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Improving Student Information Search

A metacognitive approach

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Summary of the study

To improve education graduate students’ information search behavior during problem-solving exercises, this book presents a mixed method study that evaluated the effectiveness of a tutorial designed to enhance participants’ metacognitive strategies during information seeking for problem solving. It represents an expanded and updated version of the first author’s unpublished dissertation research (Blummer, 2012). The use of the think-aloud protocol facilitated an understanding of individuals’ strategies and perceptions as they searched for information to solve a problem. A variety of quantitative data offered evidence of the impact of the tutorial on students’ problem-solving abilities. The study focused on individuals’ use of specific idea tactics and especially the differences in their problem-solving efforts executed before and after exposure to the tutorial.

The study centers on the first author’s unpublished dissertation research that examined the impact of metacognition on education graduate students’ information search. Chapters 3–5, 8–10, and 15–17 focus on the metacognitive aspect of information search. Education students’ information-seeking skills are highlighted in chapters 6 and 7. Information on the research study is offered in chapters 1 and 10–18.

The book is organized in two parts. The first half of the book discusses the literature on the main themes in the research study, and these encompassed information search, metacognition, problem solving, metacognitive scaffolds, and education graduate students’ information-seeking behavior. Chapter 1 provides an introduction to the study. Chapter 2 presents a review of the literature on information research and online search. Chapter 3 defines metacognition and traces its development. Chapter 4 examines the role of metacognition in problem solving. Chapter 5 considers the impact of metacognition on information problem solving. Chapters 6 and 7 explore education graduate students’ information seeking and information problem-solving skills respectively.
Chapter 8 focuses on the role of metacognition in online search. Chapter 9 traces the literature on metacognitive scaffolds.

The second half of the book centers on the research study and its findings. Chapter 10 describes the development of the idea tactics tutorial. Chapters 11 and 12 discuss the research methodology, including the problem-solving activity and post-activity interview and the data analysis respectively. Chapter 13 tracks the impact of the Indexes on six participants’ problem solving. Chapter 14 provides the findings in relation to the research questions for these six participants. Chapters 15, 16, and 17 discuss the themes that emerged from the study, including: idea generation and mental pattern breaking, participants’ adoption of metacognitive strategies and behaviors, as well as the incorporation of metacognitive strategies in information literacy instruction. Chapter 18 offers suggestions on utilizing the tutorial to maximize its effectiveness and modifying it for different user groups. The last chapter, 19, provides the conclusion and recommendations for future research.
Overview of the study

Abstract: Students often experience difficulties locating information despite library training in database search techniques. Research suggests metacognitive strategies including: planning, monitoring, and self-regulating actions could enhance individuals’ search in research databases. An idea tactic tutorial that promoted metacognitive strategies was developed to improve education graduate students’ searching in research databases for problem-solving activities. Bates identified 17 idea tactics, and nine of these concepts were incorporated in the idea tactics tutorial. We developed three additional tactics based on metacognitive strategies and they are included in the tool. A mixed method study evaluated students’ use of the tutorial as well as its impact on their search techniques and outcomes. This work constituted the first author’s dissertation study and our book represents an expansion and update of the research.

Key words: library training, education graduate students, metacognition, problem solving, research databases, tutorial.

Introduction

Academic library services provide research training to users. Traditional library training focused on students’ information literacy skills and included instruction in utilizing advanced database features and searching relevant materials. However, some students still have difficulty locating resources following library training in database search techniques (Blummer et al., 2012). This likely stems from the multitude of problems users encounter during information search. One novel approach to enhancing students’ research techniques highlights individuals’ information problem-solving abilities and especially their metacognitive skills. This perspective views information problem solving (IPS) as a form of information literacy that requires students to employ
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metacognitive skills or the ability to plan, monitor, and evaluate one’s own action (Lazonder and Rouet, 2008). IPS researchers equate information problem solving with information seeking in online databases and the web. Moreover, they note the importance of problem solving competencies in fostering students’ success in academia and beyond (Walraven et al., 2008, p. 624). To this end, the dissertation study examined the effectiveness of an idea tactic tutorial to enhance participants’ information searching in research databases for problem-solving activities. The tool centered on “idea tactics” that expert searchers employ to “help improve the searcher’s thinking and creative processes during searching” (Bates, 1979, p. 280). Bates identified 17 tactics, and nine of these concepts are incorporated in the idea tactics tutorial. We developed three additional tactics based on metacognitive strategies and they are included in the tool. This tutorial also contains definitions as well as examples, and it was provided to participants in an online format during a problem-solving exercise.

This chapter discusses the role of metacognition in problem solving during search as well as the lack of research on students’ use of metacognition in information seeking. It also highlights the value of metacognitive scaffolds in problem solving and especially the use of online tutorials to deliver skills training.

Background – metacognition in information search

Research on information need, information behavior, and information retrieval highlighted the enormous cognitive demands placed on users during information seeking. Ellis (1989) and Kuhlthau (1991, 2004) suggested that users progress through various stages of information acquisition. Dervin (1983, 1992) maintained that users aim to satisfy an information gap that exists between an individual’s experiences and their knowledge. Marchionini (1995) highlighted users’ efforts to assess the effectiveness of the information retrieval process especially “how it relates to accepting” the information need and the ability of the retrieved material to support the task (p. 58). Wilson (1999) emphasized the importance of feedback loops in information behavior models due to the “iterative” character of the process that produced “new research questions” (p. 268).
The cognitive demands on users can be particularly excessive in searching research databases. Research by Ahmed et al. (2009) suggested users’ search problems stemmed from the failure of database designers to incorporate human computer interface techniques into information retrieval interfaces. The authors developed a prototype interface design that they maintained “improved performance and satisfaction” for novice and experienced users (Ahmed et al., 2006, p. 169).

Some research suggests metacognition could enhance individuals’ interactions in research databases. Marchionini (1995) pointed to the importance of metacognition in information seeking. He maintained that metacognition triggered our need for information, enabled “mental models for systems and domains,” and monitored “our progress” (p. 14). Likewise, Gorrell et al. (2009) noted the “emergence of interest in metacognition in the context of web search and online inquiry” (p. 447).

Recent studies focus on promoting students IPS skills particularly metacognitive strategies to support online search (Brand-Gruwel et al., 2005; Walraven et al., 2009). Wopereis et al. (2008) illustrated the effectiveness of providing IPS instruction to distance education students in a research methodologies course. This instruction focused on specific sub-skills within five categories, including: define problem, search information, scan information, process information, and organize and present information. Pre-test and post-test results focused on how frequently a skill was performed by the experimental and the control groups. According to the authors, the experimental group performed better following a pre-test and post-test of students IPS skills. Students receiving IPS instruction engaged in text scanning and information evaluation more often than those individuals in the control group. In addition, these students engaged in significantly more metacognitive activities compared to those in the control group.

Research on problem solving also underscored the role of metacognition in promoting favorable outcomes. Salomon and Perkins (1989) referred to general knowledge as how to think well and they believed it supported the development of strategies for “problem solving, inventive thinking, decision making, learning and good mental management” (p. 17). Likewise, Flavell (1978) also linked metacognition to problem solving. According to the author, a “metacognitively sophisticated individual” would approach problem solving by focusing on the “task features” such as the identification of the problem and any sub-problems, as well as tracking “past solution efforts, their outcomes, and the problem-relevant information they yielded” (p. 237).
Other theorists have recognized the significance of metacognition in facilitating individuals’ problem-solving skills. Schoenfeld (1982) surmised that cognitive behaviors were affected by task, social environment, and the “problem solver’s perception of self and his or her relation to the task and the environment” (p. 1). He highlighted the importance of all three components of cognitive endeavors in problem solving, but noted most students lacked awareness of their potential to “observe, evaluate, and change” their behavior (p. 30).

Sternberg’s triarchic theory of intelligence pointed to the role of metacomponents in problem resolution by fostering the recognition and definition of the problem, the gathering of “mental resources” for tackling the problem, the development of steps and strategies for problem solving, and support for monitoring the process and evaluating the solution (Sternberg and Frensch, 1990, p. 89). Frensch and Sternberg (1989) linked problem solving to an individual’s flexibility in adapting their thought processes to the current situation. The authors promoted instruction in “learning-to-learn skills” (p. 183).

Need

Despite the importance of metacognitive abilities in influencing information search outcomes, there is minimal research on graduate students’ metacognitive activities during information seeking for problem solving. Hess (1999) investigated one graduate student’s cognitive processes during a web-based information retrieval session. He pointed to information overload as an obstacle for retrieving material and advocated training users in information skills, defined as the ability to “retrieve, filter, and store relevant information” as well as differentiate it from irrelevant material (p. 7).

While there is some research on individuals’ use of metacognitive strategies during information problem solving, these studies are largely directed at younger students. For example, Bowler (2010b) studied the metacognitive strategies of adolescents during information search. Laxman (2010) reported on 25 freshmen students’ successful use of an intervention to assist their information seeking in confronting both well- and ill-structured problems. The intervention provided students with search skills as well as worked examples and practice problems to foster the “activation of learners’ prior knowledge” (p. 516).
Still, research suggests metacognitive scaffolds offer potential to improve information processing for graduate students as well. Chen and Ge (2006) described the development of a web-based cognitive modeling system to support ill-structured problem solving through question prompts, expert modeling, and peer review. This prototype system was aimed at facilitating scaffolding for instructional technology graduate students in solving instructional design problems. The availability of a case library fostered students’ abilities to “perform analysis” and “propose solutions” to instructional design problems (p. 300). The evaluation of the pilot program indicated that the system facilitated students’ abilities to utilize “prior knowledge, organise their thoughts, and articulate their reasoning” (p. 301).

Although there are an abundance of studies on the information-seeking behaviors of various professional groups and undergraduate students, librarians have directed little effort to identifying the “research process of graduate students” (George et al., 2006, para. 6). This trend is especially pronounced among studies focused on education graduate students. Still, information-seeking behavioral research supports the development of services and collections to targeted groups. Vezzosi (2009) emphasized the need to explore users’ information-seeking patterns to design and plan activities “tailored to users’ learning needs” (p. 65).

A pilot study of education’s master’s students’ information-seeking behaviors at a mid-sized public university, based on interviews and a survey, revealed that graduate students had feelings of confusion and uncertainty when researching (Blummer et al., 2012). Several interview participants reported difficulty determining when to stop gathering information as well as in creating the final product. In addition, some survey respondents expressed dissatisfaction with the content of their previous library instruction. The pilot suggested these graduate students were savvy searchers, but required instruction in techniques to enhance their ability to locate and process the volume of information on the web.

**Problem solving, literacy in research databases, and tutorial-based library instruction**

Librarians differ over the most appropriate focus of information literacy instruction. Johnston and Webber (2003) believed instructional efforts in
the United States suffered from a dependency on the Association of College & Research Libraries' definition of the information literate individual. According to the authors, their guidelines reduced “a complex set of skills and knowledge to small, discrete units” (p. 337). Grafstein (2002) observed the information explosion called for an understanding of the “differences between knowledge and information” (p. 200). She pointed to the importance of prior knowledge in individuals’ acquisition of new knowledge as well as users’ abilities to integrate various ideas. Likewise, Thelwall (2004) predicted that the next generation of scholars would require a new skill set to interact with research from a variety of disciplines. Bowler (2010) suggested librarians instruct students in “how to think about their own thinking” and especially using metacognitive knowledge to enhance problem solving (pp. 38–9).

Research also highlighted the value of tutorials in providing research skills to scholars. Ragains (1997) underscored the role of online and web-based instructional guides and tutorials in his calls for “more aggressive, proactive planning and delivery of instruction” (p. 169). According to the author, librarians required a variety of “ways to reach students” other than one-shot, course-related, faculty-requested training (p. 168). Diekema et al. (2011) reported on the success of an online information literacy tutorial that centered on problem-based learning. The authors noted some students “displayed metacognitive strategies that enabled them to conduct a more extensive research process” (p. 264).

Consequently, idea tactics are utilized as a metacognitive intervention to support education graduate students’ information problem solving in research databases. These tactics represent search strategies used by information specialists and compiled by Bates (1979) to “help generate new ideas or solutions to problems in information searching.” She described the tactics as part of a “facilitation model” that may help the searcher in an online or print environment (p. 280). In this instance, the tactics are presented in a tutorial and the study measures the impact of the intervention on participants’ search strategies and their search outcomes. Table 1.1 lists nine of these tactics and includes three additional strategies designed to promote individuals’ metacognitive skills. An initial search served as a pre-test that illustrated participants’ problem-solving strategies and database search skills. This information was compared with strategies and search techniques that participants demonstrated following access to the tutorial.
The value of metacognition in promoting favorable outcomes in information search cannot be overstated. Consequently, this research examines the role of metacognition in facilitating information problem solving in research databases.

### Table 1.1  Idea tactics in the metacognitive tutorial

<table>
<thead>
<tr>
<th>Tactic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think</td>
<td>Identify search goals or what you wish to accomplish.</td>
</tr>
<tr>
<td>Catch</td>
<td>Recognize an unproductive search and instigate a new approach.</td>
</tr>
<tr>
<td>Notice</td>
<td>Consider the appearance of any clues that may affect your interpretation of the question or how to answer it.</td>
</tr>
<tr>
<td>Meditate</td>
<td>Analyze the search strategy by incorporating scientific as well as intuitive thought processes for problem solving. This is often described as convergent and divergent thinking. Individuals typically employ one or the other in developing solutions. However, some researchers claim creative problem solving involves both modes of thought.</td>
</tr>
<tr>
<td>Change</td>
<td>Instigate a new search behavior, a different keyword, source, or strategy.</td>
</tr>
<tr>
<td>Create</td>
<td>Develop a search strategy by identifying relevant keywords, search fields, and databases to access. Research suggests expert searchers adopt a plan rather than follow trial and error techniques.</td>
</tr>
<tr>
<td>Wander</td>
<td>Examine the sources for indications of new source opportunities and avenues.</td>
</tr>
<tr>
<td>Jolt</td>
<td>Move out of conventional thinking to view the source in an unconventional way.</td>
</tr>
<tr>
<td>Identify</td>
<td>Determine personal and system knowledge that may improve search results.</td>
</tr>
<tr>
<td>Break</td>
<td>Change standard search habits.</td>
</tr>
<tr>
<td>Regulate</td>
<td>Pay attention to your thought processes as well as to how you structure the search process.</td>
</tr>
<tr>
<td>Skip</td>
<td>Explore the topic from a different perspective or tackle another component of a multipart query.</td>
</tr>
</tbody>
</table>

The mixed method study targeted education graduate students, an underserved population in library information-seeking research (Earp, 2008, p. 74). Quantitative measures tracked participants’ accesses to the tutorial components, number of revised searches and records examined, as well as the time spent in the tutorial, devising search strategies, and reviewing results. Scores comparing students’ initial (pre-tutorial) search with their post-tutorial search were also used. The study’s qualitative component centered on a think-aloud protocol that also captured participants’ mouse movements during problem solving in Ebsco databases. The study focused on four research questions including the following:

1. **What search techniques did participants demonstrate in their initial search?** This question considers what strategies and skills participants utilized in their pre-tutorial search such as selecting additional databases, employing Boolean operators, truncating terms, accessing the advanced search mode, conducting subject searches, and locating terms from relevant articles.

2. **What general attributes were common among participants in their use of the tutorial?** This question tracks the number of seconds individuals spent in the tutorial and the number of accesses to the various components of the tutorial. It explores how participants used the tutorial. Did participants refer back to the tutorial during their searches or merely utilize it as a one-shot learning tool? How many tactics did participants read and did they access a variety of tactics or stay in one category? Were some tactics used more often than others? How much time did participants spend accessing the various tactics in the tutorial? How frequently did participants access the tutorial?

3. **What search techniques did participants demonstrate in their final searches?** This question compares the search techniques participants demonstrated in their revised searches after exposure to the tutorial. These techniques were not revealed in participants’ initial search.

4. **How did the tutorial affect the outcome of the problem-solving activity?** This question compared participants’ initial search skills with those demonstrated in subsequent searches. It also compares participants’ initial search scores with their final search scores for relevance, ability to answer the question, authoritativeness, and the quality of the response. In addition, it considers the number of revised
searches participants conducted, the number of records they examined, and the time they spent devising search strategies and reviewing results. Were there relationships among the time spent in the tutorial, the number of tutorial accesses, the number of revised searches, and the time spent devising search strategies and reviewing results? In addition, how did the amount of time spent in the tutorial and the number of accesses to the tutorial, and the number of revised searches affect participants’ final search scores? The question also examines participants’ satisfaction level with the results. Lastly, the question noted any issues that affected participants’ problem-solving activities.

Outcomes facilitated the design of a protocol to guide students in applying relevant metacognitive strategies during online search thereby enhancing individuals’ information-seeking behaviors. These are discussed in in latter chapters.

Limitations

The small number of students in the sample – eight participants – was a major limitation of the study and prevented the generalization of the findings. The study also attracted participants with more search experience than others. Similarly, some students were more knowledgeable in the task subject area or had enhanced database skills compared to others. Moreover, all of the participants stemmed from one academic institution’s College of Education and had similar library training classes.
Information research and the search process

Abstract: Information professionals may question the effectiveness of a metacognitive scaffold for enhancing users’ search capabilities. Information research is utilized to document the difficulties users encounter during the search process as well as the cognitive and metacognitive aspect of information search. The literature contained references to individuals’ use of metacognitive strategies in information search for planning strategies, differentiating among sources, monitoring the process, and evaluating results. Still, studies underscored deficiencies in the user as well as the process that impeded their information-seeking activities. Theorists also described efforts to support users’ information search including librarians’ awareness of user strategies as well as improvements in search interfaces and database design. Authors failed to consider the role of metacognition in enhancing individuals’ information search.

Key words: information models, information search process, information search difficulties, problem solving, users’ uncertainties, behavior, retrieval systems.

Introduction

Studies in information behavior and information seeking illustrate the numerous activities associated with information search. Although theorists focused on different perspectives of information use (Ellis, 1989; Dervin, 1983; Kuhlthau, 1993; Taylor, 1962; Wilson, 1999), much of the research acknowledged the complexity of users’ information behaviors and especially the social, cognitive, and affective issues that impact it. The literature also contained references to individuals’ use of metacognitive strategies in information search for planning strategies,
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differentiating among sources, monitoring the process, and evaluating results. Still, studies underscored deficiencies in the user as well as the process that impeded their information-seeking activities. Some of these deficiencies included difficulty in translating the problem to librarians and systems, as well as feelings of uncertainty. Consequently, the authors proposed various methods to enhance individuals’ information seeking, including identifying users’ stage in the information-seeking process and providing relevant support (Kuhlthau, 2004), as well as improving information system design (Dervin, 1992; Ellis, 1989; Taylor, 1962; Kuhlthau, 1999). Unfortunately, none of the authors promoted metacognition strategies to improve individuals’ information searching.

This book proposes a metacognitive-based scaffold to help education graduate students overcome the problems they encounter in information search. The scaffold can be adapted for users in other disciplines and academic stages. Although metacognitive scaffolds are popular instructional tools among educational technologists, report of their use for information literacy instruction remains limited. An analysis of the information search process from the perspective of information behavior, information seeking, and information retrieval theorists supports the use of a metacognitive tool for information search instruction.

Early research

Information need

Taylor (1962) was one of the earliest authors to address users’ information seeking through his exploration of the problems associated with question formation. He identified four levels of information need, including: actual (visceral), conscious, formalized, and compromised. He defined the fourth level, compromised, as the question that was provided to the information system. Taylor maintained that the question was distorted as it moved through the various levels. He also pointed to three obstacles that affected an individual’s interaction with an information system such as the system organization, the type of question and its complexity, and “the state of readiness” (p. 394). The latter, he suggested, referred to the inquirer’s state of mind that he described as constantly changing and this influenced their ability to select the appropriate system message. In his summary, Taylor emphasized the need for additional research for “better design” of information systems and especially to consider the “inquirer” as “an integral part” of the process (p. 396).