

Differences between Novice and Experienced Users in Searching Information on the World Wide Web

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Searching for information on the World Wide Web (WWW) basically comes down to locating an appropriate Web site and to retrieving relevant information from that site. This study examined the effect of a user's WWW experience on both phases of the search process. Twenty-five students from two schools for Dutch pre-university education were observed while performing three search tasks. The results indicate that subjects with WWW-experience are more proficient in locating Web sites than are novice WWW-users. The observed differences were ascribed to the experts' superior skills in operating Web search engines. However, on tasks that required subjects to locate information on specific Web sites, the performance of experienced and novice users was equivalent—a result that is in line with hyper-text research. Based on these findings, implications for training and supporting students in searching for information on the WWW are identified. Finally, the role of the subjects' level of domain expertise is discussed and directions for future research are proposed.

Introduction

Seeking information on the World Wide Web (WWW) closely resembles the work of a detective. To trace relevant information, one has to ask the right questions, consult proper sources of information, and creatively combine search outcomes. In other words, efficiently searching the WWW involves considerable thinking, especially because the WWW opens up an inconceivable volume of frequently ill structured information. Information scientists and software designers try to improve the accessibility of information on the Internet by developing sophisticated retrieval tools. Despite their efforts to develop sophisticated retrieval tools, present-day WWW browsers and search engines still largely perform the routine actions of a search, leaving the brainwork to the user. Thoughtlessly entering a word in a

search engine is comparable to walking into a library and whispering that same word in the ear of the first librarian who comes along. In both cases, the chance of instantly getting a list of useful references is close to zero.

In spite of this impending information overload, the WWW is increasingly being used as an educational tool. The most likely reason why the WWW has found its way into schools is the current stress on independent learning. Among other things, this is expressed in the gradual shift from formal lecturing to class projects, self-instruction, and other instructional methods in which collecting one's own information occupies an important place. As a result, the school library has increasingly become a place for students to learn. Training and supporting students in seeking information on the WWW is therefore increasingly included in the school librarians' responsibility. This development prompts the question of which knowledge and skills should be taught to search the WWW efficiently and effectively. In this respect Chen, Houston, Sewell, and Schatz (1998) suggested that users must have experience with the system where the information is stored, including skills in navigating through the information system and knowledge of how the information is organized. Users must also have domain expertise. That is, they should be familiar with the subject of interest, in particular with the vocabulary of the task domain.

Research consistently shows that domain expertise enhances search performance. Without exception, studies report superior performance of domain experts over domain novices in terms of efficiency and effectiveness (Hirsch, 1997; Marchionini, 1995; McDonald & Stevenson, 1998; Patel, Drury, & Shalin, 1998). That is, experts take less time to complete the search tasks and produce a greater number of correct solutions. However, increasing the students' level of domain expertise is the responsibility of subject teachers rather than of school librarians. In keeping with their own field of expertise, school librarians should direct their attention to teaching students how to operate the retrieval tools that are available on the WWW.

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Clearly, only first time WWW-users require an introductory course on operating the retrieval tools that are available on the WWW; more experienced users are postulated to have already mastered the knowledge and skills necessary to navigate the WWW. Marchionini (1989) corroborated this assumption by showing that a brief introduction is sufficient for hypertext users to be able to apply minimal search system features to find information. Although the users in Marchionini's study did not take full advantage of the system's potentials and applied naive information-seeking strategies, they managed to locate the information relevant to their needs. Marchionini's conclusion was that system expertise is of lesser importance to information seeking than is domain expertise.

Hill and Hannafin (1997), however, reached a different conclusion. They studied a heterogeneous group of adults participating in an introductory WWW-course. Among other things, they observed that the level of WWW-experience had a stronger influence on strategy use than domain knowledge. Subjects with little WWW-experience engaged in more primitive search strategies than subjects with high WWW-experience, even though some novices possessed significant domain expertise. Marchionini and Shneiderman (1988) who analyzed the search strategies of students using an electronic encyclopedia on CD-ROM confirmed these findings. They found that novices favored less cognitively demanding browsing strategies, whereas more experienced users preferred an analytical approach.

Vassileva (1996) also showed differences in strategy use between novice and expert browsers. Users familiar with the experimental software (a hypermedia office documentation system) were able to cope with a wider browsing space and organized their search differently. More specifically, experienced users got bored with clicking hyperlinks and tried to speed up their search by using direct access options such as queries. Users with a less elaborate understanding of the system's information structure confined themselves to browsing categories, thus reducing the chance of "getting lost" in hyperspace.

Khan and Locatis (1998b) signaled a similar difference in strategy use. They also compared the search performance of users with varying levels of browsing experience and found that experienced users were better able to prioritize the search tasks. That is, the experts were better in judging task complexity and, as a consequence, they performed simple tasks before complex ones. Yet this did not result in higher efficiency and accuracy scores: experts were neither faster nor better than novices were. Other studies (Jones, 1989; Wang, Liebscher, & Marchionini, 1987) also failed to show superior search performance of experts over novices. Consistent with Marchionini (1989), it was suggested that the novices could have learned during the experiment and that their performance improvement might have neutralized initial differences in task performance. Another explanation may be that hypertext browsing calls on the same skills as reading printed text and using search aids such as indexes.

If so, these skills could have concealed the actual effect of browsing experience on search performance.

These findings suggest that there is little need to teach novice users the basics of navigating hypertext systems. Even though novices use less advanced strategies, their browsing performance measures up to those of experts. However, it is unknown whether all conclusions from hypertext research apply to searching information on the WWW (Ramsay, Barbese, & Preece, 1998). Because it is a global hypertext infrastructure, the WWW shares many, but not all, of the features of small-scale hypertext systems. Perhaps one of the most striking differences is that browsing (i.e., following hyperlinks) is not the only way to retrieve information from the WWW. The current volume of information on the Internet has reduced the effectiveness of this search strategy. Content-based searching (i.e., entering keywords in a search engine) is currently considered a more fruitful information-seeking strategy (Chen et al., 1998). Its benefits mainly apply to locating relevant Web sites. In general, locating information on a particular site still requires browsing because not all Web sites have a built-in search engine. Navigating the WWW thus requires browsing skills in addition to proficiency in using search engines.

Only a few studies compare novice and experienced searchers' use of search engines. The Hill and Hannafin (1997) study provides valuable insight into the search strategies of adults, but the limited sample size of this survey kept the authors from generalizing their findings to a broader population. Fidel et al. (1999) inventoried the search strategies of high school students with varying levels of WWW-experience. While this study indicates that students strongly prefer content-based searching to browsing subject categories, the subjects' level of WWW-experience was not treated as an experimental variable. Rather, the study illustrates differences in strategy use between students with varying levels of WWW-experience, but does not analyze these differences in a systematic way. A related study (Watson, 1998) investigated students' experiences in using the WWW. The author supplies many illustrative narratives on the use of search engines, but does not differentiate between students with high and low levels of expertise in searching the WWW.

The purpose of the present study was to examine whether proficiency in using the WWW affects online search performance. To this end, students with various levels of WWW-experience were observed while searching and browsing the WWW. Students with a high level of WWW-experience were predicted to yield more effective and efficient performance than would students with little WWW-experience. This distinction was expected to reveal itself especially on the "locate site" tasks. As experts were presumed to be more proficient in using search engines, they were expected to outperform novice users on tasks that involve locating Web sites. No performance differences were expected on tasks that required subjects to locate information on specific Web sites because these tasks require a substantial amount of browsing. To anticipate pos-

TABLE 1. Operational definition of task complexity.

Complexity	Type of task	
	Locate site	Locate information
Simple/Low	URL is given in the task description	Site contains distinct categories and subcategories with well-structured information
Medium	URL can be easily inferred from the task description	Site contains indistinct categories and subcategories with well-structured information
Complex/High	URL cannot be inferred from the task description	Site contains indistinct categories and subcategories with ill-structured information

sible intervening effects of domain expertise, the study used a sample that was homogeneous in every respect except for WWW-experience. Preliminary analyses were performed to verify this claim.

Method

Subjects

Twenty-five fourth graders from two schools for pre-university education participated in the experiment. There were 13 males and 12 females with a mean age of 15.4 ($SD = 0.7$). The subjects were selected based on their previous experience in working with Internet and the WWW. WWW-experience was assessed by means of three questionnaires administered some weeks prior to the experiment. Subjects were denominated as novice ($n = 17$) if they had worked with the WWW for less than 10 hours and considered themselves proficient in no more than 4 of 12 Internet facilities. Experts ($n = 8$) had over 50 hours of WWW-experience. Their self-reported proficiency ranged from 8 to 12. Moreover, the experts outperformed the novice users on a knowledge test on navigating and searching the WWW.

The subjects' level of domain expertise was indicated by their grade in Dutch literature. On a 10-point scale, the overall mean for this measure was 6.0, with scores ranging from 4.2 to 8.0. The WWW-experts' mean score for domain expertise was 6.4 ($SD = 0.9$). The domain expertise of WWW-novices was lower ($M = 5.8$, $SD = 0.9$), but this difference did not reach traditional levels of statistical significance ($F(1,23) = 2.35$, $p = 0.14$).

Preliminary checks further revealed no significant differences between novices and experts based on sex or ethnic background. Both groups differed with regard to age, however, with experts being about one year younger than novices. All subjects completed the experiment. Due to a computer breakdown, data were incomplete for four subjects.

Materials

Technical Equipment

The experiment was performed on Pentium II computers with the Dutch version of Microsoft Internet Explorer 4.0. A Dutch search engine called Ilse was used to access infor-

mation on the WWW (<http://www.ilse.nl>). Ilse resembles well-known browsers, such as AltaVista, Yahoo!, and Lycos, in that it enables users to find information by content-based searching. Ilse was chosen because it is the predominant Web search engine in schools for secondary education. Each computer was equipped with a registration program that captured the action from screen and saved it in a dribble file as an AVI (Audio-Video Interleaved) movie.

Questionnaires and Experimental Tasks

Prior to the experiment, three questionnaires were administered to assess the subjects' experience in working with the WWW. The first questionnaire addressed the nature and scope of the subjects' WWW-experience and domain expertise. This questionnaire also gathered some personal data such as age, sex, and ethnic background. The second questionnaire recorded the subjects' perceived proficiency in using various facilities of the Internet and the WWW. Items dealt with basic issues, such as following hyperlinks and printing a Web page, but also addressed advanced topics, such as downloading files and creating a personal home page. Subjects scored each item on a dichotomous "yes/no" scale, indicating whether they thought themselves able to perform that task individually. The third questionnaire was a knowledge test containing five multiple choice items dealing with navigating the WWW and five items referring to searching information on the WWW.

During the experiment, three assignments assessed the subjects' abilities in searching information on the WWW. All assignments concerned a nineteenth-century volume of poetry the subjects had to study for their reading list. Each assignment consisted of two tasks: The first task dealt with locating a Web site, and the second task dealt with locating information on that site. Both types of tasks differed with regard to the degree of complexity. The complexity of the "locate site" tasks was determined by the level of inferencing (low, medium, high) required to deduce the site's URL from the task description (cf. Khan & Locatis, 1998b; Mosenthal, 1998). The difficulty of the "locate information" tasks was determined by the structural complexity of the particular WWW-sites. As Mosenthal's (1996) study did, structural complexity was defined by the presence and comprehensibility of organizing categories as well as the orga-

nization of information in these categories. Table 1 details the operational definitions of task complexity. Pilot tests and observations prior to the experiment proved the experimental tasks to be adequate to avoid bottom and ceiling effects.

Procedure

Data Collection

The experiment was conducted in groups of two to five subjects. Subjects were randomly assigned to a group and each group attended one experimental session. In all, there were 10 sessions, which took place in the school library or computer class. Each session lasted up to one hour and the same experimenters guided all sessions.

At the beginning of a session, subjects were informed of the experiment's goal and received instructions. (The questionnaires on the subjects' WWW-experience had been administered some weeks prior to the experiment.) The subjects were told to work individually, without any help from the experimenter. Moreover, the subjects were informed that each assignment had to be completed within 13 minutes, but that they were free to relinquish an assignment.

Next, the subjects started the hands-on part of the experiment. The first assignment was handed out, using a counterbalanced administration to preclude order effects. When a subject had solved the assignment within 13 minutes, the subject wrote down the answer and received the second assignment. If a subject exceeded the time limit, the experimenter interrupted task performance and handed the subject the second assignment. The third assignment was administered similarly.

Coding and Scoring

The subjects' performance was analyzed by replaying the dribble files and examining the answers that were written down. Four measures were scored to assess whether and how novices differ from experts in searching information on the WWW. The four measures concerned success, time, efficiency, and effectiveness.

Performance success was indicated by the percentage of successfully completed tasks. A distinction was made between success in locating sites and success in locating information. Success in locating sites was defined as the ratio of the number of successfully completed tasks to the number of attempted tasks. Because locating a Web site is a prerequisite to locating information on a site, performance success on "locate information" tasks was indicated by the number of successfully completed "locate information" tasks to the number of successfully completed "locate site" tasks.

Performance time was scored as the mean time subjects required to complete the experimental tasks. As with performance success, a distinction was made between the time to locate sites and the time to locate information. Both

measures were scored for completed and abandoned tasks only, excluding all tasks at which subjects exceeded the time limit. The time to locate sites was corrected for the computers' download time (i.e., the latency between requesting a Web site and receiving it), thus eliminating possible differences in processing speed between experimental sessions.

Time and success were combined in a measure of performance efficiency: the ratio of the number of successfully completed tasks to the time to complete these tasks.

Performance effectiveness was defined as the overall number of actions to complete a task. This measure was computed for correctly solved tasks only.

Data Analyses

The study used a quasiexperimental design with WWW-experience as an independent variable with two levels (novice and expert). Four dependent variables were measured for each type of task: success, time, efficiency, and effectiveness. The majority of the analyses addressed the effect of WWW-experience on these variables. Following from the hypotheses, "locate site" and "locate information" tasks were analyzed separately.

Preliminary analyses (Levene's tests) were performed to check the homogeneity of variances among cell groups for all dependent variables. In case of homogeneity, univariate ANOVA's were used to examine the effect of WWW-experience on that variable. Variables with unequal variances were analyzed by means of *t* tests with separate variance estimates. Effect size estimates were calculated for statistically significant outcomes (Light & Pillemer, 1984). Missing data were excluded on an analysis-by-analysis basis, leading to variable group sizes in some of the analyses.

Results

Table 2 summarizes the subjects' performance on the "locate site" tasks. Overall, experts performed these tasks more than three minutes faster than novice users. This difference was statistically significant ($t(23) = 3.36, p < 0.01, ES = 0.88$). Experts also produced significantly higher performance success scores ($t(24) = 2.52, p < 0.01, ES = 0.71$), indicating that they successfully completed more tasks than novices. The efficiency and effectiveness scores also differed in favor of the experts ($F(1,22) = 5.11, p < 0.05, ES = 1.48$ and $t(19) = 3.06, p < 0.01, ES = 0.89$ respectively). Compared to novice users, experts needed both less time and fewer actions to successfully complete the "locate site" tasks.

Table 2 also displays the mean scores for the "locate information" tasks. In line with our expectations, WWW-experience did not affect search performance on these tasks. Novices and experts were equally fast in locating information on Web sites ($F(1,17) = 0.56, p = 0.47$). As the performance success scores show, both novices and experts produced an equal number of correct solutions ($F(1,18)$

TABLE 2. Mean performance scores (and standard deviations) on both types of tasks.

	Type of user	
	Novice	Expert
Locate site		
Time (min.)	4.3 (3.6)	1.1 (0.8)
Success	44.1 (34.8)	68.8 (13.9)
Efficiency	11.4 (10.1)	25.4 (15.3)
Effectiveness	6.6 (5.5)	1.7 (0.7)
Locate information		
Time (min.)	3.6 (1.7)	3.0 (1.1)
Success	73.6 (38.6)	77.1 (25.1)
Efficiency	23.2 (17.7)	31.6 (16.7)
Effectiveness	15.0 (4.1)	11.9 (4.7)

Success = percentage of tasks successfully completed.
 Efficiency = number of tasks successfully completed per time \times 100.
 Effectiveness = number of actions to successfully complete a task
 (lower scores indicate higher effectiveness).

= 0.05, $p = 0.83$). No statistically significant differences were found with regard to the efficiency and effectiveness scores either ($F(1,19) = 1.17, p = 0.29$ and $F(1,16) = 2.26, p = 0.15$, respectively). Apparently, novices and experts require the same amount of time and just as many actions to successfully locate information on Web sites.

Discussion

Seeking information on the WWW basically comes down to locating a Web site and, subsequently, to locating information on that site. This study investigated the effect of WWW-experience on both components of the search process. Subjects with WWW-experience were expected to be more proficient in locating Web sites. Following from hypertext research, WWW-experience was hypothesized to produce no effect on tasks that involve locating information on Web sites.

The first hypothesis is clearly supported by the results. Experts scored higher than novice users on all performance measures that relate to locating Web sites. They were faster, produced a greater number of correct responses to the tasks, and needed fewer actions and less time to find relevant Web sites. The analyses of the dribble files reveal that the subjects searched rather than browsed the WWW to locate sites. Experts therefore appear to be more proficient in using search engines than novice users. This conclusion has substantial practical value because all effect-size estimates exceeded 0.70, indicating that all effects were large enough to be visible to the naked eye (see Light & Pillemer, 1984).

The results also confirm the second hypothesis that WWW-experience would not affect performance on the "locate information" tasks. Finding information on a Web site generally implies browsing, and hypertext research has shown little to no differences between novice and expert browsers. The subjects in this study bore this out in that novices and experts did not differ on any of the performance

measures concerning the "locate information" tasks. This is not to say that the experts performed poorly. Rather, as the scores in Table 2 imply, the experts simply were not better than novices in browsing Web sites to find information. Our findings suggest that novice-expert differences found in hypertext research can be generalized to browsing Web sites to locate information.

These results are further substantiated by the relatively small difference in the subjects' WWW-experience. The experts in this study were experienced WWW-users, yet their level of expertise was not up to that of true experts such as librarians or information scientists. On the other hand, novice users were more knowledgeable than absolute beginners were for they had up to ten hours of WWW-experience. Even though the subjects' level of WWW-experience could have been more divergent, this difference was large enough for the anticipated effects to show. The results of this study imply that even a limited amount of WWW-experience provides performance benefits in using search engines to locate Web sites. Consistent with Marchionini (1989), this study further shows that little hands-on experience is needed for novice users to develop browsing skills comparable to those of experienced users.

Critics might argue, however, that the time limit attached to the assignments affected the results of the study. For example, the subjects could have produced a greater number of correct solutions if they were allowed more time to complete the tasks. Yet, we feel that imposing a time limit did *not* affect our findings. Observations prior to the experiment indicated that 13 minutes was sufficient for students to find information on the WWW. Extending this time limit would increase their frustration, not their performance success. Furthermore, a post-hoc analysis indicated that novices and experts exceeded the time limit just as often (mean scores: 1.3 and 0.9 times, respectively; $F(1,23) = 1.77, p = 0.20$). Besides that, requesting students to locate information within a given period of time is a valid thing to do. After all, in their regular schoolwork, they don't have all day to find information.

This study used domain expertise as a controlling variable. From the subjects' grades in Dutch literature, it appeared that WWW-novices and WWW-experts were equally knowledgeable about this subject matter. We therefore concluded that there was no need to correct the results of this study for the subjects' domain expertise. Although one can think of more refined measures of domain expertise, such measures are not presumed to disprove the conclusion of equal domain expertise because a group as homogeneous as our sample is unlikely to differ substantially in prior knowledge of Dutch literature. But what if our sample of fourth graders had been compared to university students in Dutch literature. Would the domain experts outperform the domain novices? And would domain expertise interact with WWW-experience? These and other questions should be addressed in future research.

Another suggestion for further research concerns the training needs of novice WWW-users with varying levels of

domain expertise. This study suggests that school librarians can leave domain expertise out of account when teaching a homogeneous group of students how to navigate the WWW. However, this is not to say that students with varying levels of domain expertise will equally benefit from a standard introductory course. Research should identify how training programs can be tailored to meet the specific needs of these students. Following from the aforementioned discussion, the subjects in this study should have widely divergent levels of domain expertise.

Future studies should also address qualitative differences in searching the WWW. The performance scores presented here show that novices differ from experts. They also indicate for which part of the search process these differences are most apparent, but provide little insight into the search strategies novices and experts apply to locate sites and information. In-depth analyses might reveal why novices were equally proficient in browsing sites to locate information. For instance, experts might have been too careless or impatient when browsing the WWW (cf. Khan & Locatis, 1998a). Analyzing search strategies might also explain why experts were better at using search engines. In short, detailed analyses will increase our understanding of students' information seeking on the WWW, which, in turn, provides valuable insight into the training needs of novice users.

In conclusion, the present study suggests that students who are unfamiliar with the WWW may benefit from an introductory course. Such training programs should be brief and aimed exclusively at content-based searching skills (i.e., using search engines to locate Web sites). Teaching browsing skills is unlikely to improve search performance. Hence browsing skills should merely be included in initial skill training to illustrate how information can be retrieved once a relevant Web site is located. Unfortunately, it remains unclear how the instruction should account for the students' knowledge of the task domain. Students with divergent levels of domain expertise may have different training needs, but the present study was not designed to reveal whether and how instruction should be tailored to the needs of domain experts and domain novices.

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