Exploring novice users' training needs in searching information on the World Wide Web.

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Running title

Searching information on the WWW

Abstract

Searching for information on the WWW involves locating a Website and locating information on that site. A recent study implied that novice users' training needs exclusively relate to locating Websites. The present case study tried to reveal the knowledge and skills that constitute these training needs. Fourteen pre-university students, classified as novice (*n*=7) or experienced WWW-user (*n*=7) performed three Web search tasks. Their actions and verbalisations were recorded. Between-group comparisons showed minimal performance differences. However, qualitative analyses of novice users' search performance suggest that their ability to locate Websites could be enhanced by instructing monitoring skills and advanced system knowledge.

Exploring Novice Users' Training Needs in Searching Information on the WWW

Introduction

Internet's World Wide Web (WWW) offers a vast volume of information. As more and more people go online, this extensive database is increasingly being consulted by interested lay people with little or no formal training in information seeking. Yet these users have to cope with an information space even information specialists consider difficult to search. Few of them (if anyone) know precisely what information the WWW opens up or how specific information can best be retrieved (Bruce & Leander, 1997).

Information scientists and software designers try to improve the accessibility of information on the WWW by designing sophisticated retrieval tools. Although their efforts have been useful to some extent, present-day WWW browsers and search engines still perform merely the routine actions of a search, leaving the brainwork to the user. That is, the users still have to perform the cognitive and metacognitive skills required to retrieve information from the WWW. In case of first-time users, these skills should be trained since research has shown that unguided exploration is a highly inefficient approach to learning to use software (e.g., Kamouri, Kamouri & Smith, 1986; Kluwe, Misiak & Haider, 1990).

But, what knowledge and skills should be taught to efficiently search the WWW? A classical yet fruitful way to answer this question is to identify differences between naive and experienced searchers. Some researchers studied the search performance of students with varying levels of WWW-experience (e.g., Fidel et al., 1999; Hill, 1999; Hill & Hannafin, 1997; Watson, 1998). Their work revealed many idiosyncrasies of Web searching and has unmistakably increased our understanding of the search process. However, as these studies did not treat the students' level of expertise as an experimental variable, they are unsuited for identifying novice users' training needs.

This observation gave rise to a systematic comparison of novice and expert search performance (Lazonder, Biemans & Wopereis, in press). In this study, the search process was subdivided into two phases: locating a site, and locating information on that site. The experts clearly outperformed their novice counterparts on the first phase of the search. They needed less time to locate a site and

successfully located more sites than novice users did. No performance differences were found on tasks requiring participants to locate information on a site. It was therefore concluded that novice WWW-users should be trained at locating sites; their ability to locate information on a site already equals that of experts.

The present study was designed to specify novice users' training needs. The study employed cross-case comparisons to contrast novice and expert search performance, and within-case comparisons to identify inefficient patterns of novice users' search performance. A process model, outlining the stages users tend to process in Web searching, guided the analyses. This model was adapted from theoretically based frameworks for how users search electronic environments such as the WWW (Hill, 1999; Marchionini, 1995; Sutcliffe & Ennis, 1998).

Process model of Web searching

Web searching includes locating a site and, subsequently, locating information on that site. Both phases of the search comprise four activities (goal formation, strategy selection, strategy execution, monitoring) which are described below. As this study concentrates on locating Websites, the process model merely details this part of the search, treating the 'locate information' phase as a black box (see Figure 1).

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insert Figure 1 about here

Goal formation

Before initiating a search, a user must first sense a need for information. Information needs thus constitute the users' search goal, identifying the information they aim to retrieve. The user may decompose the overall goal into subgoals addressing distinct parts of the search (locate site, locate information). Users may also search the WWW when no specific goal is present apart from the intention to explore the information space (Chen et al., 1998; Marchionini, 1995; Sutcliffe & Ennis, 1998). However, such explorations are rare in an experimental setting where the experimental task serves as the goal, designating what to look for, and sometimes even where to look for it. As users can

identify the search goal by reading the task description, goal formation was not taken into account in the present study (cf. Guthrie, 1988)

Strategy selection

Search strategies comprise the activities a user consciously selects, applies, and monitors to perform a search (Marchionini, 1995). By selecting a search strategy, the user decides on the approach to the search problem. Generally speaking, the user may choose between (1) entering a site's URL, (2) browsing subject categories, and (3) content-based searching. Since search strategies represent information seeking skill (Sutcliffe & Ennis, 1998), experienced searchers were expected be faster and better at selecting appropriate strategies. Less knowledgeable users are more likely to adopt sub-optimal or even naive strategies (e.g., Hill & Hannafin, 1997; Marchionini & Shneiderman, 1988; Vassileva, 1996). Whether a strategy is effective depends on the features of the search task at hand. For example, entering a URL is the best way to locate a site which URL is known, but its effectiveness is minimal in case the user is unaware of potentially relevant sites.

Strategy execution

Having selected a strategy, the user executes it. Strategy execution typically involves skills like clicking hyperlinks, entering keywords, and scrolling a page. Performing these skills requires at least some basic understanding of the WWW browser and search engine. For example, to locate a site by content-based searching a user must know where to enter a query, how to use multiple search terms, and which button to click to start the search. As experts have a more extensive, well-structured knowledge base than novices (Chi, Feltovich & Glaser, 1981; Ericsson & Smith, 1991), they are predicted to execute a strategy swiftly and correctly. Novice searchers with insufficient system knowledge will perform less efficiently because they need more time to perform an action and because they perform incorrect actions (e.g., Fidel et al., 1999; Hill & Hannafin, 1997; Watson, 1998). It is important to note that the skills in itself are not particularly difficult to perform because they also apply to (and, hence, transfer from) operating other Windows programs (cf. Kamouri, Kamouri & Smith, 1986; Kluwe, Misiak & Haider, 1990).

Monitoring

Users monitor their search by evaluating intermediate search outcomes. That is, they assess whether the provisional search outcomes might fulfil their information need, and decide what ought to be done next to locate a relevant site (Hill, 1999). Users automatically skip this step if they locate a site by entering its URL. This strategy produces no intermediate outcomes because it directly opens up the requested site. In case of searching or browsing, intermediate search outcomes come in the form of a hit list. Users evaluate the list of potentially relevant sites from summary and evaluative metainformation (Harris, 1997). Summary metainformation includes a site's title, abstract, content summary, and so on. Evaluative metainformation includes all types of information that provide judgement of a site's content. Examples are relevance ratings, number of hits, and keywords found on a site. Given their thorough system knowledge, experts were expected to take advantage of both types of metainformation. Novices will mainly refer to summary metainformation to monitor their search.

Depending on the presumed relevance of the search outcomes, the user may decide to alter the search or to start a new search. In both cases, the user returns to a preceding stage in the model. The user may also choose to view the content of a site, thus shifting the focus of the search from 'locating sites' to 'locating information'.

In sum, experienced searchers were assumed to perform each step of the model swiftly and correctly. Novices were expected to perform these steps less efficient. More specifically, novices would need more time and make more errors when selecting a strategy, executing it, and monitoring the outcomes. The reported case study examined whether these predictions prove correct. The study also analysed novice users' performance in order to identify inefficient behaviour that could indicate training needs.

Method

Participants

Fourteen fourth graders from pre-university education participated in the study. There were nine males and five females with a mean age of 15.3 (*SD*=. 6). Participants were denominated as novice (*n*=7) in

case they had worked with the WWW for less than ten hours and considered themselves proficient in at most four out of twelve Internet facilities. Experts (*n*=7) had over fifty hours of WWW-experience. Their self-reported proficiency ranged from eight to eleven. Both groups were equivalent with regard to sex, ethnic background, and expertise in the task domain (i.e., Dutch literature). They differed with respect to age, however, with the experts being about one year younger that the novices.

Materials

The experiment was performed on Pentium II computers with Microsoft Internet Explorer 4.0. A Dutch search engine called Ilse was used to access information on the WWW (http://www.ilse.nl). Each computer was equipped with a registration program that captured the participants' actions and utterances in an AVI (Audio-Video Interleaved) file.

A background questionnaire recorded some personal data and assessed the participants' level of WWW-experience. A self-report questionnaire measured the participants' perceived proficiency in using browsers and search engines. Items dealt with basic issues such as following hyperlinks and printing Web pages, but also addressed advanced topics like downloading files and creating a personal home page. Participants scored each item on a 'yes/no' scale, indicating whether they thought themselves able to perform that task individually. Scores could range from zero to 12.

Three search tasks assessed the participants' capacities in locating Web sites. These tasks were identical to those used by Lazonder et al. (in press). Task complexity was determined by the level of inferencing required to deduce the site's URL from the task description (cf. Khan & Locatis, 1998; Mosenthal, 1998). The simple task referred explicitly to the site to be located, while the more complex tasks involved some inferencing (see Table 1).

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insert Table 1 about here

Procedure

All sessions took place in the schools' computer class and lasted up to one hour. Individual participants attended one session (the questionnaires were administered prior to the experiment). A

time limit of 13 minutes was attached to each task, but participants were free to relinquish a task. Participants were instructed to work individually and to think aloud during task performance. After the instruction, participants started working on their first task. Consecutive tasks were administered when participants completed or abandoned a task, or when they exceeded the time limit. If necessary, the experimenter reminded participants to think aloud with undirected prompts such as "What are you doing?", and "What are you looking at".

Results

Strategy selection

Table 2 reports the mean time to select a search strategy. Experts needed less time to select a strategy for task 1 and 2. No significant difference was found on task 3.

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insert Table 2 and 3 about here

The experts also tended to select better search strategies. On task 1 and 2, all experts immediately identified the site's name or address from the task description and transformed it into a successful strategy (see Table 3). Some novices overlooked these references; others were unable to use them properly. On task 1, for example, one novice identified the URL from the task description, but used it as a query instead of entering it on the address bar. Another novice completely overlooked the URL and searched for the collection of poems. On the second task, two novices initially disregarded the site's name and searched for keywords related the subject matter (i.e., Piet Paaltjens, Snikken en Grimlachjes).

Task 3 showed no difference in strategy selection between novices and experts. As this task contained no reference to a particular site, selecting a successful strategy hinged on information seeking skills rather than system knowledge. Searching for multiple keywords would be the best strategy, but none of the participants chose this approach on their first attempt. Three experts and three

novices selected the second best approach: searching for the author of the biography. The other participants choose an unsuccessful strategy.

Table 3 also shows the strategies that were selected on subsequent attempts. On task 1 and 2, participants who initially selected a successful strategy held on to their choice. Some novices whose initial strategy was unsuccessful choose a successful approach at a later stage; others did not. On task 3, most participants tried more than one strategy, regardless of the quality of their initial attempt. In general, the participants systematically searched for every keyword presented in the task description, and there were no striking differences between novice and experienced participants.

Strategy execution

On task 1, experts tended to be faster at executing a search strategy (see Table 2). The transcripts indicated that the experts were faster because they executed a strategy readily and correctly, whereas novices made errors and performed unnecessary actions. For example, novices pressed the ‘start’ or ‘search’ button to begin a search, pressed the ‘stop’ button to clear the screen, explored the bookmarks, and consulted the search engine’s help function. These actions seem to result from insufficient system knowledge. In fact, several novices wondered about the operation of the Internet browser and the search engine as was indicated by utterances like “...you automatically get there by clicking. But I’m not sure if that goes for the black words too...” and “I’m looking for this Internet site, but I have no idea how to get there”.

On task 2 and 3, novices committed fewer errors and explorations and, consequently, executed their strategies three to four seconds faster compared to task 1. The novices even performed slightly faster than the experts, but this difference failed to reach statistical significance due to a high variability of scores.

Monitoring

Table 2 also shows the mean time to monitor search outcomes. On task 2, experts and novices took an equal amount of time to evaluate the sites from the hit list. The experts were faster at monitoring on task 3. The standard deviation for the novices further indicates considerable within-group differences

on this task. Some novices spent much time on monitoring search outcomes; other established their merit at a single glance.

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insert Table 4 about here

Monitoring occurs by judging the search engines' hit list. As Table 4 shows, participants predominantly used summary metainformation for this purpose. Evaluative metainformation was rarely referred to; even the experts consulted it on an irregular basis. The following examples show some of the adverse consequences of disregarding evaluative metainformation.

On task 1, the novice who searched for the title of the collection of poems chose to inspect a site which URL differed from the URL presented in the task description. The novices who employed an unsuccessful strategy on the second task acted accordingly. They choose to examine a site which title and summary were relevant, ignoring the fact that its URL did not refer to SMC in any way. Another novice correctly searched for SMC, but preferred a site called 'SMC-information point' to the SMC-homepage. Her choice was incorrect, and she might have realised this if she had considered the relevance estimates (63% vs. 100%).

The consequence of disregarding evaluative metainformation was most apparent on the third task. Almost every hit list contained a site that was relevant, but had an indecisive title and abstract. Most participants overlooked this site, although the relevance estimate and 'keywords found' showed its significance. Four participants (1 expert, 3 novices) eventually located this site, but their decision to view its content was motivated by inferences about the site's content ("I will look at this poetry site because he has written poetry as well") rather than an examination of evaluative metainformation.

Monitoring also entails the decision about what action to take next. Surely, a full description of every decision and its resulting actions would go beyond the scope of this paper. Some decisions must be pointed out, however. On task 3, five experts and two novices decided to refine a search. They made the right decision, but generally failed to put it into effect. Instead of selecting the 'refine' command or using Boolean operators, most participants added keywords to the original query. Ironically, this broadened their search because the search engine, by default, searched for 'any word'

instead of ‘all words’. Although this imperfection could have been negated by referring to the ‘keywords found’, the participants predominantly judged the relevance of a site by its title and abstract, thus undoing the advantage of their advanced search strategy.

Discussion

Web searching involves locating a site and, subsequently, locating information on that site. A recent study showed that experienced WWW-users outperform inexperienced users on the first part of the search (Lazonder et al., in press). Starting from this conclusion, the present study examined why novices are less efficient at locating sites and what kind of instructional support is needed to enhance their search performance.

The cross-case comparisons show minimal differences between experts and novices. On the simple task, experts tended to be more proficient in selecting and executing a search strategy. However, these differences decreased as the search task became more complex. On the one hand, experts needed more time to select a strategy and choose successful strategies just as often as the novices did. On the other hand, the novices became more skilled in operating the search engine, which reduced the initial differences in strategy execution.

There may be several reasons why the predicted findings failed to appear. The small sample size is probably the most obvious explanation. Furthermore, the experts were experienced WWW-users, yet their level of expertise was not up to that of true experts such as librarians or information specialists; the novices were more knowledgeable than absolute beginners for they had up to ten hours of WWW-experience. Taken together, the anticipated differences might have shown if more participants with more divergent levels of WWW-expertise were compared. This prediction should be verified in future research because extreme group comparisons provide a sound basis establishing the instructional content.

Another interpretation is that the two groups differed with regard to system knowledge and skills, but not on information seeking skills. This study postulated that these types of expertise would go hand in hand—a reasonable assumption because the WWW is exclusively being used to find information. Unfortunately, the within-case comparisons disproved this presumption by showing that

the experienced participants lacked information-seeking skills (especially monitoring skills). As a consequence, no instructional implications can be drawn from the cross-case comparisons until research establishes the relation between WWW-experience and information seeking skills.

The within-case comparisons yield interesting directions for enhancing novice users' search performance. For example, several findings suggest that the basic operation of the search engine should not be elaborated on in the instruction (cf. Marchionini, 1989). Initially the novices executed their search strategies somewhat inefficiently. They made errors, explored the function of task buttons and menu commands and consulted the on-line help. However, their hands-on skills improved rapidly during the course of the experiment (cf. Khan & Locatis, 1998) even though they received no instructional support at all. In spite of these performance gains, novices never took full advantage of the search engine's potentials. For example, they were unaware that they could change the search engine's default from 'any word' to 'all words' in order to search for multiple keywords. They also overlooked the 'refine' and 'broaden' commands, and failed to use Boolean operators. Teaching novices the meaning and use of these advanced features might yield a further increase in performance efficiency.

Novice searchers should also be taught to identify and interpret the information that appears on screen. Even experienced participants hardly used system cues such as relevance ratings and 'keywords found' to monitor search outcomes. The consequences of this neglect were most apparent on the complex task. Participants frequently overlooked relevant sites, examined the content of irrelevant ones instead, and failed to notice that their attempt to refine a search had an adverse effect. Because the complex task closely resembles the information-seeking problems students encounter in real practice (i.e., open-ended search tasks without reference to a particular site), their monitoring skills need improving in order to search the WWW efficiently.

Finally, the results are indecisive as to whether novices should be taught to select search strategies. The participants' initial approach to the search tasks showed great similarity, although the novices tended to be less proficient at strategy selection on tasks designating which sites to visit. Their choice of strategies on subsequent attempts depends, at least to some extent, on their ability to monitor search outcomes. For example, participants decide to refine a search only if they are convinced the

intermediate outcomes are relevant to their information needs. Given the participants' weak monitoring skills, their true capability to select search strategies cannot be assessed.

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Table 1
Experimental search tasks and their level of complexity

Task		Complexity	Rationale
1	On Internet site "www.uittreksels.com" you will find a book report on *Snikken en Grimlachjes.* Surf to this site and locate this review.	Low	URL is given in the task description (www.uittreksels.com)
2	On the SMC web-site you will find a module on literature comprehension. Surf to this module and locate the page on Piet Paaltjens. Answer the following question: Why are most poems in *Snikken en Grimlachjes* untitled?	Medium	URL can be inferred from the task description (www.smc.nl)
3	In 1964 Rob Nieuwenhuys wrote a biography of François HaverSchmidt (Piet Paaltjens). What is the title of this biography?	High	URL cannot be inferred from the task description (www.internetcollege.nl, or www.xs4all.nl/~boekglas/poezie.html)

Table 2

Mean time (sec.) for strategy selection, execution, and monitoring (standard deviations in parentheses)

	Strategy selection			Strategy execution			Monitoring[1]	
	Task 1	Task 2	Task 3	Task 1	Task 2	Task 3	Task 2	Task 3
Novice	10.8 (6.1)	14.5 (7.0)	13.8 (6.2)	15.0 (4.8)	10.8 (15.0)	11.5 (3.8)	27.8 (9.0)	81.4 (84.1)
Expert	3.6 (1.9)	5.7 (4.6)	8.9 (5.1)	11.3 (2.3)	12.7 (12.7)	14.7 (5.0)	23.3 (12.7)	22.9 (6.7)
Mann-Whitney U	2.0***	5.0***	14.0	13.5*	15.0	14.0	8.5	4.0**

[1] Task 1 was precluded because 12 participants entered a URL to locate the site

* $p<.10$ ** $p<.05$ *** $p<.01$

Table 3

Search strategies selected on the first and subsequent attempts

	First attempt		Subsequent attempts	
	Novice	Expert	Novice	Expert
Task 1				
* Open www.uittreksels.com	5	7	0	0
Search “Snikken en grimlachjes”	1	0	1	0
Search “www.uittreksels.com”	1	0	0	0
Search “uittreksels”	0	0	1	0
Browse subject categories	0	0	1	0
Task 2				
* Open www.smc.nl	0	3	2	0
* Search “SMC”	5	4	1	0
Search “Piet Paaltjens”	1	0	1	0
Search “Snikken en grimlachjes	1	0	0	0
Open familiar site	0	0	1	0
Task 3				
* Search “Nieuwenhuys”	2	2	1	4
* Search “Rob Nieuwenhuys”	1	1	3	3
Open familiar site	2	3	0	1
Search “Paaltjens”	0	1	0	1
Search “Piet Paaltjens”	2	0	0	0
* Search “biography”	0	0	4	1
* Search “HaverSchmidt”	0	0	4	2
Search “www.internetcollege.nl”	0	0	1	0
Browse subject categories	0	0	0	1
Search multiple keywords	0	0	1	3

Note. Numbers indicate the number of participants that selected a strategy. Successful strategies are marked with an *.

Table 4
Types of metainformation used to monitor search outcomes

	Summary metainformation		Evaluative metainformation			
	Title	Abstract	No. of sites	URL	Keywords	Relevance
Number of participants						
Novice	6	6	2	1	3	0
Expert	6	6	0	0	2	1
Frequency of use						
Novice	28	26	6	1	3	0
Expert	27	26	0	0	2	1

Note. Two participants (1 expert, 1 novice) entered URLs to locate sites and were therefore not included

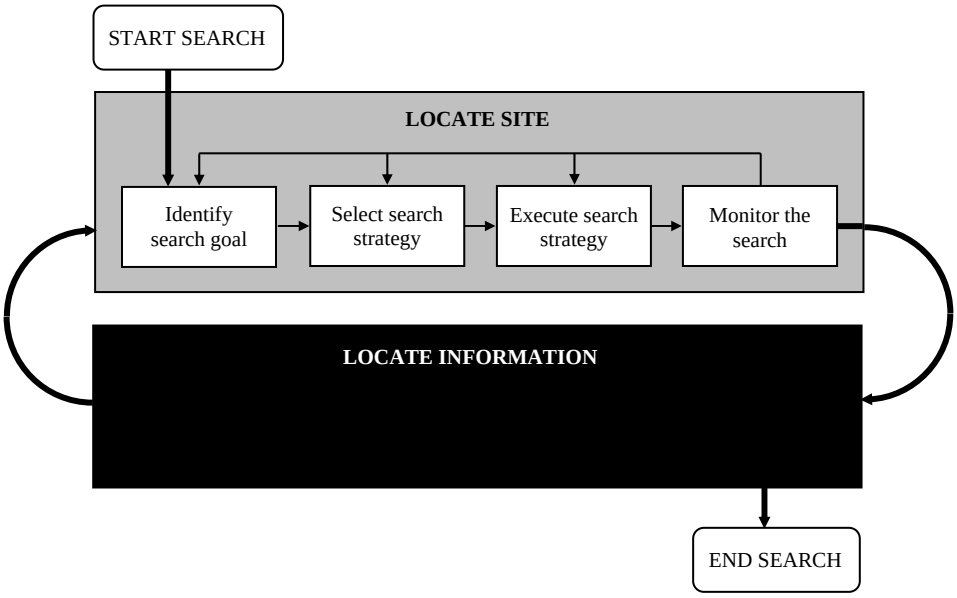
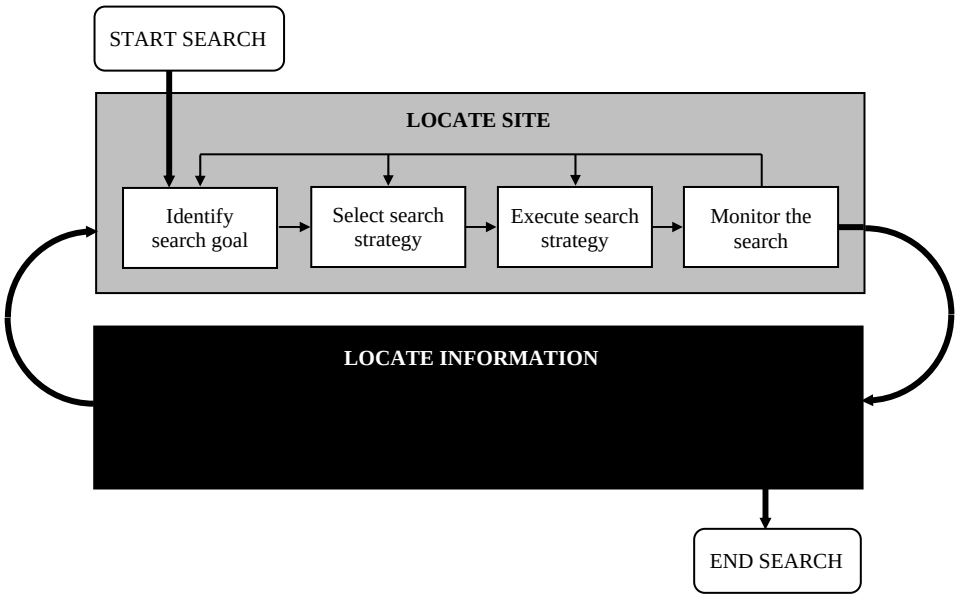

START SEARCH
LOCATE SITE
Identify search goal
Select search strategy
Execute search strategy
Monitor the search
LOCATE INFORMATION
END SEARCH

Figure caption

Figure 1: Process model of information searching on the WWW


START SEARCH
LOCATE SITE
Identify search goal
Select search strategy
Execute search strategy
Monitor the search
LOCATE INFORMATION
END SEARCH