Hydrographie</li> </ul> <p><b>ECONOMIE</b></p> <ul style="list-style-type: none"> <li>Agriculture             <ul style="list-style-type: none"> <li>Une Agriculture de Plus en Plus Performante</li> <li>Vers de Nouvelles Exigences d'agriculture</li> </ul> </li> <li>Industrie             <ul style="list-style-type: none"> <li>Les Industrie Traditionnelles</li> <li>Les Industries de Pointe</li> </ul> </li> <li>Les Transports             <ul style="list-style-type: none"> <li>Un Réseau Routier Performant</li> <li>Rail: l'ame du TGV</li> </ul> </li> </ul> <p><b>LA SOCIETE</b></p> <ul style="list-style-type: none"> <li>Une Société Plus Riche et Moins Inégalitaire</li> <li>Langages             <ul style="list-style-type: none"> <li>Deux Articles de l'ordonnance de Villers-Cotterêts</li> </ul> </li> <li>Les Modes de Vie             <ul style="list-style-type: none"> <li>La Famille Française</li> <li>Les Français au Travail</li> <li>L'apprentissage du Temps Libre</li> </ul> </li> </ul> <p><b>GEOGRAPHIE ADMINISTRATIVE</b></p> <ul style="list-style-type: none"> <li>Les Régions             <ul style="list-style-type: none"> <li>La Capitale                 <ul style="list-style-type: none"> <li>Climat de la Capitale</li> </ul> </li> <li>La 2ème Plus Grande Ville                 <ul style="list-style-type: none"> <li>Climat du 2ème Plus Grande Ville</li> </ul> </li> <li>La 3ème Plus Grande Ville                 <ul style="list-style-type: none"> <li>Climat du 3ème Plus Grande Ville</li> </ul> </li> </ul> </li> <li>DOM TOM</li> </ul>	<p><b>LA FRANCE</b></p> <ul style="list-style-type: none"> <li>Des Climats Tempérés</li> <li>Un Réseau Routier Performant</li> <li>Géographie Physique</li> <li>Un Relief Diversifié</li> <li>La Carte de la France</li> <li>Les Hautes Montagnes</li> <li>La Population</li> <li>DOM TOM</li> <li>Hydrographie</li> <li>Statistiques Météorologiques</li> <li>Alpes</li> <li>La Fin de l'Élan Démographique</li> <li>Les Industries de Pointe</li> <li>Pyrénées             <ul style="list-style-type: none"> <li>Une Agriculture de Plus en Plus Performante</li> <li>Statistiques Météorologiques du Lyon</li> <li>Densités de Conforts Contrastes</li> <li>Statistiques Météorologiques du Paris</li> <li>Une Vieille Terre d'immigration</li> <li>Economie</li> <li>La Fin de l'Élan Démographique</li> <li>Agriculture</li> <li>La Population Active</li> <li>Les Régions</li> <li>Les Industrie Traditionnelles</li> <li>Vers de Nouvelles Exigences d'agriculture</li> <li>Statistiques Météorologiques du Marseille</li> <li>Les Transports</li> <li>Rail: l'ame du TGV</li> <li>Géographie Administrative</li> <li>L'apprentissage du Temps Libre</li> <li>La Capitale</li> <li>Les Français au Travail</li> <li>Industrie             <ul style="list-style-type: none"> <li>Climat de la Capitale</li> <li>La Famille Française</li> <li>Climat de la 2ème Plus Grande Ville</li> <li>La 3ème Plus Grande Ville</li> <li>La Société</li> <li>Les Modes de Vie</li> <li>Climat de la 3ème Plus Grande Ville</li> <li>Une Société Plus Riche et Moins Inégalitaire</li> </ul> </li> <li>Langages</li> </ul> </li></ul>
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## 3.2 Research Methodology

### 3.2.1 Design & Measures

The hypothesis is tested with the help of an experimental study, which was supported, by a one-week pre-pilot study in order to improve the experimental study. All individuals (N = 32) in a 2 (Web site structure) X 2 (prior knowledge subject) between-subjects factorial experiment were randomly assigned to one of four experimental conditions: 1) structured home page; high prior knowledge; 2) structured home page; low prior knowledge; 3) non-structured home page; high prior knowledge; 4) non-structured home page; low prior knowledge. A fourth of the participants were assigned to each condition. After participants were exposed to the Website. The dependent measures

(recall of number of titles of lower level pages in descending order, number of lower level pages in ascending order, maximum number of relative links recall in order as described in the home Web page) were elicited via a paper-and-pencil site map presentation delivered by the subjects at the end of each navigation session.

Navigation tool was in the form of a site map and forward, backward button, buttons to navigate one level up or one level down and the time pressure under which the recall of site map was done.

### 3.2.2 Participants

The sample consisted of 32 university students at studying in the University of Valenciennes, University of Paris 8, and University of Lille 3. We first evaluated their knowledge concerning the Web sites in order to assign to one of the four treatment groups. All participants signed an informed consent form prior to their participation. After reading the stimulus materials for a specified amount of time from the text-base Web site, subjects were asked to draw a site map. It was followed by a second navigation session to complete a multiple-choice questionnaire based on the information presented in the Web site. At the end of this session they were asked to draw the site map once again.

The subjects were undergraduate/graduate/post graduate students. There were 6 women and 26 men in the experiment with age range (20-40) years with an average of twenty-six years. All subjects were familiar with Web browsing having minimum two years of experience. All subjects were well familiar with the French language because the Web page information was provided in French. Half were high prior knowledge subjects (H K) and half were low prior knowledge subjects (L K).

### 3.2.3 Material

Two types of Web pages were distinguished, differing in structure of home pages only (cognitively designed Web page vs. non-cognitively designed Web page). Four home pages were created with two types dealing with general information about France and about the European Nuclear Research Center were written from various sources. The texts about France dealt with issues of Geography like Physical Geography, Population, Economy, Administrative distribution and Society whereas the texts about the European Nuclear Research Center dealt with information about the researchers who work there and which type of research is being carried out and why we need advancement in sciences and what is the need of that

organization. Each Web site consisted of 42 pages and was approximately same in length.

Each of the four home pages designs had a different Web address. The only difference between Web sites with cognitively designed home page and non-cognitively designed home page was in the design of the home page; i.e. the underlying information in the lower-level pages was identical in form and content.

### 3.2.4 Procedure

The experiment was run individually. The personal computer which was used for the experiment was Intel-based Pentium 4 with version 6 of Internet Explorer. The experiment was divided into three phases, which are the following.

**Phase 1:** Subjects were given instructions about the nature of experiment and to fill out a short form asking their age, gender, educational level, frequency of World Wide Web usage, academic score and a questionnaire to evaluate their knowledge level on the topic. This questionnaire was used to access the participant's prior knowledge of the topics covered in the Web site. It contained 6 questions about the Geography of France and 6 questions about the Nuclear Physics in order to assign the prior knowledge levels groups. The same researcher delivered the experimental details throughout the experiment to avoid any difference in explanation.

**Phase 2:** Subjects were assigned to one of the Web site according to their evaluation by phase 1. Subjects were allowed to navigate freely. In all conditions, subjects were given 30 minutes. They were asked to understand rather than just memorize the information presented in the Web site. They were asked to draw a site map.

Recall of the site map was measured:

- By the order of hyperlinks used or navigation to get the specific page
- By the number of titles of lower level pages in descending order
- By the number of lower level pages in ascending order
- By the number of relative links in overall order (global) as described in the Web page
- By the time spent in order to draw the site map

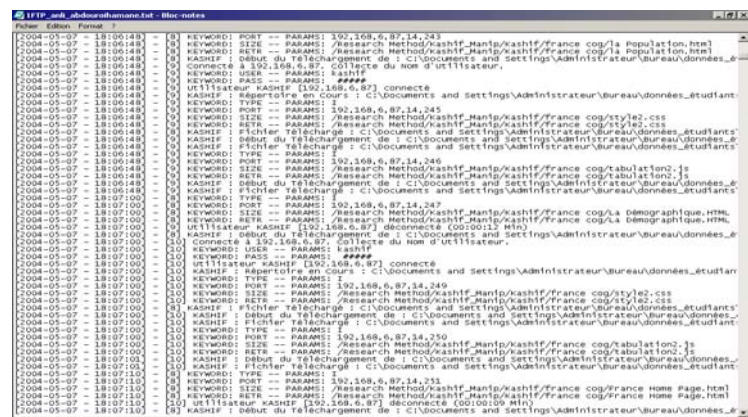
Then, at the assigned Web site, subjects were given a questionnaire containing 30 questions. To answers the questions, the subjects were required to click on appropriate hyperlinks on the home page

and navigate to the lower-level content page that has the needed information. We recorded the time for each question using a program on visual basic. While participants were selecting different navigational choices, the navigational behavior of each participant was recorded in system log files. Following this phase, the subjects were instructed to exit from Internet Explorer.

**Phase 3:** After the phase 2, the participants were finally asked to draw the site map once again. The goal of the task was to compare the first recall with this one and we also measured the recall in the same way as described earlier for the first navigation session. At the end, the subjects were also asked to fill out a questionnaire concerning some usability problems that were indicated by the 10<sup>th</sup> survey of Graphics, Visualization and Usability Center (GVU) problems with the World Wide Web. ([http://www.gvu.gatech.edu/user\\_surveys/survey-1998-10/](http://www.gvu.gatech.edu/user_surveys/survey-1998-10/))

These problems were difficulty in finding a page already visited, not being able to find the page, difficulty in position determining on Web, difficulty in organizing the pages and information, where to go next, etc.... We found significant difference in reported usability problems while navigating through cognitively design home pages as compared to non-cognitively design home pages. The time spent on non cognitively design home pages was significantly higher than cognitively design home pages because the subjects found it difficult to access the right page [15]. Thus the home page containing different categories of information placed accordingly can help subject to make easy choice. Relationship between headings and subheadings is also important. Clear, well-structured pages are likely easy to comprehend.

**Figure 2: A part of recording the navigation session to measure time of visit, Web page visited, date, etc...**



## 4 Results & Discussion

The first interesting result was observed in terms of structure that 2 out of 8 students of HK (non cognitive) drew the map in structured form however they were provided with the unstructured page. The subjects with LK sketched the site map in ordered form though their recall was low as compared to HK.

The hypothesis that structured site map is better for recall than non-structured site map was found significant in terms of structured recall via univariate analysis of variance ( $p < 0.007$ ,  $F = 8.33$  after first navigation) and ( $P < 0.021$ ,  $F = 5.97$  after second navigation). On the other-hand, overall recall of headings and sub-headings (irrespective to structure) was not found significant. On the basis of the results presented above which support our 2 out of 4 hypotheses, we can make an assumption that the best way of engaging students is to guide them through the stages of comprehension that facilitate the construction of a mental model. The user spent less time in comprehension if the factor of cognitively designed is involved and in addition, memorization was better also. Students spent more time studying the non-structured hypermedia presentations. This indicates that structured site map can be more effective. However, many students pointed out absence of graphics-based Web pages, which they believe important. As it is not in our primary objectives so we will not enter into the debate of graphics page.

## 5 Conclusion

Our study examined the effects of using the cognitively guidelines to reduce disorientation and cognitive surcharge. We enabled the user to visualize the structure of the Web page. Overview diagrams and map, a visualization of the organization of the hypertext is significantly important as it provides an exocentric view of the space [14]. We used the information in the form of headings and subheadings (higher order information unit) that serves as the hierarchical structure of the hypertext [3].

Finally the influence on the navigation of the cognitive home page is interesting, because it clarifies the general difficulty to abstract a complex representation of a continuation dispersed from contexts; the study thus makes it possible to study the strategies employed by the individuals more and less dependent. The important findings of the empirical research can be summarized as:

- Cognitively designed home page is a more effective navigational tool in terms of structured recall as compared to non-cognitive home page.
- Both high prior knowledge subjects and low prior knowledge subjects can take significant advantage of the cognitively designed home pages.
- The cognitive Web pages were not found significant for in-depth levels (till third level & above) as compared to non-cognitive home page for both HK & LK.
- HK students were found less affected by non-structures pages as compared to LK students.

All the Web pages should be designed while considering the cognitive measures including clarity, simplicity, classification of different pieces of information in categories, legibility, and precise and structured information [7]. It is important to make the site structure explicit, and providing a visible and easily accessible site map can enhance user's performance [23]. A visible site map can enhance performance in an information-searching task [24].

From the above review, there are many research topics still open concerning questions of designing useful navigation systems for easy, better and quick information retrieval. These include basic research in appropriate cognition models for navigating session, and role of memory in navigating, construction and development of mental model which influence the user comprehension of hypermedia, user prior knowledge of the subject he is looking for, etc.

For instance, site map have proven to be useful. It may be argued that a site map is also used to make sense of "where am I?" in the space. In this case, a site map should be presented through a navigation process. One may consider that a site map may be helpful tool only when we are lost [1]. Developing a more logical understanding of site maps and its effects on users' behavior on the Web provides a promising challenge for future research.

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