Online Searching Styles: A Case-Study-Based Model of Searching Behavior

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The model of operationalist and conceptualist searching styles describes searching behavior of experienced online searchers. It is based on the systematic observation of five experienced online searchers doing their regular, job-related searches, and on the analysis of 10 to 13 searches conducted by each of them. Operationalist searchers aim at optimal strategies to achieve precise retrieval; they use a large range of system capabilities in their interaction. They preserve the specific meaning of the request, and the aim of their iterations is an answer set representing the request precisely. Conceptualist searchers analyze a request by seeking to fit it into a faceted structure. They first enter the facet that represents the most important aspect of the request. Their search is then centered on retrieving subsets from this primary set by introducing additional facets. In contrast to the operationalists, they are primarily concerned with recall. During the interaction they preserve the faceted structure, but may change the specific meaning of the request. Although not comprehensive, the model aids in recognizing special and individual characteristics of searching behavior which provide explanations of previous research and guidelines for further investigations into the search process.

Introduction

The study of online bibliographic retrieval is a promising and convenient starting point for the investigation of more general topics in information retrieval. Numerous recent review articles bear witness to the attractiveness of online retrieval as a research area (e.g., [1]–[3]). Investigators have been particularly intrigued by the online search process as performed by experienced as well as novice searchers. Fenichel [1] reviewed the research studies in this subject area and her summary of their results points out that among other questions at issue "... there

is considerable variation in individual approaches to searching ..." and "the online search process is sensitive to many factors other than the obvious...." She concludes that in order to solve most of the problems frequently mentioned we need "to understand what is actually happening at the man–machine interface in online systems."

This article describes a model of *searching styles* that has been developed from a study undertaken to understand "the man–machine interface," by examining the skills employed by experienced intermediaries in the process of heuristic iteration to improve search results.

Study Method

The case study method (as defined by Becker [4] and thoroughly explained by Diesing [5]) was adopted for this study. This method attempts to arrive at comprehensive understanding of an individual case while at the same time, to identify general regularities that are significant beyond the individual case. The selection of the case study method was selected for two major reasons: it can accommodate the study of individual approaches to searching, and it can deal with a large variety of factors that are involved in the online search process.

Five experienced searchers were studied. They were selected from institutions that provide free-of-charge online services in the health sciences, and, by chance, all five were female. They were observed systematically, one after the other, performing their regular, job-related searches. The searchers were asked to verbalize their thought processes during the search process. These verbalizations were recorded and together with the search protocol and any other available documents (e.g., search request forms) they provided the data for analysis.

Based on the data collected during the observation period for each searcher (10 to 13 searches), a description of her searching behavior was written. This description was read by judges who also pointed out issues that should be

validated with the searcher. The searcher was then interviewed to provide information not accessible to observation and to gain additional evidence for the observed searching behavior. The description was consequently modified and submitted to the searcher for a final validation. After the first three searchers were observed and the descriptions of their searching behavior were written, a pattern of searching styles emerged. A first version of the model of online searching styles was then drafted and was general enough to describe the searching behavior of all three searchers. This model was given to the participating searchers for additional validation. After the fourth and fifth searchers were observed, the model was modified to incorporate new information gained. A detailed description of the procedure followed and the analyses performed in the study is given elsewhere [6,7].

Operationalist and Conceptualist Searches

The observed searchers formulated and reformulated search statements using moves that could be assigned to one of two levels: the operational and the conceptual. An *operational move* is defined as a move that uses the system features in order to modify a retrieved set without changing the conceptual meaning it represents. For example, to limit the retrieval to documents published in

TABLE 1. Abridged comparison of operationalist and conceptualist searches.

	OPERATIONALIST SEARCHES	CONCEPTUALIST SEARCHES
The Preparation Stage		
Understanding the Request	Identify the Boolean components	Fit into a faceted structure and identify the primary (most important) facet
Database Selection	Formulate queries for major and minor databases	Formulate queries for a major database and tentative approaches to minor ones
Search Terms Selection	Choose descriptors and free-text terms	Choose descriptors primarily
Concept Representation	Each conceptual component is represented and its meaning preserved; some representations may be suggestive only	The primary facet is better represented than other facets and the meaning of concepts might be changed; all are well-defined
The Search Proper		
The Invariant of the Search	The specific meaning of the request	The faceted structure
Starting Point	The first step is to combine all the query components	The first step is to retrieve the primary facet (representing the most important facet)
Reviewing Displayed Entries	First display a tentative answer set, elements of which are checked for relevance	First display the primary set to check its recall
The Nature of the Interaction	Modify the tentative answer set, primarily using descriptor/free-text trade-offs	Incorporate the remaining facets, using primarily descriptors
Search Termination	When enough items have been retrieved	When recall is satisfactory
Answer Set	Is homogeneous and represents the answer to the request	May be composed of subsets, each representing a different approach to answering the request
Quality Controls and Assessments		
Satisfying the Information Need	Answer the specific request	Supply sets from which users select pertinent items
Attributes in Quality Assessment	Context-related and/or situational attributes	Primarily subject-related attributes
Rules to Assure Quality	Rules related to moves	Rules related to the structure of the search
Type of Access Points	Descriptor and free-text searching complement one another	Strong belief in descriptor searching
System Capabilities	Actively interested in new developments in search systems	Conservative is selecting which search system to use

the last year, to add synonyms and variant spellings, or to designate a descriptor (i.e., a heading or code from a controlled vocabulary used to index entries in the database) as a major one (i.e., taking only the occurrence of a descriptor that indicates that a document is primarily about this subject).

A *conceptual move* modifies a retrieved set by changing the meaning of the concept it represents. For example, to use a broader or a narrower descriptor, to use related descriptors, or to combine a component from an additional facet.

Experienced searchers have a "stock" of moves from which they select the appropriate one when a certain result is desired. They tend to choose their moves consistently at one of the two levels, operational or conceptual. The nature of the moves most typical for a searcher characterizes the style of his searching. Searchers who choose most of their moves at the operational level are here called *operationalists*, and those who interact mainly at the conceptual level are called *conceptualists*. Operationalists may make conceptual moves and conceptualists may make operational ones. But while operationalists interact mainly by using the system features, conceptualists typically modify their retrieval by changing the conceptual representations of retrieved sets.

The following discussion presents paralleled illustrations of the activity performed by operationalist and conceptualist searchers in the framework of a three-stage model of the search process:

> *The preparation stage* includes any ground work performed by searchers before they begin to construct the answer set. At this stage, searchers seek to

understand the requests, translate them into query formulations, decide which databases to search, plan the search strategies, and formulate the initial search statements. The preparation starts before the terminal session but many continue after logging on, as some additional planning may be performed online.

The search proper starts with the first attempt to construct the answer set. Searchers may perform the search proper with almost no preparation, but they also may take steps which are preparatory in nature (e.g., consulting the thesaurus, displaying entries from auxiliary files) during the search proper. The process of building the answer set is heuristic (not programmed), and involves differing amounts of interaction, depending on the individual request and on situational factors.

Quality controls and assessments. During their searching experience, searchers develop certain general (not request-specific) rules to follow in order to assure the quality of results expected, or measures to assess the quality of the retrieval. Searchers will apply these rules to most of the searches, unless users make a strong point that something else is needed. Searchers may modify their rules and/or measures to fit changing environments, but it seems that the nature and characteristics of these rules are part of the searcher's style of searching.

This description emphasizes the typical distinction between the two searching styles (characteristics in common are not listed). Table 1 highlights points of the description.

The Operationalist Search

The Preparation Stage

Understanding the Request. The first step in the preparation stage is an attempt to understand the request by identifying the various conceptual components that should be combined in the query formulation. For operationalist searchers, the degree to which they need to understand the request depends on the specific request and on situational factors. They may tolerate ambiguities and vagueness, and they determine the amount of effort to be put into looking for additional information by the efficiency of the strategy. If the query is relatively vague, they may not invest much time and effort in getting additional information if they think that it could be immediately formulated to retrieve citations related to the topic. When the information is easily obtainable, they try to use it to form as comprehensive an image of the information need as possible.

The Conceptualist Search

The Preparation Stage

Understanding the Request. Conceptualist searchers "understand" requests by analyzing them as a faceted structure, fitting concepts into predetermined basic categories, and they feel that they understand a request when this structure is completed. They consider a certain degree of understanding of the subject to be a necessary condition for their searching, and have a low level of tolerance for ambiguities and vagueness. When submitted requests do not provide the information needed for completing the faceted structure (which is not uncommon), they look for additional sources to consult in order to gain more insight. For most of these searchers there is often a single preferred source of information, but they may refer to additional sources if some information needed to fill in all the essential facets is still missing. During this activity they may encounter elements of information that may not

Database Selection. After identifying the components of the request, operationalist searchers develop the query formulation for each database, if needed. They decide which databases to search, depending on the topic of the request. If the request relates to one subject area, they usually search only one preferred major database, favoring those that provide a comprehensive coverage and are indexed with the aid of a controlled vocabulary. They are familiar with the structure of the vocabulary and the indexing policy of their preferred database, and they search this database even when they know that more comprehensive coverage is furnished by another database (which will be searched later). Searching the most familiar database first provides a better notion of the nature of the request and the manner in which its topic is discussed in the literature.

Search Terms Selection. Operationalist searchers formulate a query by identifying the pertinent descriptors for each component of the request. Looking for the appropriate descriptors and checking their categories and locations in the hierarchical structure is usually performed, not only to find the permitted entry points, but also for a better understanding of the request. They use a thesaurus as the main source for request clarification and frequently as the only one. If they cannot find a descriptor to represent a concept, they search the original term in free-text mode.

Concept Representation. Operationalist searchers consider all conceptual components equally, regardless of how "important" they are for the request. The number of terms, free-text terms or descriptors, to represent each component is determined mainly by the nature of its con-

be necessary for the initial query formulation, but retain these elements and may refer to them later needed.

In understanding the request, conceptualist sear also identify the *primary facet*. The status of this fa determined by the concept and its relation to the par lar request. They refer to that concept as the most sp one, the most meaningful one, the most important or the one "about which all the retrieved docum would have to be." Although the searchers could ne provide a clear definition about the nature of the nor devise a formula for choosing one out of several p ble ones, the notion of a primary facet plays a signifi role in database selection, query formulation, and search proper.

Database Selection. Although conceptualist searc routinely search a number of databases, they almost ways search a major database first. They may system cally follow specific procedures to identify additiona tabases when they suspect that they may encou problems in identifying enough citations from a searc the primary facet in the major database, but the deci to search minor databases depends on the outcome of major database search and databases may be adde dropped during the search proper.

Search Terms Selection. The conceptual analysi the request and the query formulation are largely in enced by the structure of the vocabulary of the major tabase, since conceptualist searchers look for corresp dence between the facets of the request and the struct of the controlled vocabulary. They may look at a thes rus from several different angles, frequently display items from auxiliary files that consist of unit records terms, and often conduct pre-searches. They tend to free-text terms for the initial search formulation or when they are sure that there is no controlled way to press the concept, when the terms are very specific a well-defined, and very little has been written about subject.

Thesauri for minor databases (if available) are co sulted only when necessary for efficient searching (e. code searching). If the only database to be searched minor one, and its thesaurus is not available to the conceptualist searchers may use the thesaurus of the m jor database in order to develop the initial query formul tion.

Concept Representation. In looking for descriptor each facet is considered separately. The concept in th primary facet is always searched first, and it is the on that is most thoroughly treated. The treatment of th secondary facets varies from one request to another. Du

cept and the particular problems in representing it for efficient retrieval. Whether the representation is comprehensive or straightforward, the searcher aims at preserving the meaning of the concept.

Suppose, for example, that a request includes a term that is unfamiliar to the searcher. Suppose, also, that an appropriate descriptor exists in a thesaurus and the term is the name of a disease. Operationalist searchers are likely to consult the thesaurus, find the descriptor, learn that the term is a name of a disease, identify the class to which it belongs, and incorporate it into the initial search formulation with no further investigation before some output is retrieved and reviewed. If the name of the disease has no entry in the thesaurus, they may decide to enter it as a free-text term since it is a distinct name. They expect to learn more about the subject when some relevant articles are displayed, and they may plan to look again for descriptors at that stage. When a request includes a concept such as "skills," which is an abstract concept, and there is no descriptor available, the operationalist searcher may try to find a comprehensive representation for it. For instance, if the user mentioned particular skills as examples, they may try to find comprehensive representations for those (using descriptors, if available, or free-text terms), or they may think about different ways to express the concept "skills."

Regardless of this close correspondence between the request and its formulation, the terms incorporated in the first formulation may be well-defined or vague and suggestive only. Operationalist searchers may enter suggestive terms (which are usually also free-text terms) which they think are not the "right" ones. They integrate these access points into the initial query formulation in order to receive some feedback which may help in improving the formulation.

The Search Proper

The Invariant of the Search. Operationalist searchers approach the search proper with the actual request translated into a Boolean expression. The invariant of the search proper is the *specific meaning* of the request; they may delete or add terms, but the specific meaning of the request is always preserved.

ing query formulation, conceptualist searchers decide whether or not the secondary facets will be incorporated in the query formulation. When they think that some or all of the secondary facets should be integrated, they identify the appropriate descriptors to represent them. Only when one or more of the secondary facets are important would they be treated thoroughly at the preparation stage.

An example may illustrate the nature of the preparation and the presentation of the primary facet. Consider a request about the effect of human exposure to a certain chemical. Conceptualist searchers are likely to consult first a source that can provide them with information about the chemical (e.g., a technical dictionary). They may learn, say, that the chemical is used for grain fumigation (from which they may infer that agricultural workers are most likely to be affected by the exposure to the chemical). The faceted formulation of the request may then be: the effect of human exposure to the chemical on agricultural workers. They may also have learned that the chemical includes elements which may cause eye irritation but may decide not to incorporate this fact in the initial query formulation. Suppose the searchers decide that the primary facet is the phenomenon facet, i.e., the concept "human exposure," and suppose further that there is a specific descriptor in the thesaurus. Conceptualist searchers may decide to use the specific descriptor in the initial search formulation, but may look for broader or related descriptors (e.g., "environmental exposure," "occupational diseases") to be used later, if needed. If the concept in the phenomenon facet has no entry in the thesaurus, they may use the information provided by the consulted sources to identify a broader concept which is represented by a descriptor. They may also display the entry for the descriptor in the auxiliary files, read the definitions, indexing history and policy, and the synonyms. If they feel that they need to know more about the way articles dealing with human exposure are indexed, they may conduct a pre-search, entering, say, the descriptor for the broader term combined with the descriptor for the sites affected by the chemical and review the indexing of retrieved citations.

Terms in the first search formulation have the same status. Conceptualist searchers usually start the search proper using well-defined terms; they rarely attempt to construct the answer set using terms that are not clear to them and/or which are not defined in the system's vocabulary.

The Search Proper

The Invariant of the Search. Conceptualist searchers approach the search proper with a faceted query formulation. In order to complete this structure, they may decide to express certain elements explicitly that are only implicit in the request. In approaching the search proper, they may prepare some alternative presentations of the various facets and, if needed, they may change the mean-

Starting Point. More often than not, the search proper starts at the beginning of the terminal session. The first phase is to combine all the elements of the query formulation and to display some articles. Operationalist searchers may achieve this end by introducing the various elements gradually or by incorporating all the components of the request in the first search statement. Unless they suspect that incorporating all the components may result in very little, or zero, retrieval, they do not display citations before all the various components are represented in the retrieved set.

Establishing a tentative answer set is the starting point for the interaction. Most often the first set which operationalist searchers display is a set which fully represents the request. If the number of postings seems too high, they may try to reduce it before displaying the citations. To achieve this end they apply an ordered sequence of moves (e.g., first, limit descriptors to be major ones; second, eliminate foreign language documents; third, limit to documents published in the last year). The set should be of a certain size to facilitate easier interaction, although they may consider the possibility of printing the eliminated portions later on.

Reviewing Displayed Entries. At this point, the operationalist searchers display the tentative answer set and review the entries for the citations. They are primarily concerned with the relevance of the retrieved documents to the request and in the quality of the retrieved set as an answer set. If the first formulation includes only descriptors, and/or the free-text terms are specific and well-defined, and if the output is of a reasonable size, and the searchers understand the titles and think that most of the articles are relevant, they may end the search at this point. In most searches, however, further interaction is performed.

The Nature of the Interaction. The nature of the interaction depends on the specific problems introduced by the request. In order to overcome these difficulties, operationalist searchers may display titles, sources, and descriptors of retrieved articles, as well as abstracts (if the previous elements could not serve as useful clues), or consult a thesaurus, in order to gain a better understanding of the subject and the terminology used.

Operationalist searchers are familiar with the trade-off between descriptor and free-text searching and this understanding plays a major role in their interaction. Whenever they use a free-text term in the query formulation they display the descriptors assigned to relevant articles. They examine the descriptors to find out whether they can incorporate them as additional terms in the query formulation in order to increase recall (if needed) or to improve the retrieved set. The list of descriptors assigned to a certain article may also help them assess the relevance of the citation; or it may suggest "better" descriptors to replace descriptors in the query formulation,

ing of the elements within a facet, but the invariant of the search is the *faceted structure*.

Starting Point. The search proper rarely starts at the beginning of the first terminal session, which is almost always exploratory; the search proper may sometimes be deferred to a later session. The first step in the search at the terminal is to retrieve the *primary set*, which is constructed by entering the expression for the most important facet; secondary facets are never explicitly involved in this move. The primary set serves as the center of the search; it forms the "universe" from which the answer set will be selected.

Reviewing Displayed Entries. When conceptualist searchers display items from the primary set at this point, they are not concerned with their relevance to the specific request. Rather they refer to them as a main source of information to employ in their attempts to improve recall. They may first display some entries, identify relevant documents, and display their descriptors and/or abstracts. Or, they may decide to display titles and descriptors (and sometimes even abstracts) of randomly selected citations. During this process, they may conceptually modify the primary set.

The Nature of the Interaction. When conceptualist searchers feel that the primary set is well established, they start to select subsets from it to form the answer set. At this point they have gained information about the specific problems of the search, and the selection process is largely determined by the specific characteristics of individual requests. In the selection process they are performing a series of trials to introduce the other facets using various approaches. Sometimes they have a notion of which approach will be most promising and chose it first; at other times they choose randomly. In their decisions about the next move they use the retrieved articles as their main source of information. They may neglect approaches that have been planned but have not yet been tried, or they may try new approaches that are suggested by the retrieval. Depending on the specific request, they may try to introduce all the remaining facets, part of them, or they may try to modify the primary set without introducing explicitly any of the remaining facets.

The example of a request for the effect of human expo-

even when they are not actively looking for better descriptors. When they do not know the meaning of a free-text term, the displayed descriptors serve as the main clue. When they use free-text terms to search databases for which a thesaurus is not available (or when the available thesaurus is unfamiliar to them), they frequently display and compare the descriptors assigned to relevant citations in an attempt to identify the descriptors that are assigned to most of the displayed citations. They regard a descriptor assigned to several relevant citations to be a "good" descriptor to use.

An example may further illustrate the nature of such interactions. Consider a request for material about voice synthesizers for the blind that is searched in a database whose thesaurus is not available to the searchers. They may enter the first search formulation representing the two concepts ("voice synthesizers" and "blind") using free-text terms. Suppose also that this combination retrieves only a few documents. The searchers may display first the few articles that were retrieved. Browsing through the titles, they identify the apparently relevant citations and then may display the descriptors of these citations. Examining these elements they may find that "synthesized speech" is a descriptor that was assigned to relevant citations. They may also identify more synonyms to represent the concept "blind." Their next step may be to combine the newly discovered descriptor with the enriched set representing the concept "blind." In displaying records of relevant citations, they may not be able to decide whether some articles are relevant, and may therefore display their abstracts. Reading the abstracts they may discover the name of a commercially available voice synthesizer. This name would be added to the first conceptual component to achieve a more comprehensive representation.

sure to a certain chemical may further illustrate the nature of such interactions. In establishing the primary set, conceptualist searchers may first enter the descriptor for human exposure. Examining displayed citations they may find that the use of this descriptor in indexing is rather limited, and may decide to add to the initially retrieved set the sets retrieved by the descriptors for the concepts "environmental exposure," and "occupational diseases." If they still think that documents dealing with specific types of exposure are being missed, they may consider adding terms for the concept "fumigation exposure." Once they believe that the primary set is well established, they begin to incorporate the remaining facets. They may try to introduce first the set for the chemical. Reviewing various elements of retrieved citations, they may identify synonyms for the chemical that might be added. If the newly created set is of a reasonable size, they may attempt to introduce the system facet, i.e., the concept "agricultural workers." Scanning descriptors assigned to retrieved citations, they may identify additional descriptors that could be added to represent the system facet (e.g., specific types of workers). Even if the set representing the three facets of the request is of a reasonable size, the searchers may try to retrieve additional documents. They may construct a trial set to be retrieved by the combination of the primary set with the sets representing agricultural workers and the site affected. Browsing through the output, they may conclude whether this trial results in documents that might be relevant to the information need and whether the set could be modified. If the searchers think that the first combination (i.e., the primary set and the chemical) results in too small a set to be further narrowed, they may consider this set to be part of the answer set.

When conceptualist searchers approach databases that provide no controlled vocabulary as a searching tool, their search follows the previous pattern. The faceted structure that they have crystallized during the search in the major database is carried over to the new search, and most often they follow the previous strategy. They search descriptors as free-text terms, and frequently display titles to suggest more synonyms and related terms to be incorporated in the sets representing the various facets. They may try, however, to introduce more specific terms in cases where an adequate descriptor was not found. For such requests, the minor database is also the more appropriate one to search, and they usually perform the search on the major database only to get familiar with the literature.

Search Termination. Operationalist searchers decide to end the search when they believe (1) they have an overview of what has been published about the subject; (2) that enough items have been retrieved; and/or (3) when they feel that more interaction would not change the quality of the retrieved set significantly. They submit an *answer set* to the users which represents a single entity: the answer to the request. This set may have different

Search Termination. Conceptualist searchers decide to end the search when they feel that recall is satisfactory, or when they think that additional efforts to increase it are not worthwhile. They collect the subsets resulting from the various trials to form the *answer set*. Thus, answer sets may include numerous approaches; they may submit to users sets which are composed of subsets and each subset may represent a different aspect of the re-

parts (e.g., because two databases were searched, or because part of it was printed online and another offline), but all of its relevant elements are supposed to provide the specific information needed.

Quality Controls and Assessments

Satisfying the Information Need. Operationalist searchers believe that they supply users with entry points to the literature. They are trying to answer specific questions, and the users may use the retrieved set for further investigation if needed. They feel that they can never claim to have retrieved everything that is relevant to the request and available in the database.

Attributes of Quality Assessments. When assessing expected results, or when evaluating retrieved sets, operationalist searchers refer to a large variety of attributes, including context-related as well as situational ones. An operationalist searcher may, for example, decide not to search a certain database because it covers journals that are not easily available to the user; or they may conclude that certain articles are highly relevant because they deal with the subject and they are published in a well-respected journal.

The Nature of the Rules to Assure Quality. Searchers have sets of rules that they try to follow, unless "they do not work." An operationalist searcher may, for example, follow a rule stating that when more than two concepts are to be combined, the set for each of the concepts should be enlarged. Or, one should not use word proximity operators when searching only the title field. Generally speaking, they claim that it makes no difference which concept is entered first.

Types of Access Points as Quality Measure. Most searchers (operationalists as well as conceptualists) feel comfortable searching descriptors. Operationalist searchers believe that quality is maintained by treating controlled vocabulary and free-text searches as complementary procedures. They believe that searching with free-text terms may compensate for lack of specificity in some descriptors, or overcome problems caused by indexing when it is not sufficiently exhaustive or reliable. They like to think of synonyms, and make sure that they cover all the possible variant spellings.

System Capabilities for Efficient Retrieval. Operationalist searchers are actively interested in new developments in search systems and in the advances that these new features provide for more efficient searching. They are keenly aware of newly available capabilities and integrate them into their searching. They use a large variety

quest. In the example illustrated above, the answer set may consist of three subsets: the first one would include documents dealing with the effect of the exposure to the chemical on agricultural workers; the second one would include documents about exposure to the chemical (not included in the previous one); and the third subset may include additional documents relating to environmental exposure of agricultural workers.

Quality Controls and Assessments

Satisfying the Information Need. Conceptualist searchers believe that they supply users with sets from which users are supposed to pick the relevant documents, they provide the users with "what is out there in the literature" that is pertinent to their need. Unlike operationalist searchers, they believe that they are able to retrieve almost everything that is available in the searched database that is relevant to the request.

Attributes of Quality Assessments. When assessing expected results, or when evaluating retrieved sets, conceptualist searchers refer primarily to subject-related attributes. When a clinician submits a request, for instance, conceptualist searchers may decide not to search a certain database because it is not clinically oriented; they may conclude that certain articles are not relevant because, although they deal with the topic, they treat the subject from a specific point of view in which the user is not interested; or they may decide to search a specific database because a particular method is an important aspect of the request, and the database consistently assigns index terms for the method used.

The Nature of the Rules to Assure Quality. The rules which conceptualist searchers follow in order to assure quality usually refer to the structure of the search. For example, they may routinely choose the agent facet to be the primary facet if it is of a certain nature (e.g., if it includes names of chemicals). Or, when the database is expensive and has no controlled vocabulary, they always enter it with the least posted facet first.

Type of Access Points as Quality Measure. Conceptualist searchers are devoted advocates of controlled searching. Although they maintain that the structure of certain vocabularies may not be adequate for some requests, they always prefer to search a database that provides a controlled vocabulary. They think that searching this way is more professional and likely to give better results. The human intervention in the indexing process, they maintain, provides a better analysis, since indexers can assign descriptors to represent aspects that cannot be captured by free-text searching.

System Capabilities for Efficient Retrieval. Conceptualist searchers are quite conservative in choosing the search system to be used. Even if they can approach a large number of systems, they prefer to keep the number of systems they actually use to the necessary minimum, and they usually search a certain database on one system

of commands and system features in their searching and may search a certain database on more than one system. They prefer the system which provides the greatest manipulative power, the most efficient searching, the greatest capabilities, the best differentiation between the various elements of the unit record, and the easiest access to these elements. Although they generally prefer to search on a specific system, they realize the advantages and disadvantages of each system. They may search on another system if, for a specific search, it seems to them to be more suitable.

only. They do not actively follow new developments in the technological aspects of online searching. While they are familiar with a large range of system features and commands, and may occasionally use a special feature, their searches are mostly limited in the variety of commands used. They prefer to use the system that corresponds most closely to their way of approaching a search and will search this system whenever possible.

Limitations and Implications of the Model

Some of the attributes of this model of online searching styles are not common among models used in information science; it is a specific kind of typology and its explanatory power is of a certain type. It is beyond the scope of this article to discuss these attributes but some limitations of the model should be mentioned.

First, the boundaries of the subject matter should be explicitly defined. The model describes styles in which searches are performed; it concentrates on the search process, not on the people who are performing the search. Although the model describes conceptualist and operationalist searchers, it does not refer to their personalities or cognitive processes (e.g., problem solving, information processing); it focuses on their searching behavior. In other words, the model describes searches rather than people. Searches are performed by people, and they are performed in a particular style because they are peformed by certain persons, but it is the manifestation of the integrated approach of a person to the search process that is delineated and not the person himself.

Second, at this point the model is not "comprehensive" in any sense. Indeed, it is limited in many respects (and some are quite obvious). For instance, the observed searchers were selected from settings of a particular type and they were searching in a specific scientific area. The model may, therefore, not describe searching behavior in other types of settings or in different scientific areas. Moreover, generalizations from observing only five searchers are questionable and the model does not necessarily describe searching behavior of all searchers of the same kind. Another example is the limited number of factors that were taken into account in the model, which may overlook other factors that influence searching style and the flow of each particular search.

At this point, the significance of the model lies in its ability to facilitate a rapid and correct classification of a case. Using the definitions of operationalist and conceptualist searchers, an observer can determine whether a certain searching behavior belongs to one of these styles, or whether it does not fit into the pattern. This model, therefore, provides a solid starting point and proposes explicit guidelines for further observation and study of online searching behavior. Future explorations, in turn, would expand the model and eliminate some of the limitations; examining more searchers would account for more factors, and would describe a larger diversity of searching environments and behaviors. In spite of its limitations, the model, even at this preliminary stage, suggests explanations for previous studies and new approaches to various areas of investigation. Some examples are discussed below.

Explaining Previous Research

Several prior studies have tried to find relationships between search variables and the search process or between those and search results. By operationally defining factors like connect time or number of descriptors used and measuring them, these studies have revealed that there is a large individual variability in performing a search. Search protocols and other data collected in such studies may now profitably be reanalyzed in order to suggest that some puzzling or disappointing findings can be explained by the model. The following discussion of two such studies is based only on the published reports, not on the actual data.

Oldroyd and Citroen [8] systematically analyzed search protocols to construct a model of the dynamics of search processes. Two requests were delegated to 20 experienced searchers from eight European countries who were familiar with the European Space Agency ESANET system. One request was specific, with few references found, and the other was general with a great many references. The searchers worked in various types of settings, and were not instructed how to carry out the search. To the investigators' surprise, the examined behavior did not differ significantly when searching the two requests. Instead, they found that most search formulations conformed to one of two models, regardless of the request searched.

These models are quite limited in their scope, but features can be mapped to the online searching style model.

The features of Model A are typical of a conceptualist search: only the concepts that are most relevant to the request are selected for the initial search statements; they are then grouped together; the remaining concepts are introduced one after the other and results are analyzed before the next concept is integrated into the search; the search may be terminated before all the concepts of a request were entered; recall oriented moves rely on broader descriptors; and precision oriented moves usually result in integration of additional concepts. The features of Model B are typical of an operationalist search: a large number of possibly relevant concepts are combined for the initial search statements; recall oriented moves involve requiring less restrictive combinations; precision oriented moves employ deletion of synonyms.

Realizing that these models represent different searching behaviors, the data could now be analyzed (e.g., concepts selected, logical combinations) in the light of the operationalist/conceptualist model to provide more meaningful results. For instance, once the variable of style has been accounted for, the kind of concepts selected by searchers of each style could be analyzed by request. Such analysis may help in finding the differences in searching the two requests.

Another experiment was performed by Fenichel [9] and is the first attempt to compile a comprehensive and systematic list of measurable variables that reflect the search process. The research sought to identify the differences among searches performed by searchers who had varying amounts of experience in online searching and in searching a particular database. Seventy-two searchers were selected to form five groups according to their degree of overall and ERIC database experience. They searched pre-elected requests. The search protocols were analyzed to compare various search variables, the amount of "search effort," and the quality of search results among the different groups. No significant differences among the groups was found. The study suggests, however, a possible relationship between search effort and recall.

Most of the analyses and interpretations provided in this data-rich study could be explained in a new way in the light of the model of online searching styles. Search variables that require some interpretation of the search flow, for instance, would consistently give lower or higher scores depending on searching styles. For example, the variable "Search modification" was defined to measure whether search results were modified after the initial answer set was retrieved. Fenichel explains that in her experiment the point when an initial answer set was retrieved was recorded after the searcher had combined all the concepts that made up the topic of the request. Such a definition, however, applies meaningfully only to operationalist searches. Conceptualist searchers usually combine only part of the request elements first. They may modify the search (and the strategy) before all the elements are combined. Using this definition of "Search modification" in analyzing search protocols of concep-

tualist searches may lead investigators to the conclusion that the searches are rarely modified, which is not necessarily the case.

One of the study results that may seem rather alarming to educators and online searching practitioners is Fenichel's finding that searches performed by experienced searchers were strikingly simple. She considered a simple search to be one in which no advanced techniques were used and no modification of the initial strategy was detected. Bearing in mind the model of online searching styles, one can easily see that almost every conceptualist search would be considered a simple one by these measures. This is not to suggest that every simple search is a conceptualist one, but rather to point out that some searches considered by Fenichel to be simple might have involved complex conceptual analyses and more iterations and modifications than she detected. The general conclusion that a considerable number of experienced searchers perform "simple" searches is thus still premature.

Guiding Future Research

Fenichel's study was stimulated by a frequently expressed question at issue: what are the special skills in online searching that are acquired with experience (e.g., [10], [11]? We still do not know what these skills are and how they affect (or are manifested in) searching behavior. The model of online searching styles suggests some attributes that are acquired with experience and seem to be important for describing the search process. These attributes can now be tested to find out whether they are associated with online searching skills.

There are probably many factors which determine searchers' styles and some may be independent of searching experience. However, even if selection of a searching style is completely independent of experience, the actual employment of a style can be acquired only over time. Each style is characterized by a stock of moves that searchers develop with experience.

The selection of preferred databases according to which searchers formulate queries and with which they start the search proper, the manner in which searchers form an image of the information need, or their notions of what aspects of the information need they are attempting to satisfy, are all attributes which are acquired with experience. These as well as other attributes were not tested in the past, but seem promising for future investigations of online searching skills. One of the manifestations of having a complete and particular image of the information need, for instance, is the willingness of experienced searchers to follow leads that are not mentioned in the request but are suggested by the retrieved citations. By comparing the degree to which novice searchers feel comfortable in following such leads with the behavior of experienced searchers when such leads are apparent, we may discover another aspect of skills in online searching.

Exploration to discover online searching skills is part

of a larger attempt to find out which factors affect the search process and in what way. Many factors have been proposed as influencing the search process and some are considered to be more significant than others. Most of the "important" factors have not been tested (e.g., subject knowledge, formal education in information science). The few factors that have been tested are: cost (e.g., [12]), experience (e.g., [9], [13]), type of request (e.g., [8], [13]), and types of training (e.g., [13]). Except for the cost factor, researchers could not prove the influence of the other factors on the search process or outcome. It is too soon to conclude that the amount of experience, the type of the request, and the type of training do not effect searching behavior. More research is needed before such conclusions are established. The idea that online searchers employ personal styles in searching, and the fact that features of these styles can be identified and described, can provide guidance for online research.

Acknowledgment

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