A STUDY OF SEARCH INTERMEDIARY WORKING NOTES: IMPLICATIONS FOR IR SYSTEM DESIGN

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ABSTRACT

This paper reports findings from an exploratory study investigating working notes created during encoding and external storage (EES) processes, by human search intermediates using a Boolean information retrieval (JR) system. EES processes have been an important area of research in educational contexts where students create and use notes to facilitate learning. In the context of interactive IR, encoding can be conceptualized as the process of *creating* working notes to help in the understanding and translating a user's information problem into a search strategy suitable for use with an IR system. External storage is the process of *using* working notes *to* facilitate interaction with IR systems. Analysis of 221 sets of working notes created by human search intermediaries revealed extensive use of EES processes and the creation of working notes of textual, numerical and graphical entities. Nearly 70% of recorded working notes were textual/numerical entities, nearly 30% were graphical entities and 0.73% were indiscernible. Segmentation devices were also used in 48% of the working notes. The creation of working notes during EES processes was a fundamental element within the mediated, interactive IR process. Implications for the design of IR interfaces to support users' EES processes and further research is discussed.

INTRODUCTION

This paper reports findings from a study investigating the nature of encoding and external storage EES processes by human search intermediaries during mediated, interactive information retrieval IR An artifact of the EES process during interactive IR is the creation and use of working notes by IR system users. 'Working notes' refers to the user process of recording written notes on paper related to their information problem, query formulation or reformulation, or other aspects of an IR system interaction, e.g. search terms and strategies, diagrams and database items retrieved. In the context of interactive IR encoding is the process of *creating* working notes to help during the understanding and translating of a user's information problem into a search strategy to retrieve relevant items from an IR system. External storage is the process of then *using* working notes during an interaction with an IR system.

Research based around a user-centered and interactive view of IR seeking to explore issues related to human information-seeking, searching and use is currently represented in various interactive IR models such as Ingwersen's cognitive model of IR interaction (Fig. l) (Ingwersen, 1996). Ingwersen's model concentrates on illuminating cognitive processes during interactive IR The strength of Ingwersen's model is the inclusion of many highly complex and dynamic interactions as sets of cognitive processes. Users are seen as interacting with 'texts' or information objects as cognitive structures within an information space. A user's situational and cognitive contexts form a strong element within the model. A major weakness of Ingwersen's model is the lack of explicit reference to user EES processes and their role in the IR interaction process. Interactive models of the IR process have paid little attention to EES processes.

However, within research focused on improving the effectiveness of interactive IR the IR process can be considered within a broad framework to include three phases (Fig. 2). The first phase is the pre-interaction preparation by the user. Secondly, the user-IA interaction, and finally the user post-interaction evaluation and use of the search results. Thus, the iterative IR process involves more

than just the direct interaction between a user and an IR system. In particular, during the pre-interaction stage, formulation and interactive reformulation of search queries are important and often difficult tasks for IR system users (Greene *et al.,* 1990). It can be hypothesized that EES processes may occur during any one or all three phases of the interactive IR process.

Within this framework, EES processes are emerging within the interactive view of IR as an important and unexplored element during user - lR interaction. Due to the increasing use of computers in educational and work environments, the nature and role of EES processes and the artifact of working notes is already an important area within educational psychology and increasingly within human-computer interaction (HCI). However, little is known about the nature and role of users' EES processes and working notes in interactive IR This paper is an initial exploration into the nature and role of EES processes within a specific context related to human interaction with IR systems. A greater understanding of the EES processes used by IR system users is needed to enhance understanding of this important interactive process to extend IR interaction models and assist the creation of more effective IR systems and interfaces to support users' EES processes.

The next section of this paper discusses the growing interest in EES processes and working notes in educational psychology and HCI.

RELATED RESEARCH

EES Processes in Classrooms

EES processes and working notes are important notions in educational psychology. The field of educational psychology has been exploring EES processes and the role of working notes recorded by students in the learning process. Extensive studies by educational psychologists show that students in classrooms synthesize, summarize or abbreviate lecturers' comments into notes for later use and make notes when reading an article or book (Kiewra, 1985; (Kiewra, *et al.,* 1991; Benton *et al.,* 1993). Two functions of student note-taking in classroom contexts have been identified as EES Within educational

psychology, encoding is regarded as the process of recording notes to help learning, and external storage is regarded as the process of reviewing written notes to facilitate performance in educational testing.

Note-taking techniques were classified as either conventional, linear or a matrix. Habner (1989) found that student note-taking by computer was generally slower than by hand and resulted in better note-taking. Monty (1990) explored the cognitive issues in the representation of ideas and identified the use of notes as an important task when using a Xerox NoteCards hypertext system. Research exploring the nature and role of working notes has recently been extended from the classroom to HCI research.

EES Processes During HCI

EES processes and working notes are emerging as an important research area in HCI. Interface designers noted that, during work activities and meetings, workers often use pen and paper to store information externally. However, HCI researchers have preferred to focus on the design and testing of interfaces facilitating working-note creation and use during computer related tasks. Little HCI research has explicitly discussed or examined the nature and role of the users' EES processes during HCI.

Electronic whiteboards have been developed and tested as electronic equivalents of office whiteboards or corkboards to support users' working-note creation, use and sharing during computer-mediated communication. Many studies have shown the utility of electronic whiteboards to informal group communication and collaboration, remote group collaboration and computer-mediated communication during computer-supported co-operative work (CSCW) (Donahue & Widom, 1986; Tang & Minneman, 1991; Brinck & Gomez, 1992; Gajewska *et al.,* 1994; Nakajima *et al,* 1994; Pedersen *et al.,* 1993). Multimedia interfaces including electronic whiteboards have also been shown to have utility during real-time video logging to enable note taking in real time (Weber & Poon, 1994).

EES Processes During IR

IR is an area of growing importance within HCI. Recent research findings by Spink (1994, 1995) suggest that note-taking with pen and paper by search intermediaries before and during IR interactions could be a fundamental IR process worthy of further investigation. Spink observed 40 mediated online searches involving a human search intermediary and user with an information problem interacting with an IR system. She found that search intermediaries made working notes on paper during the pre-online interview with the user that was also used and added to during the online interaction.

Some user-oriented papers have discussed the importance of written search-request forms detailing an information requester's problem to the work of librarians and search intermediaries (Lancaster, 1968, 1971; Atherton & Christian, 1977; Daniels, 1978; Hoover 1979; Maloney, 1983; Fenichel & Hogon, 1984; German *et al,* 1987). Papers have also discussed the nature of questions asked on search-request forms (Kolner, 1981; Allen, 1989; Hunter, 1985). However, little human-oriented IR research has explicitly investigated EES processes and working notes to understand the nature and role of this user process or examine the implications of working notes for IR system and interface design.

Studies have also focused on improving the design and usability of different IR interfaces (Efthimiadis, 1990; Shaw, 1991; Vickery & Vickery, 1993), including graphical or visual interfaces, to support Boolean query formulation and reformulation (Spoerri, 1993; Young & Schneiderman, 1993; Hemmje *et al,* 1994; Dubin, 1995; Willie & Bruza, 1995). Studies have shown that IR tasks, including query formulation and reformulation, are often difficult for many IR system users (Greene *et al,* 1990). Many studies continue to investigate various 'user' aspects of IR process, including user modeling and cognitive aspects, without explicit reference to EES processes (Burt & Kinnucan, 1990; Saracevic *et al,* 1990; Allen, 1991). However, research into the human or cognitive aspects of IR is still in its infancy (Saracevic *et al,* 1991). However, limited focus has been applied to exploring EES processes or working notes within IR research.

The aim of this paper is to explore user processes further in the IR context. EES processes, and the accompanying artifacts of working notes, are understood differently in interactive IR than within

educational psychology. Figure 3 illustrates the different conceptualizations. Within educational psychology, students' notes and EES processes are linked to learning and reviewing processes to help performance in educational testing. The emphasis is on the quality of the notes taken by students and how the recording and use of notes relate to their educational performance. In interactive IR, EES processes and working notes are linked to the process of understanding a user's information problem and translating (often with use of pen and paper) that information problem into an acceptable query for an IR system.

The study reported in this paper is an initial study investigating the nature of working notes by search intermediaries within the context of mediated, interactive IR. A large number of working notes created by human search intermediaries using IR systems were analyzed and categorized. The implications of the study for the design of IR interfaces to support IR functions, such as query formulation and reformulation, and further research is discussed.

RESEARCH QUESTIONS

This study addressed the following research questions.

(1) Do professional search intermediaries record working notes?

(2) What types of working notes are recorded by search intermediaries?

The study collected straightforward data on the nature of working notes (as artifacts of EES processes), created by search intermediaries. This is the first step in research examining the nature and role of users' EES processes and working notes created during interactive IR and their relationship to interaction performance and effectiveness.

RESEARCH DESIGN

Data Collection

This study included a micro-analysis of 221 online search worksheets containing working notes recorded by four librarians acting as search intermediaries, from the University of North Texas (UNT) Libraries, during the period 1991-1994. The worksheets were collected for this study well after the searches had been performed. Each worksheet of working notes was created by one of the four human search intermediaries, working with an academic search requester— either present or absent during an online search of the DIALOG IR system. The search intermediary wrote the name of the search requester, search topic, search time and cost on the worksheet. Each worksheet was initialed by the search intermediary conducting the online search, allowing the analysis of individual differences in the working notes recorded by different search intermediaries.

The data analyzed in this study, due to confidentiality concerns, did not include the name or academic status of the search requester (blacked out on every worksheet) or the online search log. Working notes created by search intermediaries with or without the presence of a search requester could not be clearly distinguished. Therefore, how the presence or absence of the search requester affected the nature of working notes recorded by search intermediaries is an area for further research.

Worksheets

The 8.5 x 11 inch worksheets completed by the search intermediaries were of two designs. The first design was used by the UNT search intermediaries until September 1992, when the new worksheet design was introduced. It is important to note that search intermediaries were not *required* as part of their online search procedures to write anything about the search topic or strategy or any form of working notes on these worksheets. The UNT Library's purpose for the worksheet was to track client accounting information. Any other working notes were made voluntarily by the search intermediaries.

A total of 99 (44.8%) worksheets were of the first design, including a work space window measuring 5.5 x 4 inches on the front of the sheet. Seventy-three of these worksheets contained working notes only within the work space window. Twenty-two contained working notes on the back of the sheet

and within the work space window and four contained working notes only on the back of the worksheet page. The second group of 122 worksheets (55.2%) contained no worksheet window. Search intermediaries recorded any working notes on the back of the worksheet. During the worksheet analysis, both the front and back page working notes, including attached pages of working notes, were counted as one worksheet.

Content Analysis

The coding scheme for this study was developed through iterative analysis of the worksheets. Each worksheet was systematically analyzed to identify features and patterns of unique, independent or separate marks called 'worksheet entices'—the unit of analysis for the study. Worksheet entities were divided into broad classes based on distinguishing attributes separating each entity from other surrounding entities, i.e., whether the entity was textual, numerical or graphical.

Each class of worksheet entity was further divided into categories that were mutually exclusive and exhaustive. Individual entities were not coded into more than one category, i.e. words in a list were not also counted as single words and numbers in a list were not also counted as dates, dollar amounts or any other entity category. Where dollar amounts were present with a dollar sign, the dollar sign entity and the numeric entity were counted separately. To test the validity and reliability of the coding categories, a random sample of 22 (10%) worksheets were also recoded by a graduate student, and the recoding was determined to be 100% consistent with the researchers' coding.

RESULTS

Classes and Categories of Worksheet Entities

A total of 4641 worksheet entities was identified on the 221 worksheets (a mean of 21 entities per worksheet, a range of 0-85 and a standard deviation of 0.7). Worksheet entities were divided into three different classes: textual/numerical, graphical or indiscernible. This broad classification allowed a

distinction between worksheet entities representing keyboard inputs recognized by existing IR systems, i.e. text and numbers (textual/numerical) entities as search terms and statements and entities not recognized by existing IR systems (graphics). To allow a finer analysis, each class of work space entity was further divided into categories: 17 categories of textual/numerical work space entities, 14 categories of graphical work space entities and one miscellaneous category were identified.

Figure 4 provides examples of working notes recorded by each of the four search intermediaries. Table I de number of percentage of worksheet entities within the three different classes. Table 2 shows the number and perce worksheets containing each class of entity.

Textual/Numerical Worksheet Entities

The analysis identified 3218 (69.34% of total entities) textual/numerical entities, with a mean of 14.56 textual/numerical entities per worksheet. Any mark on a worksheet consisting of letters or words, numbers of both letters and numbers, including single words, abbreviations, acronyms, word strings, dates and search commands, was classified as a textual/numerical entity. All 221 worksheets contained textual/numerical entities. These entities appeared as text only, numbers only or combination of text and numbers. For example, search commands may have contained a single letter (text) paired with a single number (numerical). Such an entire search command was classed as a textual/numerical entity and was coded as a 'search command'.

Categories of Textual/Numerical Worksheet Entitie.

Table 3 shows the number and percentage of worksheet entities within each textual/numerical category and the number and percentage of worksheets containing each category of entities. Each category of textual/numerical worksheet entity is listed and described below in the order appearing in Table 3.

· *Search commands*—an entity defining sets, e.g. (s6) or with the display and printing of sets (T s6/3/1,3,9), including entities that limit or specify authors, title, publication name, year, expansion of terms and truncation.

· *Single words*—discrete multi-letter unit, including acronyms and abbreviations.

· *Numbers*—Numerical entity not in a list, not dates, not part of a search command, or database file, including dollar amounts.

· *Multi-word string*—discrete multi-letter (word) string without subject and verb with no limitation on length of string, i.e. airplane parts

Isolated Boolean operator—a Boolean operator (and, or, not) occurring outside of a word Boolean-word occurrence that may occur in conjunction with a single word-unit entity, or as a discrete unit.

**Database files*—entity that addresses any aspect of database selection, description, or listing, e.g. ABI, MLA.

* *Dates*—any numeric entity specifying a date or range of dates, e.g. 1991-1993, 1930s, *94.*

* *Word-proximity operator-word*—discrete word-unit entity separated by a proximity command such as empty parentheses () or numeric proximity such as (W3) or w/3.

* *Word-Boolean operator-word* - discrete word-unit entity separated by a Boolean operator: and, not, or.

* *Sentence*—entity that constitutes a multi-word string consisting of a subject and verb, i.e. 'He wants abstracts only'.

**Search statements*—a complex entity string utilizing combinations of Boolean operators, search commands, proximity connectors or truncation, e.g. (car or auto?) and (driv? not drunk)

**Numeric list*—any ordering, vertical or horizontal, of more than two numbers, with or without text (numbers do not have to be sequential).

**Letters*—individual, isolated letters.

**Language*—entity that describes or restricts language, e.g. English, French.

**Words in list*—any vertical, uninterrupted ordering of more than two single words, with or without numbering.

**Time*—any numeric specification of time, e.g. 1:30.

**Isolated proximity*—a proximity command occurring outside a word-proximity-word occurrence that may occur in conjunction with a single word-unit entity or as a discrete unit, i.e. w/25 (w25) car.

The most frequently occurring categories of worksheet entities were textual/numerical entities, including search commands, single words, numbers and multi-word strings. The frequent use of textual/numerical entities was not unexpected, as they form the basis of Boolean query formulation/reformulation representing items typically input to an IR system query line. Single word entities were present in 77% of the worksheets and accounted for only 21% of the total entities used. Search commands appeared on 65% of the worksheets and accounted for the greatest number of textual/numerical entities used (27%). Some textual/numerical worksheet entities, though used consistently by all intermediaries, did not exhibit a high frequency of use per search. For example, multi-word strings appear in 67% of the worksheets and accounted for only 12% of the total worksheet entities.

The textual/numerical category of entity labeled 'sentence' occurred in 21% of the worksheets but did not represent potential query line input. Often the recording of complete sentences by search intermediaries represented notes made about the client or about the account, e.g. 'this client hates citations,' or 'this account gets a credit from last week'.

Graphical Worksheet Entities

The analysis identified 1389 (29.93% of total entities) graphical worksheet entities on 72 (33%) of worksheets, with a mean of 6.28 per worksheet. Graphical worksheet entities were not textual or numerical but included lines drawn down the length of the paper, and also circles, squares, arrows and Venn diagrams.

Categories of graphical worksheet entities. Table 4 shows the number and percentage of worksheet entities within graphical categories and the number and percentage of worksheets containing each category of graphical entity. Each category of graphical worksheet entity is listed and described below in the order appearing in Table 4.

· *Scratch through*—any entity that partly or completely obscures another entity unit, whether the original unit is readable or not (where the original entity is still readable, the entity is categorized and the scratch through is counted as well).

· *Segmentation circles*—any roughly circular or oval graphic that may enclose text, search commands, numbers, etc.

o *Segmentation boxes* - any roughly four-sided graphic, including a box in a corner of the page via the drawing of an approximate right angle that may enclose text, search commands, numbers, etc.

o *Segmentation lines*—solid or broken lines that partition groups of entities.

Underlining—a solid line directly beneath text or numbers that is not used as a segmentation device.

Dashes—short, single, unbroken lines that are not used as segmentation devices. *Arrows*—an entity with graphical attributes similar to arrows, e.g. - .

Parentheses—pertains to () when not used in conjunction with search strategy may indicate a method of isolating text or numbers as an aside or personal note, i.e. (lengthy).

Brackets—{ } or [ ]

· *Stars/asterisks—**

Punctuation—entity used as punctuation, does not include colons used as part of date ranges, or question marks used as truncation commands.

Dollar signs—entity with graphical attributes similar to $, whether followed by numbers or not.

· *Finn diagrams*—shaded or unshaded interconnected circles that graphically depict Boolean search strategy.

~ *Check marks*—e.g. ticks and crosses.

Figure 4 provides examples of the recording of Venn diagrams, segmentation circles, boxes, and lines, scratch throughs, arrows, parentheses, brackets and check marks. The most frequently occurring graphical entities were segmentation devices and scratch throughs.

Segmentation devices. Table 5 shows the number and percentage of worksheet including segmentation devices: lines, circles or boxes. A total of 107 (48%) worksheets included some form of segmentation device (lines, circles or boxes). There were 47 occurrences of a single segmentation device (21%), 29 occurrences of two different segmentation devices (13%) and 31 worksheets used three segmentation devices (14%), with a mean of six segmentation entities per worksheet. Segmentation devices were used by all intermediaries and separated different types of entities within the work space. Retrieved search set numbers were frequently separated by segmentation boxes or circles, perhaps for future use in a restructured query. Similarly, possible terms copied from the IR system search results appear as segmented entities on the worksheets, separated from the initial search strategy by lines, boxes or circles.

When search intermediaries confined their working notes to the structured query window, very little segmentation is evidenced. However, when their working notes carried over to the back page of the worksheet or to a separate blank page (any unstructured work space), segmentation devices were frequently used. As working notes become longer and more complex, segmentation became a device used to separate, distinguish or cluster different entities. The use of graphical devices to segment data suggests an ongoing process of search restructuring with implications for the design of an interface that supports the dynamics of note taking query formulation and reformulation.

Individual intermediary segmentation. Table 6 shows the number and percentage of worksheets for each search intermediary including a segmentation device. The four search intermediaries accounted for 190 of the 221 total worksheets; the remaining 31 worksheets were unsigned or the signature was unreadable.

Search throughs. Scratch throughs appeared on more worksheets than any segmentation device, but were a small number of total graphical entities. These lines (or scratch throughs) drawn on top of other entities may reflect a process of recording and revising by search intermediaries.

Indiscernible Worksheet Entities

Only a few worksheet entities (34) were classified as indiscernible. Of the 221 worksheets, only 29 (13%) contained unreadable or otherwise unrecognizable entities. Indiscernible worksheet entities accounted for only 0.73% of the total worksheet entities and did not reflect any one search intermediary.

Indiscernible worksheet category. One category of miscellaneous worksheet entity was identified and labeled 'indiscernible'.

· *Indiscernible-an* entity that was identifiable as *something,* but it was unclear whether the entity was graphical, textual, numerical or scratched-through (e.g. an entity that looked as much like a scratch through as a segmentation circle, or an entity that was shaped similar to the letter 'P' or the number '9'); twenty-nine (13%) worksheets contained miscellaneous entries.

DISCUSSION

Results from this initial study show that search intermediaries frequently create working notes. The four search intermediaries in this study recorded on average 20 textual/numerical or graphical entities per search. This represents much writing activity, as search intermediaries worked to understand a user's information problem and translate the information problem into Boolean search terms and strategies. However, from the data available one cannot tell which notes were created before and during the interactive search. Also, it is not known exactly why working notes were created or used before and during the interactive search.

However, there were commonalities between search intermediaries and individual differences in the working notes created. It can be seen that all the search intermediaries created both textual/numerical

and graphical entities, including segmentation devices. However, textual/ numerical entities predominated in all searches. The 17 categories of textual/numerical entities reflect the types of activities necessary to develop and conduct an IR interaction. Many textual entities were either search commands, single-words numbers or multi-word strings. This is not surprising, as the task of searching a Boolean retrieval system hinges on the creation of textual/ numerical entities, such as search statements, made of up search terms connected by Boolean operators. Textual/numerical entities may have been recorded both before the IR interaction and some during the IR interaction as items copied from the IR system output.

Segmentation devices were created extensively, accounting for over half the graphical entities and were recorded on over half the worksheets. However, there were individual differences in graphical devices and segmenting. Search Intermediary A used segmentation devices more frequently than the other search intermediaries. Segmentation circles, scratch throughs and segmentation boxes occurred most frequently. Search intermediary segmenting or sketching may represent a complex user cognitive process supporting memory and assisting problemsolving, strategizing and evaluation. Graphical entities may also have been created before the IR interaction to separate distinct entities. They may have also been used to distinguish a search intermediary's own thoughts from notes made of items copied from the IR system's output. Further research is needed to examine the reasons and patterns of segmentation in IR systems users' working notes.

IR System Design Implications

The analysis of search intermediaries working notes suggests initial features of an IR whiteboard, as suggested by Spink (1994, 1995), allow IR system users to record textual/ numerical notes or graphical entities prior to, during and following their interaction with an IR system. Users also needed to transfer query entities from the window to an IR system and capture output from an IR system to the whiteboard, e.g. retrieved items, search terms, graphics, etc.

The electronic whiteboard may also include features to compensate for the users' lack of short-term memory (shown in their working notes by the recording of search terms and retreival set numbers); allow for the convenient segmentation of search results (perhaps by keeping search commands and results in separate windows), and provide facilities to print any of the various parts of the search session independently (search strategy, results, working notes, etc.). An interactive whiteboard design may take advantage of standard software features familiar to users of Windows systems. This would allow them to 'drag and drop' text into a whiteboard using a word-processing package or from the whiteboard into the IR query system. Iterative design and testing would need to examine the utility of such a whiteboard to IR systems users. Further research would also assess the potential link between an IR whiteboard and relevance feedback techniques, ranking systems, indirect management systems using autonomous agents (Maes, 1994) or automatic query modification of user search queries by an IR system.

FURTHER RESEARCH

This study has identified many issues for further exploration, including investigating the process of working note *encoding or creation* and *external storage or use* by search intermediaries and end-users during interactive IR. Further research is needed to analyze the relationship between working note creation and use and query formulation/reformulation; the role working notes play in the communication process between search intermediaries and clients; and stages in the EES of working notes before, during and after interactive searching. The outcome could be a model of users' working-note behaviour. Individual differences in the EES of working notes by search intermediaries and end-users may also be related to different information problems, domain knowledge, information-seeking stages or levels of searching expertise.

The remainder of this paper attempts to lay out a framework for thinking about working-note EES during interactive IR.

Working-Note EES Processes

Although this study was limited to investigating the nature of working notes created by search intermediaries, it may be hypothesized that working-note behavior in the IR context consists of two related iterative processes: (1) encoding or working-note creation and (2) external storage of working-note use.

Encoding working notes. During interactive IR, and the accompanying demands of query formulation and reformulation, working notes may be created through either or both of the following user EES processes: *note-taking* or *user notes.*

Note-taking refers to the user encoding process of synthesizing, copying or summarizing items or system output retrieved by the IR system (e.g. copying a title, descriptor, author name or transcribing an abstract) in addition to or rather than printing the items. Working notes in the IR context may include this note-taking behavior.

User notes are created as listing potential search terms, strategies, for use during the IR interaction and generated by the user from their domain knowledge or information-seeking before or during the IR system interaction. The creation of working notes, whether as *note taking* or *user notes,* can be understood as a recording process by users. In other words, text/numerical or graphical entities may be recorded on paper during note-taking or as user notes. However, the process of recording entities may not automatically mean those entities are subsequently used during query formulation or reformulation. In other words, during note taking, a user may record a word identified (e.g. relevant descriptor) during the online interaction but may not use the word as a search term. Also, a user may record a potential search term generated from their domain knowledge as part of their user notes, not subsequently used during an IT interaction. Therefore, an important distinction can be made between working-note creation and use.

External storage of working notes. The second user EES process is *external storage* or the *use of working notes.* This process may occur when working notes created during *note-taking* or as *user notes* are subsequently used during the interactive search. These notes may be used during the same interactive

search (e.g. search term or strategy), used in a subsequent search session, called a multiple search session behavior (Spink, 1996), or form part of the information gathered by the user during their information-seeking. Some entities recorded through note taking or as user notes may not be subsequently used either during or after the interactive search.

Thus, two distinct working note processes are hypothesized to occur: the *encoding* of working notes (as *note-taking* or *user notes)* and *external storage* or *use of working notes.* Further research is needed to examine the nature and role of both aspects of working notes in the IR process and their relationship to search effectiveness.

CONCLUSION

The results of this study suggest that what users communicate to an IR system through search queries during an interactive IR search potentially represents a fraction of the possible communications between a user and the IR system. Users currently interact with IR systems by entering Boolean commands, search queries as search terms within search statements and commands or natural-language statements. The process of interactive IR often consists of complex interchanges between the user and an IR system requiring the user to create a record of the search output, principally a printed listing of items retrieved.

However, users also engage in EES processes by recording working notes as search strategies and terms, lists of potential search terms found in the IR system output, and their thoughts, ideas, graphics or just doodles. These working notes do not currently form part of user-lR interaction models. However, EES processes are a complex and important aspect of the user-IA interaction requiring further research. This initial analysis shows that an IR whiteboard supporting the creation and use of users' working notes should also be investigated to learn the utility of such an interface to interactive IR.

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