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Edited by  
Diane Henderson

Contributed Papers Chair  
Charles T. Meadow  
University of Toronto

Compiled by  
Carol Nixon

Technical Program Chair  
Bonnie C. Carroll  
Information International

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# ONLINE SEARCHING STYLES

Raya Fidel  
Graduate School of Library and Information Science, University of Washington  
Seattle, WA

## ABSTRACT

Individual searching style has a primary effect on searching behavior. Observation and analysis of 47 professional searchers revealed three dimensions of searching behavior: level of interaction, preference for operational or conceptual moves, and preference for textwords or descriptors.

## INTRODUCTION

Investigators of online searching behavior have been concerned with individual searching styles of professional searchers since the first large-scale study in this area. "Searching style" as a factor, however, played unrewarding role in research: Investigators felt that it muddled the results of their experiments.

Most studies of searching behavior focused on the effect of a variety of variables on the search process and its outcome. Variables tested were both external, such as searching experience (Fenichel, 1981) or the request type (Saracevic & Kantor, 1988), and internal, such as cognitive styles (Woelfl, 1984) or personality traits (Bellardo, 1985). Most of these studies failed to provide conclusive results, and often this failure has been attributed to individual searching styles which, it is assumed, override the effect of the tested variables.

Despite their significant effect on research results, individual searching styles remained unexplored. We still do not know what characteristics of searching behavior constitute a searching style, that is, in what way one individual searcher is different from another, all external conditions being equal.

The study reported here examined the decisions searchers make during an online search, focusing on modifications of search strategies (or moves) to improve search results and on the selection of search keys. The data collected for the study suggest typical characteristics of searching behavior that identify elements of searching styles: Individual searchers differ from one another in their degree of interaction during a search, and in their preference for type of move and for type of search key.

## THE METHOD

To investigate the decisions searchers make when they select search keys and when they make moves during a search, 47 professional searchers were observed performing their regular, job-related searches of bibliographic databases (Fidel, 1988). Each searcher was observed for approximately five searches, for an overall total of 281 searches. Two formal models were developed from search protocols, from verbal protocols of thought processes while searching, and from interviews with searchers to determine reasons for their search-key selection:

- (a) The Selection Routine which is a decision tree that describes the rules used by searchers in the selection of search keys, descriptors or textwords. This model is described elsewhere (Fidel, 1988).
- (b) Moves in Online Searching is a list of modifications of search strategies that are aimed at improving the result of a search. The moves are of two types: operational moves which do not change the meaning of a request, and conceptual moves which change the meaning of a request. A detailed description of the moves is available elsewhere (Fidel, 1985).

In addition to the models, eight variables were defined:

1. Number of moves. The average number of moves, i.e., search-strategy modifications, made by a searcher per search.
2. Operational moves ratio. The percentage of operational moves, that is: the total number of operational moves, divided by the total number of moves made by a searcher. This variable indicates whether a searcher prefers to make one type of move over the other. Searchers who score relatively high on this variable are called operationalist searchers because they prefer to make operational moves, and those who score relatively low are called conceptualist searchers.
3. Number of search keys. The average number of search keys selected by a searcher per search.

4. **Textwords ratio.** The percentage of textwords selected, that is: the total number of textword keys, divided by the total number of search keys selected by a searcher. This variable reflects the tendency of a searcher in the selection of search keys. Searchers who score relatively high on this variable prefer to use textwords and those who score relatively low prefer descriptors.
5. **Thesaurus neglect ratio.** The percent of textwords entered without consulting a thesaurus, that is: the total number of terms entered by a searcher without consulting a thesaurus, divided by the total number of search keys entered by the searcher.
6. **Recall tendency.** The percentage of moves made to increase the size of a set, that is: the total number of recall moves, divided by the total number of moves made by a searcher. This variable reflects the degree to which a searcher is usually concerned with improving recall.
7. **Subject area.** The subject area in which a searcher specializes. This variable had four values: medicine, the sciences, social sciences (including both the social sciences and the humanities), and general (for searchers who habitually search requests in a variety of subjects, as is often the case in public libraries or with independent consultants). This variable was selected to examine whether the subject specialty of a searcher affects his or her searching behavior.
8. **Environment.** The environment in which a searcher works. This variable had three values: practical environments, theoretical environments, and general environments. A practical environment is a work place in which searchers are usually called upon to search requests that result from immediate and practical problems, for instance, most small or medium-size consulting companies or industries. In contrast, a theoretical environment is an establishment whose users are often involved in research or investigation, for instance, universities or regulatory agencies. Search environments that could not be assigned any of the first two categories were called general environments. This variable was selected to examine whether the nature of the requests habitually searched has an effect on searching behavior.

Correlation tests between these variables, data about the frequency of moves selection, as well as about the reasons for search-key selection, together point to practices in searching behavior that are typical of an individual searching style.

## THE INTERACTIVE SEARCHER

The average number of moves a searcher made per search reflects the degree of interaction during a search: the larger the number of moves, the more interactive the searcher. The data collected in the study show that the average level of interaction varied greatly from one searcher to another. Analysis of Variance revealed that the average number of moves per search for highly interactive searchers varied significantly from the average for less interactive ones ( $F(46, 280) = 4.45, p < .01$ ). That is, each searcher has his or her own typical level of interaction. Additional tests can examine the characteristics of searching behavior that are typical of searchers who are more interactive than others.

Statistical analyses show that number of moves is associated with only one variable: number of search keys. A Pearson Product-Moment Correlation test shows that number of moves is directly correlated with number of search keys ( $r(45) = .777, p < .01$ ). This association shows that interactive searchers are characterized by two variables: number of moves and number of search keys. Specifically:

**Interactive searchers, who, on the average, make more moves per search than their colleagues, are likely to use a larger number of search keys than searchers who are less interactive.**

Of equal importance is the finding that number of moves does not correlate with any of the other variables. That is, regardless of their preference for textwords or descriptors, the subject matter, the environment in which they search, and whether they are operationalist or conceptualist searchers, some searchers routinely interact more than others.

Because the degree with which a searcher is interactive is also represented by the typical number of search keys per search, it is useful to examine the variable number of search keys, that is, the average number of search keys a searcher used in a search. Analysis of Variance found the difference between searchers who used relatively large number of search keys per search and those who used a few to be significant ( $F(46, 280) = 4.07, p < .01$ ).

Like the variable number of moves, the variable number of search keys does not associate with most of the other variables. There is one exception: it does correlate with environment.

Analysis of variance shows that number of search keys is associated with

the environment in which a searcher works ( $F(2, 44) = 5.22, p < .01$ ). Searchers who work in practical environments use an average of 6.76 search keys per search, those in theoretical environments use an average of 18.56 search keys per search, and those who work in general environments use an average of 11.76 search keys. A post-hoc test shows a significant difference between the practical and theoretical environments. Although environment as a variable lacks a rigorous definition, this association suggests that:

**Searchers who are used to answering practical questions use a considerably smaller number of search keys per search than do searchers who habitually answer theoretical requests.**

This conclusion was unexpected, particularly because it was found that searchers who habitually answer theoretical questions do not make more moves than their peers who answer practical questions. This result can lead to the observation that searchers who answer theoretical requests encounter terminological difficulties more frequently than do their colleagues, and therefore typically use more search keys per search. This observation, however, still needs to be substantiated.

The finding that interactive searchers make more moves and enter more search keys than their peers who are less interactive is highly relevant to studies of online searching behavior. Most of these studies have defined a group of variables, usually called search-effort variables, to measure the effect of the external and internal variables on the search process. First introduced by Fenichel (1981), this group includes variables such as number of commands, number of search keys, number of sets viewed, number of search modifications, and connect time. These variables clearly relate to the level of interaction as defined here: An interactive searcher would score higher on search-effort variables than would a less interactive searcher. The present study leads to the conclusion that effort variables, as commonly defined, are not adequate to represent the search process.

At present we do not know what makes one searcher more interactive than another, and hopefully future research will address this issue. This study's results, however, strongly suggest that "being interactive" is an inherent characteristic of a person and that is unlikely to be changed by experience, training, subject area, environment, or by similar variables that are of interest to researchers. It is inadvisable, therefore, to use variables that represent level of interaction to measure changes in searching behavior. For

example, if future research reveals that the level of interaction is determined by a certain cognitive characteristic of a searcher, one should not expect experienced searchers to consistently demonstrate a level of interaction that is significantly different from that of novices (unless one is willing to assume that experience in online searching changes that cognitive characteristic).

This clearly shows that the inability of experiments in online searching behavior to provide conclusive results with respect to the search process is partly caused by the poor choice of variables to represent the search process.

#### OPERATIONALIST AND CONCEPTUALIST SEARCHERS

The data collected in this study indicate that individual searchers often prefer a specific type of move, that is, the type of moves a searcher prefers is an element of searching style.

The variable that measured this element is operational moves ratio, which is defined as the percentage of operational moves made by a searcher. Analysis of Variance shows that searchers who score highly on this variable are significantly different from those who score lower ( $F(46, 280) = 1.8, p < .01$ ).

Further, this variable correlates with four other variables: textwords ratio, thesaurus neglect ratio, recall tendency, and subject area.

Operational moves ratio directly relates to textwords ratio ( $r(45) = .434, p < .01$ ). This correlation suggests that:

**Operationalist searchers prefer to use textwords and conceptualist searchers prefer to use descriptors.**

Similarly, operational moves ratio relates directly to thesaurus neglect ratio ( $r(45) = .413, p < .01$ ). That is:

**Operationalist searchers are more likely to avoid consulting a thesaurus than conceptualist searchers.**

Another variable that distinguishes operationalist from conceptualist searchers is recall tendency, which represents the degree to which a searcher is usually concerned with improving recall. Operational moves ratio relates inversely to recall tendency ( $r(45) = -.405, p < .01$ ). That is:

**Operationalist searchers put less emphasis on recall than do conceptualist searchers.**

Further, the subject area in which a searcher specializes has a significant effect on operational moves ratio

( $F(3,43) = 6.31, p < .01$ ). Medical searchers made operational moves 45 percent of the time, searchers in the social sciences and the humanities 51 percent, in science and technology 76 percent, and generalist searchers made operational moves 79 percent of the time. A post-hoc test found a significant difference between general searchers and both medical and social-sciences searchers, as well as between medical and science searchers. That is:

**Science searchers and searchers who have no subject specialty are more likely to make operational moves than their colleagues in other subject areas.**

The large percentage of operational moves among generalist searchers can be explained by the nature of their task. They are called upon to answer requests in a large variety of subjects. Unlike searchers who specialize in one subject area, their knowledge of the subject of a request is usually limited. This limitation prevents them from making conceptual moves because conceptual moves, since they change the meaning of a request, require some subject knowledge. A person who is familiar with the subject of a request is more likely to feel comfortable modifying its meaning for the purpose of a search than a person who has little experience in the subject matter.

While the tendency to make operational moves among generalist searchers is well understood to be inherent in the nature of their searching, finding this tendency among science searchers is puzzling. The significant difference between science and medical searchers could be explained by the average number of databases they used per search. Data show that medical searchers used an average of 1.33 databases per request, while science searchers used an average of 2.64 per request. It is possible that having to deal with a larger diversity of databases and thesauri, science searchers who otherwise would appear to be conceptualist find it overwhelming to manipulate the meaning of a request. Medical searchers who tend to be conceptualist, on the other hand, are more free to follow their personal tendencies because they handle a smaller diversity of databases and thesauri: they typically search MEDLINE with the MeSH vocabulary. Incidentally, the average number of databases per search could also explain the operational tendencies among generalist searchers who used an average of 2.48 databases per request.

In addition, operational moves ratio does not significantly correlate with environment ( $F(2, 44) = 1.24, NS$ ). That is:

**The environment in which a searcher works has no effect on the searching style of the searcher, whether operationalist or conceptualist.**

In summary, the results show that operationalist searchers differed from their conceptualist peers in their preference for type of search key, their habits relating to thesaurus neglect, and their concern for recall. These findings agree with the detailed description of searching behavior typical of operationalist and conceptualist searchers which was published earlier (Fidel, 1984).

#### THE "FREE-TEXT" SEARCHER

When the study's searchers gave reasons for their search-key selection, they often mentioned a general preference for a certain type of search key. Some searchers said that they preferred to use descriptors, and others explained why the use of textwords was usually beneficial to their searching. It is clear then that some searchers have a strong preference for one type of search key.

Textwords ratio, which represents the percentage of textwords entered by a searcher, is the variable to measure this tendency among searchers. Analysis of Variance indicates that the variation among searchers on this variable is significant ( $F(46, 280) = 5.16, p < .01$ ). This finding reinforces searchers' perception that a preference for textwords or descriptors is a matter of searching style.

Further, textwords ratio is associated with four variables: operational moves ratio (as explained earlier), thesaurus neglect ratio, subject area, and for science searchers, environment.

Data show that the variables thesaurus neglect ratio and textwords ratio are directly related ( $r(45) = .660, p < .01$ ). This association is trivial, however, because it is obvious that searchers who prefer to use descriptors are more likely to consult a thesaurus (in which they find the descriptors) than searchers who prefer to enter textwords, and because neglecting to consult a thesaurus most frequently leads to entering textwords.

More pertinent are the effects of subject area and environment. Analysis of Variance shows that subject area as a variable correlates with textwords ratio ( $F(3, 43) = 13.16, p < .01$ ). Medical searchers entered textwords 34 percent of the time, searchers in the social sciences and the humanities 39 percent, science and technology searchers 76 percent, and generalist searchers entered textwords 57 percent of the time. A post-hoc test shows that the differ-

ence lies between science searchers on the other hand, and medicine and social sciences searchers on the other. Textwords ratio for general literature did not differ significantly either from social sciences and humanities or from science. That is:

**Science searchers are more likely to use textwords than their colleagues who specialize in other subject areas.**

This finding would be commonly explained by the observation that searches in the scientific literature do not require the use of controlled vocabulary because the scientific terminology itself is already controlled and therefore science searchers do not "need" to use descriptors. This argument, however, is not valid here because of the difference between science and medical searchers. Medical terminology is scientific terminology, yet medical searchers used the smallest proportion of textwords while science searchers used the largest proportion.

Further, data indicate that the tendency among science searchers to prefer textwords may be caused in part by their need to search a relatively large number of databases for each request. Study results reported elsewhere (Fidel, 1988) show that having to use a number of databases for a request encourages searchers to use textwords. In addition, these data disclose that searchers refrained from using descriptors when they perceived that the thesaurus or the indexing of a database were of poor quality. Thus, there is enough evidence to indicate that the discrepancy in textwords ratio between science and medical searchers is not inherent to the subject area but due instead to the databases that are available in each subject area and to the quality of their thesauri.

This explanation is further supported by the finding that science searchers are more likely to enter textwords without consulting a thesaurus than searchers who specialize in other subject areas. This finding is brought about by the significant correlation between the subject area being searched the frequency with which a thesaurus is avoided ( $F(3, 43) = 3.51, p < 0.05$ ). The average frequencies for entering search keys without consulting a thesaurus for each subject area are revealing: No medical searcher entered a search key without consulting a thesaurus, but searchers in the social sciences and the humanities did so 13 percent of the time, science and technology searchers 32 percent, and generalist searchers entered search keys without consulting a thesaurus 29 percent of the time.

In addition, although the nature of the environment, across all subject areas, has no significant effect on textwords

ratio ( $F(2, 44) = .69, NS$ ), Analysis of Variance shows that for those who search the scientific literature, the searcher's environment has a significant effect on this variable ( $F(1, 21) = 7.43, p < .05$ ). Science searchers who typically answer requests that address practical problems used textwords 86.84 percent of the time; those who typically search for theoretical requests used textwords 67.28 percent of the time. That is:

**Science searchers who typically answer practical questions are more likely to use textwords than science searchers who usually address theoretical problems.**

It is plausible to explain this finding with the hypothesis that within each subject area, practical questions encourage the use of textwords because they are more likely to include concrete and well-defined terms that are adequate for free-text searching than are theoretical requests. This hypothesis, however, needs to be tested. Further, the failure of this study to find such an association for subject areas other than the sciences may be due to deficient sampling: the samples of searchers within other subject areas were small and therefore possibly not representative enough.

In summary, results reported here show that a profile of the searchers who use textwords more often than other searchers can now be constructed. Such searchers are likely to have these characteristics:

- they will be operationalist searchers
- they will be science searchers
- if, as science searchers, they usually answer practical requests, they will use still more textwords than science searchers who answer theoretical requests;
- they will have developed a habit of entering search keys without consulting a thesaurus.

In addition, searchers who prefer to enter textwords do not enter more search keys than those who prefer descriptors, nor are they more interactive than their counterparts.

The nature of the "free-text" searcher as described here raises the question: Is the preference of textwords an inherent attribute determined by factors such as cognitive style or personality traits? Answering this question is significant for research in online searching behavior.

The results of this study cannot provide a definite answer to this question, but

they do offer some suggestions. On the one hand, the results show that inherent attributes have some effect on habitual preference in the selection of search keys: it was found that operationalist searchers prefer to use textwords. On the other hand, the results also show that the tendency to prefer textwords is encouraged by the realities of searching: by subject area, environment, and the availability and quality of the-sauri.

The conclusion that preference in search-key selection is in part determined by factors external to a searcher's personal traits is supported by another finding. Only 20 percent of the reasons for selecting a search key stemmed from habitual searching behavior (Fidel, 1988). That is, the selection of search keys is usually determined by the specific requirements and constraints of a search; the effect of inherent searching behavior on this selection is less extensive.

But preference in the selection of search keys is characteristic of a person's searching style. It is plausible to assume, therefore, that searching conditions help searchers to crystallize their searching styles. When measuring searching performance, studies of online searching behavior should consider the effect of variables such as the subject specialty and environment of a searcher or the number and quality of databases she habitually searches.

#### CONCLUSION

This study demonstrates that searching is not such an imprecise art as it may seem; it does exhibit lawful behavior. The study uncovered reasons for the selection of search keys, a typology of search modifications guided by the reasons for these modifications, and a few individual characteristics of searchers that are part of a person's

searching style. Moreover, the study points to the manner in which searching style affects searching behavior, and suggests that some characteristics are inherent and others are acquired through professional experience. It is the task of future research to study the factors involved in developing a particular searching style.

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