Effects of Search Experience and Subject Knowledge on the Search Tactics of Novice and Experienced Searchers

Ingrid Hsieh-Yee
School of Library and Information Science, 240 Marist Hall, Catholic University of America, 620 Michigan Avenue N.E., Washington, DC 20064

This study investigated the effects of subject knowledge and search experience on novices' and experienced searchers' use of search tactics in online searches. Novice and experienced searchers searched a practice question and two test questions in the ERIC database on the DIALOG system and their use of search tactics were recorded by protocols, transaction logs, and observation. Search tactics were identified from the literature and verified in 10 pretests, and nine search tactics variables were operationalized to describe the differences between the two searcher groups. Data analyses showed that subject knowledge interacted with search experience, and both variables affected searchers' behavior in four ways: (1) when questions in their subject areas were searched, experience affected searchers' use of synonymous terms, monitoring of the search process, and combinations of search terms; (2) when questions outside their subject areas were searched, experience affected searchers' reliance on their own terminology, use of the thesaurus, offline term selection, use of synonymous terms, and combinations of search terms; (3) within the same experience group, subject knowledge had no effect on novice searchers; but (4) subject knowledge affected experienced searchers' reliance on their own language, use of the thesaurus, offline term selection, use of synonymous terms, monitoring of the search, and combinations of search terms. The results showed that search experience affected searchers' use of many search tactics, and suggested that subject knowledge became a factor only after searchers have had a certain amount of search experience. © 1993 John Wiley & Sons, Inc.

Introduction: The Context

Search intermediaries were the major users of online search services in the 1970s. They became more aware of problems involved in online searching and often suggested improvements to database producers and vendors. As a result, database producers and vendors drew upon this group for ideas on improving existing systems. The improvements suggested by professional searchers might benefit nonprofessionals, but it is questionable whether online systems predicated on professional searchers' experience can adequately address the needs of the novice searcher.

Since the early 1980s, end-user searching has become prevalent. As more and more end users have ventured to conduct their own searches, their needs for assistance in negotiating with online retrieval systems became more urgent. Independent companies and vendors in particular took note of the potential end-user market and intense research effort was placed on the user interface. Mischo and Lee (1987) observed the development of search aid software to be one of the most active areas in information technology and presented an overview of the growth of front ends, gateways, and intermediary systems. In addition to these efforts, artificial intelligence and expert system techniques were also applied to the design of user-oriented interfaces (Hawkin, 1988; Smith, 1980). The problem with these approaches, however, is that most of them were developed on the basis of interface designers' idea of how people search, instead of empirical evidence on end users' search behavior. Consequently, the effectiveness of these search aids for end users remains a question.

As an initial step to identifying principles that may help develop better interfaces and information systems ("better" in the sense of easier for novice searched to use at no expense of retrieval power), this study investigated how people conduct online searches by focusing on their search tactics. Since end-user searching is a phenomenon of great interest to the profession, and since the literature has provided some insight into the search behavior of professional searchers, a comparative approach was adopted for this investigation. The intent of the study was not to determine the effectiveness of the two groups' searches. Rather, it was to examine how search experience and subject knowledge affected the two groups in their use of search tactics (defined as moves taken to advance a search).
Subject knowledge and search experience were chosen as the independent variables in this study because professional searchers and end users often differ in these two aspects and such differences might explain the differences in their search behavior.

Related Research

Search Performance

The literature on online searching conducted since 1979 reflects two major concerns of the profession. First is a strong concern for the searcher's performance. As a result, search outcome variables such as precision and recall, despite their technical and conceptual problems, have become standard measurements of performance. The second concern is a strong interest in developing a profile of an effective searcher. Therefore, various characteristics of searchers, such as search experience (Fenichel, 1979; Harter, 1984; Howard, 1982; Oldroyd, 1984; Penniman, 1981), training (Wanger, McDonald, & Berger, 1980), cognitive characteristics (Brindle, 1981; Saracevic, Kantor, Chamis, & Trivison, 1988; Woelfl, 1984) and intelligence and personality traits (Bellardo, 1985a), have been analyzed and correlated to outcome measures and a number of search process variables. But contrary to what common sense would lead one to expect, search experience, training, and cognitive styles were found to have little association with search outcome or search process. Inadequacy of dependent variables was suggested to be the reason for such findings (Fidel, 1987), and great within-group variability and small sample sizes were also speculated to be the causes for such finding.

Research on the effect of subject knowledge on online searching, on the other hand, has been lacking until Fidel's recent study on professional searchers (1991). She provided valuable insight into searchers' selection of search terms and reported that science professional searchers are more likely to use textwords without checking a thesaurus than searchers in other fields. The role of subject knowledge in matching subject headings in the manual environment was investigated by Bates (1977) and found to have a slightly negative, but not statistically significant, effect. Whether the same negative effect holds in an online environment remains to be tested. The lack of research on this variable in the online literature could probably be attributed to the fact that professional searchers have long served as intermediaries and could obtain subject information from the patron if necessary. As the number of end-user searches has risen, however, the role of subject knowledge may turn out to be an important factor on online searches. Since novice end-user searchers typically do not possess much search experience, subject knowledge is their only asset when they start doing their own searches. The extent to which such knowledge affects their search behavior seems worth investigating.

Search Process

Analyses of the search process have been conducted since the early 1970s. Fenichel (1980) presented a comprehensive review of this literature, which shows that inexperienced searchers can perform online searches (e.g., Chapman, 1981; Fenichel, 1979; Howard, 1982; Lancaster, 1972; Sewell & Bevan, 1976), and that search effort, such as that measured by the number of commands, seems adequate to distinguish searchers (e.g., Bourne, Robinson, & Todd, 1974; Carlisle, 1972; Martin, 1973). But more disturbing news is that searchers do not utilize sophisticated system features (e.g., Fenichel, 1979; Howard, 1982; Lancaster, 1972; Martin, 1973; Oldroyd & Citroen, 1977), that there is not much difference between experienced and inexperienced searchers' performance (e.g., Fenichel, 1979; Howard, 1982), and that great variability in search performance exists (Durkin & Egeland, 1974; Fenichel, 1979; Katzer, 1973; Oldroyd & Citroen, 1977). These studies show what searchers did and did not do during a search and reveal the complexity of studying online search behavior.

Models of the search process have also been developed. Penniman (1975) developed a useful model for the search process from his studies of searches on the BASIS system. Using a series of stochastic models, he was able to identify three search phases: index searching, logic formation, and document display. A more elaborate model was developed by the IIDA Project (Individualized Instruction for Data Access, 1978) in which nine searchers were found to display similar search flow. Based on their searches, a model drawing on seven types of commands was developed: commands for beginning or ending a search, for retrieving information about search terms, for combining terms, for displaying search result, for printing search result off-line, for displaying search history, and commands for processing saved searches. These models were able to describe the structure of the search process. But the thoughts behind these actions remained unexplained.

Approaching the search process from a different perspective, two studies have attempted to describe the search styles of searchers. Focusing on searchers' choice of file, search terms, and concepts and logical operations, Oldroyd and Citroen (1977) identified two search styles: the first style selected the most relevant concepts and combined them before deciding how to proceed, while the second style selected a large number of possibly relevant concepts and combined them in logical sets later. Using a case study approach, Fidel (1984) identified two styles of searching: the operationalists used system features to modify a search result without changing the concepts, while the conceptualists modified the meanings of the concepts to modify a search. These efforts have shed some light on the problem-solving styles of professional searchers.

Limitations of Previous Search Process Variables

Search process variables in previous studies of online search behavior typically included the number of commands
used, connect time, the number of cycles, and speed of search. Although these variables are easily quantifiable and do reflect a searcher's effort, they provided very little information on how searches were conducted. The surprising finding that search experience had no effect on search behavior could probably be attributed to the inadequacy of the measurements used in previous studies. As Fidel (1991) pointed out, the typical search process variables reflect a searcher's interaction with a system, but "high level of interaction is not always desirable" and "effort variables ... are not adequate to represent the search process" (p. 524). For instance, traditional search process variables show that professional searchers use predominantly "search" and "display" commands, often use AND to combine terms, seldom modify their searches, conduct brief and simple searches, rely heavily on controlled vocabulary, and make few errors. And previous research has found similar characteristics in nonprofessional searchers. They were found to use mostly ANDs in combining search terms (Marchionini, 1988; Sewell & Teitelbaum, 1986; Trzebiatowski, 1984), rarely modify their searches (e.g., Finichel, 1979; Lancaster, 1972), and use truncation infrequently (e.g., Trzebiatowski, 1984). The search process variables used so far do not seem to distinguish clearly professional from nonprofessional searchers.

Fortunately, conceptual analyses of the search process have produced more promising results. Bates (1979a,b) identified 17 idea tactics and 29 information search tactics searchers used to navigate through searches, manual as well as online; Fidel (1984) identified two distinctive search styles mentioned above; and Fidel and Soergel (1983) developed an impressive list of variables involved in a search. These efforts provided the groundwork for the current study in which various variables on Fidel and Soergel's list were controlled or manipulated and new search process variables developed to analyze the search tactics of two searcher groups.

Objectives

The objective of the present study was to examine, with a new set of dependent variables, the effects of search experience and subject knowledge on online searches. For the purpose of the study, novice searchers were defined as nonprofessional searchers who have little or no search experience and have not taken courses on online searching or attended workshops provided by librarians or system vendors. In the literature, they are often referred to as end-user searchers. Experienced searchers were defined as professional searchers who have at least one year of search experience and have either taken course(s) on online searching or attended workshops provided by system vendors. The study sought to answer four research questions:

1. Do experienced searchers and novice searchers differ in their use of search tactics when they search a familiar topic?
2. Do experienced searchers and novice searchers differ in their use of search tactics when they search an unfamiliar topic?
3. Do experienced searchers search differently when they search a familiar topic and an unfamiliar topic?
4. Do novice searchers search differently when they search a familiar topic and an unfamiliar topic?

Methodology

A. Research Design

Test questions were developed in the subject area of each of the searcher groups (see Appendix A). The test questions were verified with three faculty members in each subject area to ensure their content validity, and two professional searchers familiar with both subject areas and two online searching instructors were consulted to ensure the number of search concepts were the same in the two questions. Each searcher was asked to search a practice question of general public interest, then two test questions. To address the possible effect of question order, half of each searcher group was given a question in their field first, while the other half a question outside their field first. Search tactics were selected from the literature and verified in 10 pretests. Those occurring with high frequency were operationalized and grouped according to their functions; nine search tactics measures, the dependent variables, were defined to describe the frequency of their use.

B. Population and Recruitment

Novice searchers were recruited from the Department of Educational Administration at the University of Wisconsin-Madison. The assumption was that graduate students in general are more motivated than undergraduates in learning about online searching, and this population, being in the same subject field, would be more likely to have a shared pool of subject knowledge, which is also well covered by the ERIC database. Their interest in conducting online searches for themselves made this group a close approximation of end-user searchers. At the time of recruitment, all students were asked to fill out a fact sheet designed to identify eligible subjects. In return for their participation, students were entered into a drawing for gift certificates at a Madison restaurant. A total of 34 novice searchers was recruited.

Due to budget constraints, only professional searchers in the Madison area were contacted. A total of 33 professional searchers volunteered for the study. Thirty-two experienced searchers and 30 novice searchers completed the experiment. Table 1 shows the distribution of these searchers and the order in which they received the test questions. Table 2 shows the grouping of searchers and comparisons planned to answer the research questions.

C. Variables

Variables controlled: Several variables were either held constant or preselected to neutralize or reduce their possible
TABLE 2. Planned comparisons.

<table>
<thead>
<tr>
<th></th>
<th>Experienced</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) E (lib. Q.) vs. N (ed. Q.)</td>
<td>Subgroup A (n = 16)</td>
<td>Subgroup C (n = 14)</td>
</tr>
<tr>
<td>(2) E (ed. Q.) vs. N (lib. Q.)</td>
<td>Subgroup B (n = 16)</td>
<td>Subgroup D (n = 16)</td>
</tr>
<tr>
<td>(3) E (lib. Q.) vs. E (ed. Q.)</td>
<td>LIB-ED</td>
<td>LIB-ED</td>
</tr>
<tr>
<td>(4) N (ed. Q.) vs. N (lib. Q.)</td>
<td>ED-LIB</td>
<td></td>
</tr>
</tbody>
</table>

effects. Since all novice searchers had performed less than five searches by themselves before the experiment, a standard instruction was provided at the beginning of each session by the investigator, and a summary sheet of ERIC search syntax was also available for their reference. A practice question of general interest was given to each searcher to ensure that the subject was comfortable in performing simple searches independently before the main test began. Since Chapman (1981) reported that inexperienced searchers could be influenced by search strategies recommended by their instructor, no such recommendation was made to the participants.

In addition to standard introduction on online searching, several environmental variables were held constant:

(1) System and Database: The DIALOG system was selected because (a) ERIC was accessible through the DIALOG system in the School of Library and Information Studies at the University of Wisconsin-Madison; (b) DIALOG provided a grant for free search time for this study; and (c) the regular DIALOG system provided an opportunity to examine the novice searchers' behavior in using a relatively sophisticated system. Possible differences in the search behavior of the two searcher groups might therefore be more observable.1

Furthermore, only one database was used so that searchers could avoid the step of database selection—a step that can be very difficult for novice searchers. The decision also ensured that database differences could be ruled out as a possible explanation for any observed differences. Further, the relevance of the ERIC database to the selected population group might increase novice searchers' motivation to participate in the study.

(2) Cost of search: Fenichel (1979) and other researchers suggested that the concern over cost might have caused inexperienced searchers to conduct fairly simple searches. To eliminate this factor, all searchers were asked to search in a controlled environment in which the concern for the cost of searching was mitigated, if not completely eliminated. This was made possible by DIALOG's generous support in granting free search time.

(3) Search environment: All searchers were asked to conduct searches in a special laboratory set up for this study at the School of Library and Information Studies at the University of Wisconsin-Madison. By removing all searchers from their own environments, it was assumed that old environmental constraints were reduced, if not eliminated. Features of a search environment, such as a computer terminal, thesaurus, note pads, and the reference sheets for ERIC (the blue sheets), were provided to simulate a real search environment.

(4) Presearch interviews and search request form: All search requests were presented in written form and no presearch interview was allowed. This arrangement caused some frustration for experienced searchers, because a presearch interview is part of their typical workflow. Such control was necessary, however, because the variation in interviewing skills could easily introduce unwanted variance. Another justification for such an arrangement is that it is not out of the ordinary for experienced searchers to conduct searches based on written search requests.

Variables Defined and Operationalized

(1) Independent variables: Search experience and subject knowledge were manipulated through subject selection and assignment of the test questions. Search experience and subject knowledge were deliberately dichotomized and treated as discrete variables (nominal level data) so as to maximize the difference between the two searcher groups and make differences in search tactics more observable. In addition, to control for order effects, half of each group received the educational administration question first, while the other half received the library science question first. These subgroups were formed by random assignment of subjects. The advantages of such a design were that the effects of uncontrolled subject variables could be assumed to cancel out, the problem of cell size was addressed—each subgroup would have about 15 subjects, and an explicit assessment of the order effect became possible.

(2) Dependent variables: To develop new measurements of the search process, the literature was surveyed to identify as many tactics as possible. Oldroyd and Citroen (1977), Bates (1979a,b), Schroder (1983), Fidel (1985), Harter and

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1 Since most library schools teach the DIALOG system, it was expected that experienced searchers would be able to search the system. Some professional searchers were proficient in using several systems and some mainly in BRS. But, with the help of a summary sheet of the search conventions, which was provided to all searchers, experienced searchers were able to deal with the system mechanisms well.
Peters (1985), and many textbooks have provided long lists of advice or "tips" on how to conduct a search. Tactics that seemed promising in describing the search process were adopted, mainly from Bates's article (1979b), and their frequency was checked in 10 pretests conducted in June of 1989. From these pretests several search tactics were identified and operationalized. Since search tactics were not used in large numbers, tactics serving similar purposes were grouped together and measured by search tactics variables, the dependent variables. Nine search tactics variables were defined operationally (see Appendix B). They are briefly introduced here for the following discussion.

- Four variables for term selection tactics: OTAL refers to the use of the searcher's own terms and the query language; THAL, the searche’s reliance on the thesaurus structure for term suggestions; PREP, off-line efforts at term selection; ACT, online usage of search terms.
- One variable for search monitoring tactics: CHECK, the comparison of search question with a search in progress.
- Four variables for search formulation and modification tactics: PARALLEL, inclusion of similar concepts or synonyms; TRACE, the tactic of finding similar items from a relevant item; MANIPUL, the searcher's combinations of search terms; and BROWSE, the tactic of viewing records to find relevant items.

Hypotheses

The hypotheses developed for the study were:

(a) One-tailed test for the effect on THAL, PREP, ACT, PARALLEL, TRACE, and MANIPUL: The research hypothesis stated that experienced searchers would use these tactics more than novice searchers (E = experienced searchers, N = novice searchers).

\[ H_0: \mu_E = \mu_N \quad H_1: \mu_E > \mu_N \]  

(b) One-tailed test for the effect on OTAL and BROWSE: The research hypothesis stated that experienced searchers would use these tactics less than novice searchers.

\[ H_0: \mu_E = \mu_N \quad H_1: \mu_E < \mu_N \]  

(c) Two-tailed test for the effect on CHECK: The research hypothesis stated that experienced searchers and novice searchers would differ in their use of this tactic.

\[ H_0: \mu_E = \mu_N \quad H_1: \mu_E \neq \mu_N \]  

(d) Since the effects of subject knowledge on these two groups has not been investigated before, hypotheses on its effects on all variables were two-tailed. The research hypotheses stated that searchers would differ in their use of tactics when they search a topic they are familiar with and a topic they are not familiar with (F = familiar, UF = unfamiliar).

\[ H_0: \mu_F = \mu_{UF} \quad H_1: \mu_F \neq \mu_{UF} \]  

Data Collection

Since every data collection method has its limitations, a combined approach was adopted. Data were collected through protocols, transaction logs, and on-site observation. As soon as subjects started the practice session, they were asked to think out loud as the search proceeded. In the meantime, their interaction with the system was unobtrusively recorded by "Procomm," a communication program. And to capture other search activities not completely recorded by the other two methods (such as the number of times subjects checked the given search questions), a research assistant was on site throughout the experiment. Another reason for the observer's presence was to remind searchers to verbalize their thoughts during the searches. The observer was trained not to assist searchers with strategy formulation, but to provide help with the mechanical part of the system.

Intrusive as this arrangement may seem, it was adopted after a careful consideration of the trade-offs. Although the presence of the research assistant made it difficult to generalize findings of the present study to search behavior in general, the inclusion of the research assistant helped collect valuable information to provide a context for the transaction logs. Since the research assistants were instructed to be nonjudgmental and nonauthoritative, and searchers were told that the research assistants knew nothing about online searching, it was assumed that the intrusiveness of their presence was reduced. Transaction logs showed that this arrangement actually brought about positive effects. First, it eliminated the pressure, especially for experienced searchers to seek assistance in conducting the search, and yet, provided a companion for them during the search. Recordings suggested that novice searchers seemed to feel good to have sympathetic ears for their trouble with the search, even though the listener did not know how to help them with the search.
Data Analyses and Findings

Protocols were transcribed and paired with transaction logs and observation forms for data processing. Data were coded by the researcher and a research assistant. The reliability of the coding was checked by a third coder, who coded nine cases (14.5% of the sample) under the researcher’s supervision. Coding results were compared and found to be consistent for all variables.

Order Effects

To test for differences in search tactics measures that could be attributed to the order in which search questions were given, a series of independent sample t-tests were conducted using MYSTAT, a simpler version of SYSTAT. Order effects were examined by a series of tests performed at four levels: (a) novices searching a familiar question; (b) novices searching an unfamiliar question; (c) experienced searchers searching a familiar question; and (d) experienced searchers searching an unfamiliar question. For these tests, a 0.05 significance level was specified, so if the p-value is equal to or less than 0.05, the null hypothesis can be rejected. The p-value represents the probability that the null hypothesis is incorrectly rejected. Since almost all the tests were nonsignificant (33 out of 36) order effects were judged not to be present, and a series of combined analyses was performed on the data. Table 3 shows how the subgroups were combined for final analyses.

TABLE 3. Groups for combined analyses.

<table>
<thead>
<tr>
<th></th>
<th>Experienced (n = 32)</th>
<th>Novice (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A* + B</td>
<td>C + D</td>
</tr>
<tr>
<td>Familiar Q.</td>
<td>LIB1 + LIBb</td>
<td>ED1 + ED2</td>
</tr>
<tr>
<td>Unfamiliar Q.</td>
<td>ED2 + ED1</td>
<td>LIB2 + LIB1</td>
</tr>
</tbody>
</table>

aSubgroup.
bOrder in which the question was searched.

Test Results of Combined Analyses

A. E/N (f) Experienced searchers were compared with novice searchers when they both searched a familiar topic. Test statistics of independent sample t-tests in Table 4 show that for PARALLEL (t = 4.49, p = 0.00), CHECK (t = 2.17, p = 0.04), and MANIPUL (t = 3.76, p = 0.00), the two searcher groups had significant differences, and their respective hypotheses should therefore be rejected. The t-statistic value represents the difference of the estimated means of the two searcher populations. A t-value further from zero indicates that the means differ. The difference is considered statistically significant if the probability value ("p") is not greater than the selected level of significance (0.05). For instance, since p has the value of zero for PARALLEL, we can conclude that the difference between the two searcher populations (t = 4.49) is statistically significant and we know that there is only one chance in 20 (0.05) that we incorrectly reject the null hypothesis. The test results show that in searching a familiar topic, experienced searchers used more PARALLEL and MANIPUL than novice searchers, and the two groups differed in their monitoring of their search. The data suggested that novice searchers (mean = 7.37) monitored slightly more often than experienced searchers (mean = 5.41).

B. E/N (uf): Experienced searchers were compared with novice searchers when they both searched an unfamiliar topic. Test statistics of independent sample t-tests in Table 5 show that for OTAL (t = 4.76, p = 0.00), THAL (t = 5.11, p = 0.00), PREP (t = 4.56, p = 0.00), PARALLEL (t = 6.52, p = 0.00), and MANIPUL (t = 5.04, p = 0.00), there were significant differences, and their respective null hypotheses should therefore be rejected. Novice searchers used more OTAL than experienced searchers, whereas experienced searchers used more THAL, PREP, PARALLEL, and MANIPUL than novice searchers.

C. EXP (f/uf): Comparisons were made when experienced searchers searched a familiar topic and an unfamiliar topic. Because the same subjects searched the

TABLE 4. Comparisons between experienced and novice searchers when they search a familiar topic.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Exp. (n = 32)</th>
<th>Nov. (n = 30)</th>
<th>t, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTAL</td>
<td>5.41</td>
<td>7.87</td>
<td>1.82, p = 0.07</td>
</tr>
<tr>
<td>THAL</td>
<td>8.19</td>
<td>7.73</td>
<td>0.50, p = 0.76</td>
</tr>
<tr>
<td>PREP</td>
<td>6.31</td>
<td>6.83</td>
<td>0.45, p = 0.66</td>
</tr>
<tr>
<td>ACT</td>
<td>7.28</td>
<td>8.77</td>
<td>1.16, p = 0.25</td>
</tr>
<tr>
<td>PARALLEL</td>
<td>7.28</td>
<td>1.53</td>
<td>4.49, p = 0.00</td>
</tr>
<tr>
<td>CHECK</td>
<td>5.41</td>
<td>7.37</td>
<td>2.17, p = 0.04</td>
</tr>
<tr>
<td>TRACE</td>
<td>8.13</td>
<td>6.87</td>
<td>0.45, p = 0.65</td>
</tr>
<tr>
<td>MANIPUL</td>
<td>15.69</td>
<td>8.80</td>
<td>3.76, p = 0.00</td>
</tr>
<tr>
<td>DROUGH</td>
<td>28.72</td>
<td>10.51</td>
<td>4.36, p = 0.00</td>
</tr>
</tbody>
</table>

aIndependent sample t tests, t = difference of the estimated means of the two populations, experienced searchers and novice searchers; p = probability value. If p < 0.05 or p = 0.05, reject the null hypothesis.
bSignificant difference found.
cNot significant for the planned one-tailed test.
TABLE 5. Comparisons between experienced and novice searchers when they search an unfamiliar topic.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Exp. (n = 32)</th>
<th>Nov. (n = 30)</th>
<th>t, p^1</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTAL</td>
<td>3.22</td>
<td>7.83</td>
<td>t = 4.76, p = 0.00^2</td>
</tr>
<tr>
<td>THAL</td>
<td>16.03</td>
<td>7.13</td>
<td>t = 5.11, p = 0.00^2</td>
</tr>
<tr>
<td>PREP</td>
<td>10.25</td>
<td>5.30</td>
<td>t = 4.56, p = 0.00^2</td>
</tr>
<tr>
<td>ACT</td>
<td>9.90</td>
<td>9.67</td>
<td>t = 0.43, p = 0.67</td>
</tr>
<tr>
<td>PARALLEL</td>
<td>11.28</td>
<td>1.13</td>
<td>t = 6.52, p = 0.00^2</td>
</tr>
<tr>
<td>CHECK</td>
<td>8.41</td>
<td>0.80</td>
<td>t = 0.35, p = 0.73</td>
</tr>
<tr>
<td>TRACE</td>
<td>5.13</td>
<td>7.20</td>
<td>t = 0.09, p = 0.33</td>
</tr>
<tr>
<td>MANIPUL</td>
<td>21.25</td>
<td>9.07</td>
<td>t = 5.04, p = 0.00^2</td>
</tr>
<tr>
<td>BROWSE</td>
<td>22.59</td>
<td>13.97</td>
<td>t = 1.88, p = 0.07</td>
</tr>
</tbody>
</table>

^1Independent sample t-tests. t = difference of the estimated means of the two populations, experienced searchers and novice searchers; p = probability value. If p < 0.05 or p = 0.05, reject the null hypothesis.

^2Significant difference found.

two questions, paired sample t-tests were preformed. Test statistics in Table 6 show that for OTAL (t = 2.69, p = 0.01), THAL (t = 8.79, p = 0.00), PREP (t = 5.71, p = 0.00), PARALLEL (t = 3.12, p = 0.00), CHECK (t = 3.86, p = 0.00), and MANIPUL (t = 2.41, p = 0.02), there were significant differences, and their respective null hypotheses should therefore be rejected. Similar to the independent t-test, the t-statistic value here represents the difference of the estimated means of the population that searched a familiar topic and the population that searched an unfamiliar topic, and p represents the probability value. Lower probability (at or below 0.05) indicates a significant difference. According to the results here, when searching a familiar topic, experienced searchers were found to use more OTAL than in searching an unfamiliar topic. But in searching an unfamiliar topic, they used more THAL, PREP, PARALLEL, and MANIPUL. They also appeared to use CHECK differently, with data suggesting more use of this tactic by experienced searchers in searching an unfamiliar topic than in searching a familiar topic.

TABLE 6. Comparisons within experienced searchers searching a familiar topic and an unfamiliar topic.

<table>
<thead>
<tr>
<th>Variable</th>
<th>MD^a (n = 32 pairs)</th>
<th>t, p^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTAL</td>
<td>2.19</td>
<td>t = 2.69, p = 0.01^2</td>
</tr>
<tr>
<td>THAL</td>
<td>-7.84</td>
<td>t = 8.79, p = 0.00^2</td>
</tr>
<tr>
<td>PREP</td>
<td>-3.94</td>
<td>t = 5.71, p = 0.00^2</td>
</tr>
<tr>
<td>ACT</td>
<td>-1.72</td>
<td>t = 1.98, p = 0.06</td>
</tr>
<tr>
<td>PARALLEL</td>
<td>-4.00</td>
<td>t = 3.12, p = 0.00^2</td>
</tr>
<tr>
<td>CHECK</td>
<td>-3.00</td>
<td>t = 3.86, p = 0.00^2</td>
</tr>
<tr>
<td>TRACE</td>
<td>3.00</td>
<td>t = 1.37, p = 0.18</td>
</tr>
<tr>
<td>MANIPUL</td>
<td>-5.56</td>
<td>t = 2.41, p = 0.02^2</td>
</tr>
<tr>
<td>BROWSE</td>
<td>6.13</td>
<td>t = 1.30, p = 0.20</td>
</tr>
</tbody>
</table>

^aMean difference between the pair.

^bPaired sample t-tests, t = difference of the estimated means of two populations, the one searching a familiar topic, the other an unfamiliar topic; p = probability value. If p < 0.05 or p = 0.05, reject the hypothesis.

D. NOV (f/uf): Comparisons were made when novice searchers searched a familiar and an unfamiliar topic. Because the same subjects searched the two questions, paired sample t-tests were performed. Test statistics in Table 7 show that there was no significant difference: novice searchers were found to use the search tactics in the same way whether they had knowledge about a search topic or not.

TABLE 7. Comparisons within novice searchers when they search a familiar topic and an unfamiliar topic.

<table>
<thead>
<tr>
<th>Variable</th>
<th>MD^a (n = 30 pairs)</th>
<th>t, p^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTAL</td>
<td>0.03</td>
<td>t = 0.03, p = 0.98</td>
</tr>
<tr>
<td>THAL</td>
<td>0.60</td>
<td>t = 0.36, p = 0.72</td>
</tr>
<tr>
<td>PREP</td>
<td>1.53</td>
<td>t = 1.18, p = 0.25</td>
</tr>
<tr>
<td>ACT</td>
<td>-0.90</td>
<td>t = 0.56, p = 0.58</td>
</tr>
<tr>
<td>PARALLEL</td>
<td>0.40</td>
<td>t = 0.47, p = 0.65</td>
</tr>
<tr>
<td>CHECK</td>
<td>-0.67</td>
<td>t = 0.72, p = 0.48</td>
</tr>
<tr>
<td>TRACE</td>
<td>-0.33</td>
<td>t = 0.14, p = 0.89</td>
</tr>
<tr>
<td>MANIPUL</td>
<td>-0.27</td>
<td>t = 0.20, p = 0.84</td>
</tr>
<tr>
<td>BROWSE</td>
<td>-3.18</td>
<td>t = 0.87, p = 0.39</td>
</tr>
</tbody>
</table>

^aMean difference between the pair.

^bPaired sample t-tests, difference of the estimated means of two populations, the one searching a familiar topic, the other an unfamiliar topic; p = probability value. If p < 0.05 or p = 0.05, reject the null hypothesis.

^cNo significant difference found.

Discussion

For the ease of discussion, the research hypotheses and the results of the combined analyses are summarized in Table 8.
TABLE 8. Research hypotheses and test results.

<table>
<thead>
<tr>
<th></th>
<th>TOTAL</th>
<th>THAL</th>
<th>PREF</th>
<th>ACT</th>
<th>PARALL</th>
<th>CHECK</th>
<th>TRACE</th>
<th>MANIP</th>
<th>BROWSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXP</td>
<td>Nov+</td>
<td>Nov+</td>
<td>Exp+</td>
<td>Exp+</td>
<td>Exp+</td>
<td>E ≠ N</td>
<td>Exp+</td>
<td>Exp+</td>
<td>Nov+</td>
</tr>
<tr>
<td>(f)</td>
<td>(n = 32 exp., 30 nov.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXP</td>
<td>Nov+</td>
<td>Exp+</td>
<td>Exp+</td>
<td>Exp+</td>
<td>Exp+</td>
<td>E ≠ N</td>
<td>Exp+</td>
<td>Exp+</td>
<td>Nov+</td>
</tr>
<tr>
<td>(uf)</td>
<td>(n = 32 exp., 30 nov.)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXP.</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>uf+</td>
<td>uf+</td>
<td>uf+</td>
</tr>
<tr>
<td>(f/uf)</td>
<td>(n = 32 pairs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOV.</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
<td>f ≠ uf</td>
</tr>
<tr>
<td>(f/uf)</td>
<td>(n = 30 pairs)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3Research hypotheses Exp+ = experienced searchers would use a tactic more than novice searchers; Nov+ = novice searchers would use a tactic more than experienced searchers. E ≠ N = the two groups would differ in their use of a tactic; f ≠ uf = the use of a tactic would differ when a familiar and an unfamiliar question were searched.
4Test results are presented in bold: Exp+ = experienced searchers used a tactic more; Nov+ = novice searchers used a tactic more; f+ = a tactic was used more in searching a familiar question; uf+ = a tactic was used more in searching an unfamiliar question. A blank indicates the research hypothesis was not confirmed.
5E/N (f) = experienced searchers compared with novice searchers at the familiar question level; E/N (uf) = experienced searchers compared with novice searchers at the unfamiliar question level; EXP. (f/uf) = within experienced searcher group, comparisons between familiar and unfamiliar questions; NOV. (f/uf) = within novice searcher group, comparisons between familiar and unfamiliar questions.

line training component of a class. Fenichel found novices not significantly different from moderately experienced searchers and experienced searchers, except that they used more online time, used fewer commands, and made twice as many errors. She also reported that many experienced searchers conducted simple searches and did not modify their initial strategy. Wanger et al. (1980) defined “experience” by number of searches per month and reported that search experience mainly affected search time but not search outcomes (agreeing with Fenichel’s finding). Several of Fenichel’s findings, however, were not supported by Penniman’s study. Based on the duration and frequency of MEDLINE searches, Penniman (1981) categorized these users as “experienced” and “inexperienced” and found that experienced searchers used more advanced search techniques and more complex search strategies and made more errors (contradicting Fenichel’s finding), but they used more commands and searched more quickly than inexperienced searchers (confirming Fenichel’s finding). Howard’s (1982) categorization of searchers is similar to Fenichel’s. She found that the three experience groups did not differ greatly in their performance and the most experienced group did not perform best on all the variables. Harter (1984), however, found no significant relationship between experience and a variety of searching behaviors. He defined experience by number of years of searching (regardless of search frequency) and only found that more experienced searchers were more likely to interact with the system. Similar findings were reported by Oldroyd (1984) that experienced searchers were more knowledgeable of the content and structure of the databases and more flexible in using the system. But it is unclear how “experienced” searchers were defined in this study. Despite the belief that practice makes perfect, the literature does not support a positive relationship between search experience and search process and outcome. It is intriguing that, in spite of the different definitions of “experience” in these studies, the same conclusion of no correlation was found.

“Experienced” was defined in this study as completion of an online course or workshop and one year of search experience, regardless of frequency; and novices were people without formal training and with almost no search experience (fewer than five searches ever performed). In contrast to the results of previous studies, this study found that search experience did affect search behavior. The nature of the effects, furthermore, was closely tied to the knowledge a searcher had about the topic he or she was searching. When searching a topic they had some knowledge about, experienced searchers were found to include more synonyms and try out more combinations of search terms than novice searchers. This finding is worth noting, because even though novice searchers had good knowledge in the topic area and probably had no trouble coming up with synonyms (after all, the question was taken from their area of specialization), they did not seem to feel the need to include many synonyms in their search. This is probably due to their lack of knowledge of how synonyms may improve retrieval results. Bates (1987) describes a SURVEY tactic through which searchers would explore all possible search terms. Novice searchers in this study did not use that tactic. Experienced searchers, however, were found to employ this tactic and try out more combinations of their search terms. A possible explanation could be that experienced searchers could appreciate the role of synonyms more and also felt more at ease in manipulating terms by using different term combinations. This finding seems consistent with findings by Penniman (1981), Harter (1984), and Oldroyd (1984) that experienced searchers are more flexible and know how to use system features to their advantage.
Another finding is that the two groups differed in the extent they monitored the search when searching a familiar topic, with data suggesting that novice searchers monitored the search more closely than experienced searchers. One explanation for this phenomenon could be that confidence in their knowledge about a search topic made experienced searchers less careful in monitoring the search, whereas for novice searchers, knowledge of the topic probably made it more interesting to follow the search closely. This explanation will, of course, need to be tested.

The differences between the two groups became more obvious when they searched a question outside their subject area. As predicted, experienced searchers relied more on the thesaurus for term suggestion, made more effort in preparing for the search, included more synonyms and tried out more combinations of terms, whereas novice searchers relied more on their own terms. The behavior of the experienced searchers could probably be attributed to search experience, but end users’ behavior certainly seemed unusual. This could probably be explained by how the variable OTAL (the total number of nonthesaurus terms) was defined. The definition included the searcher’s own terms and the terms given in the test question. It could be that in searching a topic they knew very little about, novice searchers had difficulty coming up with synonyms so they adhered closely to the terms given in the question, hence the high number for OTAL. The underutilization of the thesaurus by novice searchers in this context was nevertheless worth noting. Despite the fact that the thesaurus was right next to the terminal and the function of the thesaurus was explained to them earlier, novice searchers consulted the thesaurus much less than experienced searchers, even when they were dealing with an unfamiliar topic.

To summarize, data on the effects of search experience show that the two groups differed mainly in term selection, inclusion of synonyms, and manipulation of search terms. Users’ reliance on nonthesaurus terms and their low use of the thesaurus when dealing with a topic they had little knowledge of suggest that end users use a limited number of sources for term selection and do not seem to appreciate the distinction between natural language and controlled vocabulary and their strengths and limitations for online searches. If making end users search like professional searchers is the goal, these areas will need to be addressed.

In training programs or interface software, the sources for search terms should be discussed, role of synonyms in retrieval could be demonstrated, and the function and role of thesaurus ought to be made very explicit. Front-end software could also include features that would encourage searchers to survey possible search terms and take full advantage of a thesaurus.3

Role of subject knowledges: Fidel’s recent study (1991) shed light on the effect of subject knowledge on professional searchers’ use of textwords. Findings of this study showed that subject knowledge affected only experienced searchers. The data indicated that experienced searchers, in searching a topic they had little knowledge about, used the thesaurus more for term suggestion, made more effort in preparing for the search, monitored the search more closely, included more synonyms, and tried out more term combinations than when they searched a familiar subject area. But, in searching a topic they knew about, they used more of their own terms. The use of these tactics seems sensible and logical. Clearly, when one is not familiar with a topic, more preparation is warranted and more effort should be made for term selection; whereas, while searching in one’s own field, it is much easier for experienced searchers to simply rely on their own terms for the search.4

The most intriguing finding about subject knowledge, however, is its lack of effort on novice searchers. Data showed that no matter which topic was searched, novice searchers displayed no difference in their use of search tactics selected for this study. A possible explanation could be that searchers need to have a certain amount of search experience for subject knowledge to have any effects on them. Another possibility is that the two subject areas chosen, educational administration and library science, are not contrastive enough to bring out possible differences in the use of search tactics among novice searchers. Searchers’ protocols suggested, however, that many novice searchers felt uneasy with the library science search topic because of their lack of knowledge in this area, so the subject variable seemed to have its desired effect. Nevertheless, it would be useful to replicate the study between more widely separated subject fields.

Findings on the role of subject knowledge suggest that experienced searchers knew how to cope with their deficiency in this area. Like all good searchers, they took advantage of the thesaurus for term suggestions, tried to identify all possible relevant terms (descriptors and nondescriptors), included many more synonyms, combined them in many ways, and monitored their search carefully. It is interesting, however, that experienced searchers, however, that experienced searchers did not use the TRACE tactic more in this context. TRACE is defined as a tactic through which a searcher examines relevant records for clues to expand a search. It can be highly effective when an unfamiliar topic is being searched. Perhaps this is a tactic that needs to be highlighted for experienced searchers.

3Bates (1977) suggested that confidence might be a factor in why participants searched slightly, but not significantly, worse than the control group in matching subject terms in their own field than in unfamiliar fields. Since lack of confidence seems to originate from lack of subject knowledge, it is difficult to determine the role of confidence in this study. Two pieces of evidence, however, indicate that confidence factor may not be a major factor. First, experienced searchers were satisfied with their searches and no damaging effect of subject knowledge was observed. Second, novice searchers’ searches were unaffected by subject knowledge.

4Bates (1989) proposed a superthesaurus which seems to hold promise in assisting users with term selection and could be developed for on-line retrieval systems as well. The cost-effectiveness of such improvement remains to be determined.
The role of subject knowledge on online searches has received some attention. Bates (1987), for instance, called for more studies on the information variable and observed that some researchers might have more difficulty in searching because of the searchability of information in their fields. To explore the effect of subject knowledge further, future studies may need to use more contrastive subject areas. In addition, as Bates suggested, the distribution of the literature of a subject and the quality of bibliographic control in that field should also be taken into account.

The new search process variables: In examining the effects of search experience and subject knowledge on the search process, the study employed nine newly operationalized dependent variables, the search tactics variables. These variables focus on three aspects of the search process: term selection, search monitoring, and search formulation and modification; and, each variable covers a number of specific search tactics. This approach is a deliberate departure from traditional search process variables (such as search time and number of search commands) for the purpose of uncovering more of the intellectual components of the search process. OTAL tells us how much searchers rely on their own knowledge and the test questions for term selection. THAL goes beyond counting the number of descriptors to include the searcher’s use of the cross references for term exploration. It reflects how searchers utilize the thesaurus structure. PREP covers the offline effort in searching for term, while ACT the actual effort in entering search terms. The two variables are more in line with traditional search effort variables, but they focus on the effort on search term consideration. CHECK tells us whether searchers use the original search request to keep the search on track. PARALLEL reflects searchers’ use of similar or related terms or concepts. TRACE shows if searchers expand a search from what they retrieve. MANIPUL shows the extent to which searchers combine search terms to represent the search request. It includes a large number of tactics which reflect their use of Boolean logic, proximity operators, and limiting devices. In essence, these tactics reveal whether searchers know how to use system features to their advantage. BROWSE indicates the extent to which searchers are willing to look through records to find the relevant ones. In this study, six of the nine dependent variables were able to reflect the differences in search behavior caused by search experience and subject knowledge. The other three dependent variables are nevertheless valuable because they also represent useful search tactics.

The new variables cannot show how searchers move from search stage to search stage. But, they still shed light on how searchers look for search terms, monitor searches, and formulate and modify their searches. As a new attempt to describe the thinking behind search action, these new variables turn out to be adequate for the purposes of this study. It is hoped that these variables, perhaps further refined, will be used in future studies and our understanding of the search process will be advanced through them.

Implications of the Findings

With an understanding of how novice and experienced searchers search an online database, an objective assessment of the effectiveness of expert systems and search aid software comes closer to reality. For instance, knowing novice searchers’ low use of PARALLEL and MANIPUL, one can examine how effectively expert systems and search aid software assist novice searchers in finding and including synonyms and in taking advantage of system features. The assumption here, it should be noted, is that search tactics measured by PARALLEL and MANIPUL are tactics novice searchers should be encouraged to use. This assumption in fact touches upon the complex issue of evaluation, which involves identifying “desirable” search behavior. The present study set out to investigate how people conduct searches and deliberately avoided evaluating searchers’ performance because a fair evaluation would require taking into account a requester’s need, the searcher’s understanding of the need, the context in which a search is conducted and many other factors. Another challenge regarding evaluation is the lack of good measurement. Precision and recall, in spite of their popularity, have their limitations. Satisfaction, as Tessier, Crouch, and Atherton (1977) pointed out, has many dimensions. Most participants in the study were happy with their search results; this is just another indication of the difficulty of evaluating search performance. Because of its focus on the search process, this study was able to illustrate how search experience and subject knowledge affect the use of search tactics, but it cannot indicate which tactics are most desirable, since “desirability” is contingent on many factors. Now that these new dependent variables have been operationalized and tested, we can begin to investigate the relationship between these variables and the search outcomes. Such findings, in turn, may suggest desirable features to be incorporated in new interface.

But, before deciding what features are desirable, a more basic question needs to be considered. Assuming we know how novice searchers conduct searches, do we want to change their behavior? Should an interface be designed in such a way that little adjustment would be required of its users? Or should it be designed to change their behavior as painlessly as possible?

Taking the findings of this study into account and assuming that the existing online systems will not change in the near future, one could say a new interface facilitating novice searchers’ search style and encouraging them to take advantage of system features would be desirable.
Some important features would include on-screen feature prompts—many CD-ROM systems have provided these prompts, but interestingly enough, not many online systems have done so. Transparent “see” references to translate user terms into terms acceptable to the system, automatic prompting for the inclusion of synonyms, suggestions for search terms (based on initial search terms), prompting for relevancy checking, and a large online thesaurus containing basic information about various fields are also desirable. In addition, since many novice searchers expressed interest in looking at the bibliography of retrieved items (this is their common method in finding relevant items), perhaps the bibliography of each record should be included in the data file as well—ISI databases are the only ones that include such information.

Some of these features have been tested in research laboratories. More sophisticated front-end systems like CITE, developed by Doszkocs (1983), was able to suggest keywords and medical subject headings based on user’s initial queries but CITE is no longer used. Oddy’s THOMAS program (1977) has experimented on assisting users in including synonyms; Meadow, Hewett, and Aversa (1982) have provided online search assistance to users of IIDA, OAKDEC (Meadow, 1988) offers diagnostic assistance to searchers too; Marcus (1983) has used a common command language in the CONIT interface to enable searchers to access multiple databases; and Zahir and Cheng (1992) recently completed an expert system prototype, ONLINE-EXPERT, for database selection. But these efforts have not yet been incorporated into commercial online systems.

CD-ROM systems, on the other hand, have included more features to assist searchers in search term selection, use of Boolean operators, and searching by citations. Grateful Med software, for instance, will suggest MeSH headings based on MEDLINE citations retrieved (Corbett & Brahmi, 1986). CD PLUS will attempt to map a user’s term to MeSH headings and ask a searcher to select the most relevant MeSH heading. After the selection, the system then displays broader and related terms for the user’s consideration (Brahmi & Kaneshiro, 1990). Both Grateful Med and WILSEARCH provide subject concept lines for searchers to enter search words and automatically OR words entered on a single line and AND terms entered on separate subject lines. SCI/SSCI® CD-ROMs provide the much desired feature of searching by references. By invoking the “Related” feature, a searcher will be able to display a list of records that have at least one reference in common—the concept of bibliographic coupling. And by selecting the “ReFerence” feature, the searcher can display the bibliography of a retrieved record (Brahmi, 1989; Burke, 1990). The ISI databases are known for their citation indexes. While searching citations and tracing related records online may be confusing, ISI has improved the search process on their CD-ROM products. The CD-ROM interface, by clearly labeling the two features, has made two unique ways of subject searching more accessible to the general users. Since many end users in this study indicated interest in seeing the references of the articles they retrieved, the “ReFerence” feature will probably be popular. The “Related” feature, though powerful, may need promotion because both end users and experienced searchers in this study have made little use of the TRACE tactics, which in essence are moves to expand from a retrieved record to other records of similar subject.

It is encouraging that some of the desirable features mentioned above have been incorporated into CD-ROM systems, but more needs to be done. Providing a single line for subject concepts and automatically connecting words with OR do not by themselves ease the burden of thinking up synonyms. Mapping a search term with controlled vocabulary, while enabling a searcher to take advantage of the controlled vocabulary, does not allow the searcher to explore the power of natural language searching. Searchers will also need assistance in identifying search concepts and in combining them, using Boolean operators or proximity operators. Guidance in monitoring the course of a search and navigating through searches is also needed.

Research on the nature of the search process and the factors affecting it has serious implications for information and retrieval. Subject expertise and search experience were found to interact in this study and to affect the use of search tactics in this study. But the role of subject expertise in end-user searching needs to be further explored. As our understanding of the search process advances, we will be able to design a more user-oriented interface to facilitate searching.

Appendix A: Practice Question and Test Questions

Practice question:

A researcher plans to investigate the reasons why young adolescents and children use drugs. He wants to survey the literature related to this topic, and would like to have at least 10 citations. Please find this information in ERIC for him. Please tell the RA (research assistant) which records you would like to print out (records will be printed later).

Test questions: Questions were worded slightly differently to address the two audience groups. Novice searchers:

(1) Assume that you are involved in a research project that will investigate the role of school administrators in improving the quality of instructional programs and the effectiveness of schools. You have decided to search ERIC for information about this topic, and you want to have at least 25 citations. Please tell the RA which records you would like to print out (records will be printed later).

(2) Assume that you are the head of a reference department and are in the process of compiling a bibliography on reference interviews. You want to cover various issues related to interviews conducted in the traditional reference setting and those conducted in the online environment. In particular, you are interested in including...
articles comparing these two kinds of interview. You want at least 25 ERIC citations. Please tell the RA which records you would like to print out (records will be printed later).

Experienced searchers:

(1) A researcher plans to investigate the role of school administrators in improving the quality of instructional programs and the effectiveness of schools. He has decided to search ERIC for information about his topic, and asked you to find at least 25 citations for him. Please tell the RA which records you would like to print out (records will be printed later).

(2) The head of a reference department is compiling a bibliography on reference interviews. She wants to cover various issues related to interviews conducted in the traditional reference setting and those conducted in the online environment. In particular, she is interested in including articles comparing these two kinds of interview. She asked you to find at least 25 ERIC citations for her. Please tell the RA which records you would like to print out (records will be printed later).

Appendix B: Operational Definitions of the Dependent Variables

All of the dependent variables are interval level data collected from three possible sources. Table B-1 summarizes the sources.

Term Selection Tactics Variables

OTAL: A variable that reflects the extent a searcher relies on the test questions and his or her own knowledge for search terms. It measures the number of terms mentioned as possible search terms (the searcher, for one reason or another, was unable to search them), and the number of nonthesaurus terms actually used online by each searcher.

THAL: A variable that reflects the extent to which a searcher relies on the thesaurus for term suggestions. It measures the number of cross references in the thesaurus used to find terms, the number of nonthesaurus terms used in the search, and the number of thesaurus terms mentioned as possible search terms.

PREP: A variable that reflects the effort each searcher makes in term selection while preparing for the search offline. It measures the number of “nonthesaurus terms” and “thesaurus terms” (including cross references) mentioned offline as possible terms.

ACT: A variable that indicates the number of terms actually searched by each searcher. It measures the number of “nonthesaurus terms” and “thesaurus terms” (including cross references) used online.

Search Monitoring Tactic Variables:

CHECK: A variable that indicates if the searcher tries to keep the search on track and to look at the query for clues to further the search. It measures the number of times the searcher looked at the query. The data were reported by the subject and/or recorded by the RA, and the larger number was used for final analyses because subjects tended to underreport this activity.

Search Formulation Tactics Variables

PARALLEL: A variable that reflects how each searcher brings in similar terms or concepts to expand a search. It measures the number of similar or related terms connected by OR, the number of truncated terms, and the number of concept sets connected by OR. Different combinations were counted and nested terms were counted in the way the nesting was done.

TRACE: A variable that reflects the searcher’s moves to expand (or reduce) the search by examining retrieved records for clues. It measures the number of records viewed, the number of terms the searcher found to be valuable search terms, and the number of terms actually used by the searcher.

MANIPUL: A variable that reflects the searcher’s move to combine search terms with an aim to include all important elements in a query. It measured (1) the number of times (w) or () is used to connect terms; (2) the number of times limiting devices are used on sets or terms—including de, ti, ab, id, and py, dt, maj, etc.; (3) the number of times AND is used to combine sets and terms; (4) the number of times OR is used to combine different search concepts or sets; (5) the number of times NOT is used to combine search concepts or sets.

BROWSE: A variable that reflects the searcher’s move to identify relevant records by displaying retrieved records. It is defined as the number of records actually viewed for the purpose of determining their relevancy to a given query.

Operational definitions provided in this Appendix reflected the structured framework in which coders operated. Further details of data measurement and guidelines were included in the author’s thesis.

| TABLE B-1. Dependent variables and sources of data. |
|---|---|---|
| Variable | Sources |
| OTAL | OB, TR, PC |
| THAL | OB, TR, PC |
| PREP | OB, PC |
| ACT | OB, TR, PC |
| PARALLEL | TR, PC |
| CHECK | OB, PC |
| TRACE | OB, TR, PC |
| MANIPULATE | TR, PC |
| BROWSE | OB, TR, PC |

OB = observation forms, TR = transaction logs, PC = protocols. Sources in bold are the chief sources of information.
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References


Drexel University, School of Library and Information Science (1978). *Individualized instruction for data access (IIDA)*. Philadelphia: Drexel University, School of Library and Information Science.


