

# Guided Surfing: A Multimethod Assessment of a Layered Hypermap WWW Interface

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**Abstract:** A multi-level hypermap interface was created for the display of world wide web pages relevant to an undergraduate class in Sensation and Perception. Assessment of the interface consisted of two experiments. Results indicated that the guides encourage students to broaden the focus of their search. Further, the guides do not appear to be particularly effective for enhancing the acquisition of detailed-factual knowledge. Over all, students subjective reactions to the guides were positive. In particular, they perceived the guides as making the search project more efficient, and providing the learner with "big picture", conceptual knowledge.

## 1. Background

There is no question that the World Wide Web offers great potential as an educational tool [Anderson & Joerg 1996]. This resource is so new that educational researchers have had little time to examine it, however, research which has been conducted indicates that it can serve to enhance learning. The web seems to be particularly effective when used as an adjunct to, as opposed to a substitute for, more traditional instruction [Goldberg 1997]. A second important finding is that hypermedia environments in general [Jacobson et al. 1995] and the web in particular [Anderson & Joerg, 1996] are most effective when the learner is given some degree of structure or guidance.

With this in mind we set out to develop an organizational tool for displaying relevant web sites within a given subject domain. In our case, we selected Sensation and Perception, since the principal investigator regularly teaches a class in this area, and since there are an extensive number of web sites available [Krantz 1998]. However, we believe that this methodology and our findings are potentially applicable to other domains beyond Sensation and Perception in particular, and Psychology in general. The method that we used was an extension of previous research on two-dimensional knowledge displays called knowledge maps. Knowledge maps are a method of displaying text in a two-dimensional node-link network. (Maps used in the present experiment can be viewed within the Guided Surfing Program). This technique, which was developed by Dansereau and colleagues [Lambiotte et al. 1989], has been found to be more effective than traditional-linear text displays [Hall & O'Donnell 1996]. In particular, the method is effective for imparting higher-level conceptual knowledge [Hall et al. 1991].

We assessed the interface on two different methodological levels. First, we conducted a controlled experiment in which students were randomly assigned to groups, and the hypermap display method was compared directly with a traditional-linear display of web pages. Second, the hypermap guide was examined within the context of a Sensation and Perception class, in which students were required to carry out two class projects using the hypermap guide and corresponding web pages.

## 2. Experiment 1

### 2.1 Method

#### 2.1.1 Participants

Twenty Students, enrolled in either General Psychology, Theories of Learning, or Theories of Motivation at a medium sized, midwestern, science and technology oriented University, participated in experiment 1. Those in the General Psychology Class participated as a regular part of their class, and those in the other classes participated outside of the regular class time, for extra credit in the class.

#### 2.1.2 Materials

*Site selection.* The first step in development was the selection of appropriate web sites for a Sensation and Perception class. An outline for the class was developed and then a number of search engines were used, and many web pages examined, and eventually a set of seventy-five web sites were selected, within four broad categories: vision, audition, smell/taste, and somatosensation. These

sites were selected based on five criteria: 1) The site was relevant to the framework of the course as specified by the instructor; 2) The site tied the basic information to be learned in the course to "real life", "meaningful" information; 3) The information contained in the site appeared to be accurate, as determined by the class instructor/domain expert; 4) The information was presented in an interesting way, making effective use of the hypermedia tools available to the site developer; 5) In the case of sites that were relevant to what the instructor considered "core" concepts, a number of sites, which presented different perspectives/representations of the information, were often selected.

*Guide Development.* The guides consisted of a series of knowledge maps. The domain expert/first author constructed these maps by forming categories of the web pages, based on the class outline, and on the nature of the sites selected, and then noted interrelationship among groups. From this, ten different guide maps were constructed. The vision and smell/taste groups of sites were each represented by two levels of maps - a map, and more specific "sub-maps". When a student clicked on a node on the main maps a second, more specific map would appear on the screen. All of the other nodes on the maps served either as place keepers to aid in the accurate representation of the information displayed within a given map, or were a direct link to one of the seventy-five World Wide Web Sites selected. Audition and somatosensation sites were represented by a single map. The program can be viewed at:

<http://www.umr.edu/~rhall/class/sap/sapsurfprogram/surfprogramindex.html>

### **2.1.3 Procedure**

Students first read a set of directions displayed on the screen. Students were randomly assigned to two conditions. Ten of the students then studied the selected sites for thirty minutes using the guide maps, ten studied the sites using 4 different guides which listed the links for each of the four highest level categories (i.e., vision, audition, smell/taste, and somatosensation), in an outline format.

After studying, students completed an essay from memory covering the information they studied. They then completed a questionnaire, presented on the computer, including specific questions, with Likert scales, and one open ended question.

## **2.2 Results**

### **2.2.1 Essay Scoring**

In order to determine the amount of information that was included in students' essays, each essay was broken down into a set of factually accurate propositions, each consisting of a simple declarative sentence. This scoring technique is based on a technique developed by Meyer [Meyer 1975]. The number of propositions included in each student's essay served to represent the accurate amount of information contained. Reliability was established by having a second experimenter score a random subset of 10 (50%) of the essays. The reliability between the this scorer and the original scorer was  $r = .90$ . Neither scorer was knowledgeable as to the group assignment of the student essays as they were scoring.

### **2.2.2 Propositional Analysis**

A t-test for independent samples was carried out with experimental group (map vs list) as the independent variable and propositions recalled as the dependent variable. The mean difference between the groups on number of propositions recalled was not statistically significant.

### **2.2.3 Questionnaire Responses**

The analysis of questionnaire responses consisted of a series of two-way repeated measures analyses with experimental group serving as a between subjects independent variable, questionnaire items as within subject independent variables, and students responses to the questionnaires, serving as the dependent variables.

### **2.2.4 Site Category Visited**

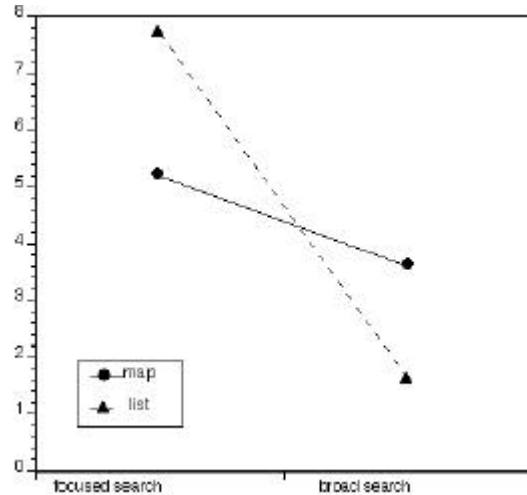
The questionnaire analysis began with a two-way repeated measures analysis of variance. Group (map versus list) served as a between subjects independent variable, and the first four questionnaire items (time spent on: vision vs audition vs smell/taste vs somatosensation), served as a within subjects independent variables. Students' ratings served as the dependent variable.

No significant effects were found.

### **2.2.5 Focus of Search**

In order to examine how focused vs broad the students' rated their searches a two way repeated measures analysis of variance was computed with group (map versus list) as a between-subjects independent variable, and questionnaire items #5 & #6 ("My search was very focused..." vs "My search was very broad...") serving as a within-subject independent variable, and ratings as the dependent variable.

A significant main effect was found for focus,  $F(1, 18) = 17.03, p < .01$ . The descriptive statistics for the within-subject variable were  $M = 6.45, SD = 2.67$ , and  $M = 2.60, SD = 2.19$ , for focused and broad search respectively. A significant group X focus interaction was also found,  $F(1,18) = 5.82, p < .05$ . The means associated with this interaction are displayed in [Fig. 1].



**Figure 1.** Questionnaire rating as a function of Group and Focus

### 2.2.6 Effectiveness of Guide Pages

Questionnaire items #7, & #8 ("I found the guide pages, helpful ..." "for learning" vs "...for helping me to get an overview) served as a within subjects independent variable in the third, two-way, analysis of variance. Group (map vs list) again served as a between-subject independent variable.

No significant effects were found.

### 2.2.7 Affect

Lastly, a two-way repeated measures analysis of variance was conducted to examine students mood while studying. Questions #9 & #10 ("I found the ... studying to be a positive experience" versus "I was anxious and nervous as I studied the web pages.") served as a within subjects independent variable, group was the between subjects independent variable, and ratings were the dependent variable.

A significant main effect was found for affect,  $F(1, 18) = 20.354, p < .001$ . The means and standard deviations for the "positive experience" versus "anxious and nervous" items were  $M = 7.2, SD = 1.74$  and  $M = 3.4, SD = 2.18$  respectively. No other effects were significant.

### 2.2.8 Students' Open Ended Responses

In general, with respect to the guides, those who were in the map group had more positive comments. Some representative comments are displayed below.

#### *Hyper Map Group*

- The guide pages helped to make the huge amount of information more manageable. It was helpful to have fewer choices and to narrow down the subject.
- I found them to be very effective in helping me to find information I wanted. The nodal guides were effective in localizing my searches.
- I liked the guide pages because you could see how everything was connected. It let you see everything that was associated with one major topic.

#### *List group*

- I found the guide pages to be fairly helpful, although I mainly just stumbled upon the topics that I thought to be the most interesting.
- Some of the guide pages were not helpful simply because I did not know what some of the things listed were
- Personally, I found the guide pages to be only somewhat helpful. I used the guide page to find a basic topic and only went back to it if I ran out of links, or at least interesting links.

### **3. Experiment 2**

#### **3.1 Method**

##### **3.1.1 Participants**

Fifty-eight students from two sections of an undergraduate sensation and perception class at the same University participated in experiment 2 as a class requirement.

##### **3.1.2 Procedure**

During the semester students were required to carry out four web projects spaced out equidistant across the semester. Each project was worth approximately 3.5 percent of their total grade (14% all together). Each web project corresponded to one of the four sections of the class. For the first two web projects students were required to go to certain web pages, read and carry activities and answer specific questions about the pages.

The last two web projects were the focus of this experiment. In both projects students used the guided surfing interface. On the first guided surfing project they were asked to focus on the vision and audition sites, since these were more relevant to the information they were covering in class at the time, and, on the second project they were asked to focus on the smell/taste and somatosensation sites for the same reason. After studying the sites students were required to email an overview to the instructor, on which their grade was determined. They were also required to complete a Likert-style questionnaire, and were asked to supply open-ended comments about the guided surfing interface.

#### **3.2 Results**

##### **3.2.1 Questionnaire Item Factor Analyses**

The analysis began with two factor analyses, one performed on items for each questionnaire. These were principal components analyses with a varimax rotation. In both questionnaires, the same items neatly into a four factor solution. The factors were: a) Guide effectiveness; b) Category concentration (in the first questionnaire, high scores represent concentration on vision, as compared to audition, and in the second questionnaire, high scores represent concentration on smell/taste vs somatosensation); c) Breadth of search; and d) Experience with computers and the world wide web.

##### **3.2.2 Factor Score and Test Correlations**

Factor scores were created by averaging the items included in each factor (after reversing the scoring of items with a negative loading). A series of Pearson correlations was then computed between each questionnaire item for the first guided surfing assignment, and scores on test 3, which was the test that corresponded to the section of the course (section 3) that was most related to those web pages, and that was given after the first guided surfing assignment had been completed. None of these correlations were statistically significant.

The same set of correlations was then computed between questionnaire items on the second questionnaire and students' test 4 scores. The correlation between category concentration and test 4 was significant  $r(46) = .378, p < .01$ . (The greater the concentration on smell/taste, as opposed to somatosensation sites, the higher the test score.) No other correlations were statistically significant.

##### **3.2.3 Comparison of the Two Web Projects**

In order to compare students' responses to the third (vision and audition) versus the fourth (smell/taste & somatosensation) web projects, a multivariate analysis of variance was computed with Web Project (3 versus 4) serving as a within-subject independent variable. Each questionnaire factor, and class test scores served as the dependent variables. A significant overall multivariate effect was found,  $L = (4,38) = .0078, p < .001$ .

This was followed by a series of with-subject t-tests with section serving as the independent variable and each questionnaire factor, and test serving as the independent variable. Statistically significant mean differences were found in the "guide effectiveness",  $t(41) = 3.12, p < .01$ ; "category concentration",  $t(41) = 2.69, p = .01$ ; "breadth",  $t(41) = 3.18, p < .01$ ; and class tests,  $t(57) = 5.04, p < .001$  analyses, and no significant difference was found with respect to www/computer experience. The means and standard deviations for the statistically significant t-tests are displayed in [Tab. 1].

factor/test	project 3		project 4	
	M	SD	M	SD
guide effectiveness	6.82	1.74	7.58	1.02
*category concentration	6.04	2.30	7.30	1.72
breadth	6.60	2.10	5.20	2.10
class test	72.00	16.75	81.29	11.20

\*high scores represent vision sites concentration on project 3 and small/taste sites on project 4

**Table 1:** Questionnaire factor scores and class test scores as a function of Web Project

The last analysis was a within subject t-test comparing students' response to questions 11 and 12, which were only included on the second questionnaire. High scores on question 11 indicated that students found the fourth web project sites (smell/taste and somatosensation) more interesting than section three (vision and audition), and high scores on question 12 indicated that they found the organization of the fourth project's guide more effective than the third project. The mean difference was statistically significant,  $t(47), = 3.14, p < .01$ . The means and standard deviations for interest and organization respectively were  $M = 6.23, SD = 2.19$  and  $M = 5.17, SD = 1.69$ . Students found the section 4 sites more interesting, as opposed to finding the guide more organized.

### 3.2.4 Open Ended Responses

An examination of student's responses to the open ended question yielded three general themes:

1. The majority of students felt positive about the guides in both projects. They felt the guides enhanced the efficiency of the searching, and aided the students in getting an effective overview of the information. 2. Those students who did feel negative about the guides felt that they were confusing, and that it was too easy to get lost. 3. Students preferred the second guided searching project to the first, as evidenced by references they made to the first project on their second project comments. This was also evidenced by the fact that virtually all negative comments were associated with the first section, and virtually none were made with regard to the second. Representative comments follow:

Experiment 2 Representative Responses to Open Ended Questions

#### *Positive Responses to Guide:*

- I have had some experience in trying to find information on certain topics, and this way of presenting the information is a great deal better than could be done by listing links vertically. By presenting the information in a hierarchy, and showing how the links are interrelated seemed to facilitate incorporating the information from the different sources.
- I don't think I could have easily or as effectively found as much information without the guide.

#### *Negative Responses to Guide (all from fourth web project):*

- I found them to be confusing and hard to keep track of the links. A simple outline or table of contents at the beginning would serve the exact same purpose and probably be more effective.

#### *Comparison of the two projects:*

- I thought this one was more interesting than the visual one, that is probably because of my own personal interests ...
- I was so interested in the smell and taste that I didn't even think about looking into the somatosensation pages.

## 4. Conclusions

The first conclusion that emerged from these two experiments was that the guides appear to broaden the students' search focus, and, this in turn leads to the student forming a better conception of the big picture. This conclusion is based on student's subjective responses to questions about focus in the first experiment, in which the map guide was compared to a traditional list, and in questionnaire responses and open ended responses in experiment two. As one student put it, " I found your guided

surfing outline to be effective in organizing the information ... for conceptualizing it I think your approach is better."

A second conclusion that can be drawn is that the guided surfing interface doesn't appear to aid students in recalling factual information. In experiment one, the interface was no more effective than a traditional, linear method of listing web pages, in effecting propositional recall. In the second experiment there was no relationship between the degree to which students found the interface effective, and their scores on related class tests. This may be partly explained by the first conclusion, in that the guided surfing interface may be most useful for imparting the general conceptual information, as opposed to factual details.

A third conclusion which was consistent across both experiments, and across both projects included in the second experiment, was that students perceived the guided interface to be effective. This was most obvious in their open-ended comments about the guides. They found the guides to make searching efficient, and, as mentioned, they perceived them as being particularly effective in providing broad domain knowledge. This finding adds further support to the contention that the maps may best serve instructional purposes when the aim of the instructor is to provide the students with broad knowledge about a domain. With respect to the World Wide Web, this would be particularly important to an instructor whose goal is to give the learner an overview of the web sites available within a given area, in order to facilitate a more efficient search.

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