Effects of Contextual Factors on Image Searching on the Web

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This research examined college students' image searching processes on the Web. The study's objective was to collect empirical data on students' search needs and identify what contextual factors had a significant influence on their image searching tactics. While confirming common search behaviors such as Google-dominant use, short queries, rare use of advanced search options, and checking few search result pages, the findings also revealed a significantly different effect of contextual factors on the tactics of querying and navigating, performance, and relevance judgment. In particular, interaction activities were differentiated by task goals, level of searching expertise, and work task stages. The results suggested that context-sensitive services and interface features would better suit Web users' actual needs and enhance their searching experience.

Introduction

The World Wide Web (Web) serves as a popular information retrieval system. The nature of the Web is diverse in that users perform varied searches to fulfill real-life work tasks based on their own characteristics and retrieve different types of information. People use the Web for various purposes and employ different strategies with an iterative process. Such factors associated with information searching and retrieval—goal, task, and searcher's characteristics—are known as contextual attributes and are considered important in understanding information-seeking behavior. Contextual attributes prompt information needs, generating associated activities to find useful information; finding useful information is formed within the context of a searcher. Thus, contextual characteristics have been a central point in understanding people's interaction and activities in searching and retrieving information, and in developing tools or information systems to support them.

To improve the searching environment on the Web, ample studies have been conducted. They have shed light on the different characteristics and searching processes of Web users. For example, studies have revealed how users navigate the Web, and described their different patterns and activities (Broder, 2002; Byrne, John, Wehrle, & Crow, 1999; Morrison, Pirolli, & Card, 2001; Sellen, Murphy, & Shaw, 2002). Several longitudinal studies demonstrate changes in Web use since its inception. They identify a decrease of back button use and an increase of new tabs and patterns of frequent revisitations (Catledge & Pitkow, 1995; Cockburn & McKenzie, 2001; Cothey, 2002; Herder, 2006; Tauscher & Greenberg, 1997; Weinreich, Obendorf, Herder, & Mayer, 2008). Other research provides an insight to improve usability in large Web sites (Bernedt & Brenstein, 2001; Herder & Juvina, 2004) and suggest better search engine tools and interfaces for searching and accessing information (Aula, Jhaveri, & Kaki, 2005; White & Drucker, 2007). By investigating information seeking, these studies contribute to the evolution of applications that access the Web more effectively and efficiently. However, a common approach employed in previous Web information-seeking studies has been based on simulated situations or transaction log analysis. Such techniques do not take various contextual attributes people apply in information seeking and searching process into account to a sufficient degree (Ingwersen & Järvelin, 2005). Thus, they do not provide a complete understanding of the searching process. This further implies that a better study would incorporate various types of task and user contexts in exploring information seeking. In turn, it would enable analyzing general patterns across tasks and contexts on the Web.

The Web offers a wide range of different formats of information, especially visual information. Previously unknown information or inaccessible materials are easily available online. Studies suggest a wide use of digital images in higher education across disciplines (Green, 2006; Harley, Henke, Lawrence, Miller, Perciali, & Nasitir, 2006; Pisciotta, Dooris, Frost, & Halm, 2005; Shonfeld, 2006). Many online image databases, image search engines, and image search sites on the Web help address the vast image needs of people. To accommodate these diverse needs, new
image retrieval systems and techniques such as content-based image retrieval (CBIR) systems (Smeulders, Worring, Santini, Gupta, & Jain, 2000) and interface designs (Yee, Swearingen, Li, & Hearst, 2003) have been developed. Despite the growth of visual information needs and availability on the Web, however, there are few studies on image searching on the Web compared to those on general Web usage. Additionally, due to the limitations of commonly employed methods (transaction-log analysis or simulated situations) used in those few studies, the results are limited, i.e., our understanding of real user interaction is constrained. We miss gaining truer insight into how users resolve real search need within the context. It is not known to what extent contextual factors affect image-searching activities. Thus, the purpose of this study is to comprehend the role of contextual factors as it relates to the image searching process on the Web.

**Research Questions**

This study aims to examine influences of contextual factors in searching for images on the Web. The main research question was which information searching activities are the most or least commonly affected by which contextual factors. Therefore, the following questions were addressed:

1. Are there any significant differences on searching tactics, and relevance judgment among different work tasks?
2. Are there any significant differences on searching tactics among searching expertise?
3. Does domain knowledge related to a user’s task goal affect search tactics, search performance, and relevance judgment?
4. Do work stages for a user’s particular task affect search tactics, search performance, and relevance judgment?
5. Is there any change in performance, search activities, and relevance judgment when a participant goes through multiple search sessions for the same task goal?

The remainder of this paper is organized as follows: first, the Related Studies section provides a framework for this research and previous studies both on information-seeking behavior on the Web and on image searching; second, the Methods section presents the design of this study and data collection; third, the Results section describes the findings from the analysis of quantitative and qualitative data; and finally, the Discussions and Conclusion sections promote further research on image-seeking behavior in context and on system improvements.

**Related Studies**

The review of the literature consists of four parts: the first provides a conceptual framework for this research and explains the framework’s origin; the second part briefly lists studies on information-seeking behavior on the Web; the third part deals with image-searching behavior; and the final part concludes with recommended improvements.

**Conceptual Framework**

One of the biggest challenges in image retrieval is that images convey multiple levels of meaning (Shatford-Layne, 1994). Many users of an image retrieval system experience the so-called semantic gap or “the lack of coincidence between the information that one can extract from the visual data and the interpretation that the same data have for a user in a given situation” (Smeulders et al., 2000, p. 1353). In other words, an image’s meaning depends on the context of users—purpose, level of knowledge, and interest and situation (task)—and the meaning of images may change over time because new information about the images they depict can influence the feelings they evoke or their significance and interest (Jaimes, 2006). According to Enser (2000, 2008), for an efficient retrieval of appropriate images, three levels of knowledge—collection knowledge, domain knowledge, and world knowledge—should be harmonized between the end user and an image retrieval system. In short, previous studies highlight that an important step in designing and developing an image retrieval system is to understand the user’s knowledge structure, goals, intent, and tasks in an information-seeking process.

Context, as an influential factor affecting the information seeking and retrieval process, has been emphasized in previous research, while its definition and dimensions have not been clearly stated (Chang & Lee, 2001; Courtright, 2007; Johnson, 2003). Recently, Kelly (2006a,b) attempted to measure context—task, stage, topic knowledge, and time—and identify the effects of context on relevance judgment and task performance. Several researchers have conceptualized context and the interplay of various elements in information seeking and retrieval (Belkin, 1980; Chang & Lee, 2001; Ingwersen, 1996; Ingwersen & Järvelin, 2005; Järvelin & Ingwersen, 2004; Kari & Savolainen, 2003; Saracevic, 1997; Sonnenwald, 1999; Wilson, 1999).

In particular, Ingwersen and Järvelin (2005) explained the information seeking and retrieval process as well as various contextual criteria embedded in its nested model and cognitive framework. The nested model of information seeking and retrieval posits that information seeking and retrieval is embedded in the contexts of retrieval, seeking, and work tasks. The notion of work task is central to their nested model in that the work task serves as the driving force underlying information seeking and retrieval. This is because an information seeker performs a sequence of information seeking and retrieval activities to obtain information in order to fulfill a perceived work task (p. 282). The notion of work task also entails nonjob-related (daily-life) tasks, including emotional interests like entertainment, in addition to job-related tasks. Ingwersen and Järvelin promote the idea that information retrieval research must collect contextual elements related to the work task and then examine how information retrieval interactions are performed as well as what relevant information is accessed. Within
the model they identified nine broad dimensions that contain multiple variables in information seeking and retrieval processes—the work task, the search tasks, the actor, the perceived work tasks, the perceived search tasks, the document dimension, the algorithmic search engine dimension, the interface dimension, and the access and interaction dimension (pp. 313–314, 356; Järvelin & Ingwersen, 2004). Based on this model, a number of dimensions involved in information seeking and retrieval may be observed. Their model and framework provides a potential set of context aspects for analyzing information seeking and retrieval. Their model and framework can help identify contextual elements potentially important to the information searching process and assess the quality of information retrieved, the quality of the search process (e.g., searcher’s effort [time]), satisfaction, and various types of moves/tactics employed (p. 322). Such studies that examine information retrieval interactions in context could provide insights into improving system design that better facilitate the information retrieval process.

As for understanding the interaction with the Web, Pharo and Järvelin (2004) called for research examining how contextual factors (searcher, social/organizational environment, work task, search task, and the process itself) influence actual Web information-seeking processes. Emphasizing that these factors affect both information seeking and retrieval, they have proposed the Search Situation Transition (SST) method for analyzing Web searching behavior and processes. Their SST method focuses on the search process as a phenomenon and explicates how different information-seeking factors directly affect the search process.

The nature of information seeking is iterative (Belkin, Cool, Stein, & Thiel, 1995; Lin & Belkin, 2000, 2005). Information needs evolve and users repeat their search as their understanding of the problem develops—information used leads to new insights into the problem. Spink and her colleagues (Spink, Wilson, Ellis, & Nigel, 1998; Spink, Wilson, Ford, Foster, & Ellis, 2002) characterized progressive changes and shifts occurring in various aspects associated with users—including their queries and related changes over time—in the type and use of information resources and search strategies. They advocated that these changes and differences could be examined via users’ relevance judgments and criteria.

In summary, the above-mentioned models address the concept that information-seeking behavior is compounded by many contextual factors. Those factors become important building blocks upon which an analysis of information seeking and system design should be based. In this study, Web searching is understood as a dynamic process associated with contextual variables defined by Ingwersen and Järvelin’s (2005) framework and the SST model by Pharo and Järvelin.

Previous Studies of Information-Seeking Behavior on the Web

Many studies have been conducted to understand various aspects of information seeking and retrieval interaction on the Web. A few experimental studies (Holscher & Strube, 2000; Navarro-Prieto, Scaife, & Rogers, 1999; Wang, Hawk, & Tenopire, 2000) identified the impact of users’ characteristics such as the search and background knowledge as well as cognitive strategies on Web search strategies, problems they encountered, their mental model, affective feelings, navigational functions they used, and users’ conception of the Web. Although these studies were based on assigned search tasks, their findings suggest that the interaction between multiple factors should be taken into account when understanding and modeling Web search behavior.

There are also a few studies based on real information needs that investigate information-seeking behavior on the Web. For example, Choo, Detlor, and Turnbull (2000) analyzed information-seeking behavior of knowledge workers on the Web in relation to the user’s tasks and found that information needs, seeking tactics, and purpose of information use influenced different modes of information behavior. Additionally, Kellar, Watters, and Shepherd (2006, 2007) characterized the differences in how users interact with their Web browsers across the range of the tasks categorized by the participants’ Web usage—fact finding, information gathering, browsing, and transactions. Kellar et al. (2006, 2007) discovered that information-gathering tasks were the most complex; participants spent more time completing this task, viewed more pages, and more heavily used the Web browser functions during these tasks. Both studies by Choo et al. and Kellar et al. suggest that it is important to examine real-life search tasks in various situations, its impact on the information-searching process, and the use of tools to gain a real understanding of the effectiveness of navigation mechanisms and search strategies.

Searching and browsing are common strategies in the electronic environment (Marchionini, 1995). Several studies reveal an influence of a user’s experience, expertise, and search tasks on strategies for navigation on the Web. For example, Herder and Juvina (2004) found that domain expertise was an important factor of navigation. Level of experience also plays a role in users’ information-seeking strategies. In a 10-month longitudinal study, Cothey (2002) investigated changes in students’ information-seeking behavior on the Web as they gained more experience over time. As the students became more experienced, they began to visit more specific sets of Web pages, accessed the Web less frequently, and exhibited lower rates of querying. Thatcher (2008) examined the cognitive strategies on the Web based on different search tasks between simulated tasks and participant-chosen tasks as well as experience levels. His study discovered significant differences in the use of cognitive search strategies by tasks and experience levels.

Some studies have focused on the ways in which information search tactics, query formulation, and relevance judgments can change over time on traditional information retrieval systems. Vakkari (2000a) and Vakkari, Pennanen, and Serola (2003) demonstrated the change in students’ search tactics and terms at different points in their development of research proposals. Vakkari (2000b) found that
an end user’s stages of problem solving are impacted by the choice of sources and access points as well as the choice of search terms. Also, Vakkari (2001) identified the different stages of the work task as influencing the searching process. Wildemuth (2004) illustrated that the search tactics changed over time as the students’ domain knowledge changed. Findings of studies by Vakkari (2006c) and Vakkari and Hakala (2000) suggest that the growth of students’ knowledge was reflected in the use of stricter relevance criteria. Furthermore, Taylor, Cool, Belkin, & Amadio (2007) studied relevance categories at different stages of completing a task and found a significant relationship between the user’s stage in the search process and relevance categories. These studies imply that relevance assessment is part of information searching and retrieval; furthermore, attributes of tasks and users affect relevance assessment.

Studies on Image-Searching Behavior

Searching images by words is the preferred method (Eakins, Briggs, & Burford, 2004) in many image retrieval systems, in spite of an increasing interest in content-based image retrieval by visual attributes such as color, shape, texture, and other image properties. However, textual representation of images brings many challenges to support keyword-based searches for images due to a lack of textual clues and many different meanings embedded in images (Panofsky, 1962; Rafferty & Hiderley, 2007; Shatford-Layne, 1994). The complex nature of images evoked ample studies that were conducted to understand how users represent information needs for image materials within special domains such as archives, history, or image-related professions such as art and journalism (Armitage & Enser, 1997; Chen, 2000; Choi & Rasmussen, 2003; Collins, 1998; Eakins, Briggs, & Burford, 2004; Fidel, 1997; Goodrum & Spink, 2001; Hastings, 1995; Jörgensen, 1998; Westman & Ottinern, 2006). These studies demonstrate that a user’s requests for image information were characterized by largely descriptive aspects (people, places, events, and objects in an image). They confirm the importance of object identification for indexing and query-in-image retrieval systems.

While there is still less research on image-information-seeking behavior than textual information-seeking behavior (Rasmussen, 1997), researchers examined various aspects of image-seeking behaviors and reported interesting results: task and information needs affect image-searching behavior (Batley, 1988; Frost, Taylor, Noakes, Markel, Torres, & Drabenstott, 2000; Hung, 2005; Markkula & Sormunen, 2000; McDonald & Tait, 2003); that the level of knowledge has an impact on the choice of search strategies (Frost et al., 2000; Matusiak, 2006); and that browsing seems to be crucial in image retrieval (Matusiak, 2006; McDonald & Tait, 2003). However, the research environment of these studies was primarily in a designated image database system.

Using search logs from general or commercial search engines, several studies have focused on image search queries on the Web (Goodrum & Spink, 2001; Goodrum, Bejune, & Siochi, 2003; Jörgensen & Jörgensen, 2005; Pu, 2005). Their findings suggest that Web users enter short queries not only when searching for textual information, but also when searching for visual information. Query modification was also found to be important in image searching (Goodrum & Spink, 2001; Jörgensen & Jörgensen, 2005). Pu (2005) found that users’ image queries tended to focus on unique searches such as personal name searches rather than on textual queries. These studies suggest that there is a difference in search interests as well as in query types between textual search and image search.

A few studies investigated search strategies on the Web. In an experimental study with given tasks in a Google environment and a metadata image database, Fukumoto (2004) showed that viewing Web page operation, actions, time, inputting keywords, and keyword uniqueness were different based on tasks, i.e., search strategies varied depending on the nature of the search tasks. Cunningham and Masoodian (2006) examined casual image information-seeking behavior. They found that the average number of terms in a query was 2.24 terms; search engines were useful in finding appropriate terms to use in searching Google Images or in browsing image Websites. It was found that browsing was the primary strategy in satisfying information needs rather than searching. Goodrum et al. (2003) examined image search patterns (state transition) of graduate students on the Web. They found that the subjects input two queries, spent 20 minutes searching per image, and changed their initial queries frequently. The main characteristic of the patterns of transitions was that the longer strings and lengthier search times occurred when users searched for images using text-only search tools that retrieved lists of Website surrogates rather than image surrogates.

It is known that subject indexing or textual description supports image retrieval. Choi and Rasmussen (2002) found that textual information associated with an image was important for relevance assessment; also, date, title, notes, and subject descriptors were considered most helpful. In Hung’s (2005) study, journalism students relied on textual descriptions when judging relevance in general and subjective image search tasks. Matusiak’s (2006) study found a similar aspect—the majority of participants discovered that hyperlinked subject headings within records enabled them to find more images on the listed topic.

Summary

Previous studies on information seeking confirm that information-seeking behavior is multidimensional and holistic. Attributes of tasks and users are an important factor affecting information searching and retrieval. However, most studies focused on limited factors in relation to specific aspects of information search and retrieval. Furthermore, work task dimension generating actual information seeking had not been fully incorporated in research (Ingwersen & Järvelin, 2005). Thus, it is little known whether work tasks and associated factors play a role in real information searching and retrieval process. To expand our understanding of
the information-seeking behavior within context, and to fully understand the multidimensional aspects of context and their effects on the information-seeking process, research should examine a number of underlying contextual elements in the overall information searching and retrieval process rather than relying on narrow aspects of search behavior.

A few studies on the academic usage of images have demonstrated an increased use of digital images for teaching and learning, as well as the potential for a more diverse disciplinary market. The demand for providing more images and appropriate system support has increased for image use. Previous studies on image users provide insights into the tasks that give rise to image searches. The images' intended uses affect the image descriptions and queries. However, most of those studies dealt with simulated tasks, rather than real information needs in a natural situation. The value of information depends on the specific situation and the information needs of the particular individual (Martzoukou, 2005). Thus, they fail to provide a comprehensive picture of the impacts of contextual factors (e.g., user characteristics, goals, needs, and situation) on searching behavior. Above all, little research has been done to investigate the searching behavior for images when users rely heavily on the Web to find images (Green, 2006; Harley et al., 2006; Waibel & Arcolio, 2005) and when college students increasingly use the Web as an information resource (OCLC, 2005, 2006; Pew Research Center, 2002). In short, studies on users' image-seeking behavior on the Web are vital in that they will contribute to a theoretical understanding of context in image search and retrieval, to an empirical understanding of students' image searching, and to a user-centered system design and support.

Methods

This research collected empirical and descriptive evidence of the image information-searching process on the Web. The study employed various techniques to collect qualitative and quantitative data such as survey, interview, questionnaires, video capturing, observation, and thinking-aloud. This mix of methods is advocated by many researchers (Choo et al., 2000; Martzoukou, 2005; Pharo & Järvelin, 2004; Wang et al., 2000). The variables in the study were adopted from Kelly’s (2006a,b) study as well as from Ingwersen and Järvelin’s (2005) evaluation framework. The study collected the following attributes related to a work task and a searcher:

1. **Task goals**—The goal is the reason or activity that prompts the need to search for an image in a real daily-life situation. For example, images are needed for course-related projects or research, for a personal interest, or for work-related activities but not course related.
2. **Searching expertise**—The level of expertise of subjects’ online searching.
3. **Topic familiarity**—Subjects’ current state of knowledge about a topic.
4. **Work task stage**—Subjects’ assessment of their progress in completing a task.
5. **Task duration**—The length of time that subjects expected to be working on a task.
6. **A number of search sessions for a certain search task** (repeated search vs. one-time single search)—A search task that a subject performed a search one time or a search task that a subject repeated a search twice or three times across search sessions.

Table 1 shows the variables, data collection method, and data analysis used in this research. To verify the applicability of the data collection method, a pilot test was conducted with five students in different disciplines: nursing, history, art, and psychology.

**Participants**

Twenty-nine college students were recruited for data collection during the spring and summer semesters of 2008, mostly from the Department of Media Studies at a private university: 22 students in Media Studies and seven students from other fields taking courses in the Department; 22 females and seven males at an average age of 21 years. Background information collected included years of computer experience, hours per day using the Web, and self-rated online searching. A number of search sessions for a certain search task (repeated search vs. one-time single search)—A search task that a subject performed a search one time or a search task that a subject repeated a search twice or three times across search sessions.

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Participants had used computers for 12 years (standard deviation [SD] = 2.99) on average. They used the Web, not counting e-mail, as follows: 34.45% (10 participants) for less than 2 hours; 41.39% (12 participants) for 2 to 4 hours; and 24.13% (7 participants) for 5 hours or more. The Web was

<table>
<thead>
<tr>
<th>TABLE 1. Method of data collection and analysis.</th>
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<tbody>
<tr>
<td>Variables</td>
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<td>-----------------------------------------------</td>
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<tr>
<td>Attributes of user and task</td>
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<tr>
<td>Performance measures</td>
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<tr>
<td>Search moves and tactics</td>
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<tr>
<td>Relevance criteria and judgments</td>
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</table>
used not only for communication, but also for class purposes and entertainment. The average rating the participants gave for their own Web usage was 6.79 (SD = 0.41) for communication, 6.55 (SD = 0.63) for class purposes, and 6.28 (SD = 1.1) for entertainment on a scale from 1 (very often) to 7 (very often). The average rating the participants gave for their experience with Web search engines was 6.28 (SD = 0.8) on a scale from 1 (not very much) to 7 (a great deal).

**Table 2. Definitions of search moves.**

<table>
<thead>
<tr>
<th>Tactic</th>
<th>Move</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Querying</td>
<td>Web_query</td>
<td>Typing a query for Web search via a general search engine (i.e., Google Web)</td>
</tr>
<tr>
<td></td>
<td>Image_query</td>
<td>Typing a query for images search via a general search engine (i.e., Google Images)</td>
</tr>
<tr>
<td></td>
<td>Site_query</td>
<td>Typing a query in images search sites or a specific site</td>
</tr>
<tr>
<td></td>
<td>URL</td>
<td>Entering a URL in the address box</td>
</tr>
<tr>
<td>Navigating</td>
<td>Back</td>
<td>Clicking the browser’s Back button</td>
</tr>
<tr>
<td></td>
<td>Forward</td>
<td>Clicking the browser’s Forward button</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>Clicking the browser’s Home button</td>
</tr>
<tr>
<td></td>
<td>Image_tab</td>
<td>Clicking Images tab in a general search engine’s navigation bar</td>
</tr>
<tr>
<td></td>
<td>Web_tab</td>
<td>Clicking Web tab or other tabs in a general search engine’s navigation bar</td>
</tr>
<tr>
<td></td>
<td>Menu</td>
<td>Choosing a menu item on a Web page</td>
</tr>
<tr>
<td></td>
<td>Button</td>
<td>Clicking something other than a standard browser button</td>
</tr>
<tr>
<td>Scanning</td>
<td>SEG_Next</td>
<td>Moving around in a list of Web search results pages (i.e., Previous or Next to move to search results page)</td>
</tr>
<tr>
<td></td>
<td>SEI_Next</td>
<td>Moving around in a list of image search results pages (i.e., Previous or Next to move to search results)</td>
</tr>
<tr>
<td></td>
<td>Local_Next</td>
<td>Moving around in a list of search results pages via a local site search</td>
</tr>
<tr>
<td>Extracting</td>
<td>Image_clicking_SE</td>
<td>Clicking on an image thumbnail in an image search results page via a general search engine image search</td>
</tr>
<tr>
<td></td>
<td>Image_clicking_local</td>
<td>Clicking on an image or viewing via a specific Web page or site</td>
</tr>
<tr>
<td></td>
<td>SE_result_click</td>
<td>Clicking on a link in a search results page via a general search engine</td>
</tr>
<tr>
<td></td>
<td>PageLinking</td>
<td>Following a hyperlink in a Web page</td>
</tr>
<tr>
<td></td>
<td>Local_text_finding</td>
<td>Finding text on a local Web page</td>
</tr>
<tr>
<td></td>
<td>Enlarging</td>
<td>Enlarging (zooming) an image to view full-size image</td>
</tr>
<tr>
<td></td>
<td>Saving</td>
<td>Saving an image/Web page on computer, copying and pasting an image/URL in a Word document/PowerPoint slides, e-mailing/bookmarking URL, posting it on a social networking site</td>
</tr>
</tbody>
</table>

**Procedure**

Target participants were recruited via flyers, email announcement, and class announcement. In the recruitment process, participants were informed of the purpose of the study and asked to contact the researcher. Once participants contacted the researcher, they agreed to take part in three search sessions and were asked to decide their own search task before the first search session was set up. After the first search session they were asked to decide whether they would continue their first search task for the following session or not.

The study was conducted in an uncontrolled, natural setting based on participants’ own aptitudes and on their own pace with their own search goals. Each participant filled out a presearch questionnaire to collect a search task, topic, self-rated topic familiarity using a 7-point Likert scale. Search sessions were performed at the university’s information commons with the researcher’s laptop; Internet connectivity was provided too. The university’s home page was set as the default home for the Web browser. The participants chose their own browser: Internet Explorer or Firefox. The search session was recorded by Camtasia v. 5.0 as screen captures. There was no time limit for a search session. The participants were free to end a search session at any time. After the session a postsearch questionnaire was given to the participants to assess the level of usefulness, satisfaction, and confidence of their searching using a 7-point Likert scale. Once the first search session was completed, the following search session was scheduled within 2 weeks after the first. To reduce the learning effect, there was at least a week hiatus between each search session.

**Data Analysis Methods**

The researcher and a research assistant manually transcribed and codified the entire search process of 29 participants from screen capture log files and thinking-aloud protocol. The coded data were shared and verified between the two coders.

The nature of information-searching activities is iterative. People alternate browsing, searching, and evaluating during the information-searching process (Bates, 1989; Choo et al., 2000; Kuhlthau, 1993; Marchionini, 1995). Thus, it seems reasonable to look at the differences of the tactics by grouping the actions rather than by looking at a single action. Based on previous studies on browsing strategies and information seeking on the Web (Choo et al., 2000; Kari, 2004; Marchionini, 1995), search moves were defined (see Table 2 for definitions), captured, and categorized into four tactics as follows:

1. Querying tactics are the moves associated with the participants prompting an active interaction by either typing a URL to access a specific page or by formulating a search query.
2. Navigating tactics are the moves to define a boundary for objects.
3. Scanning tactics are the moves that compare sets of well-defined objects.
4. Extracting tactics are the moves of working through a particular source to select/copy/save relevant images.

The results were analyzed using quantitative as well as qualitative methods. For the quantitative analysis, the descriptive statistical data, analysis of variance (ANOVA), paired-sample t-test, and repeated measures were used for comparing performance, search tactics, and relevance. The means of the different participant groups were assessed. The qualitative analysis utilized content analysis to identify interesting incidents, such as where contextual factors were associated with an interaction. The Findings Based on the Qualitative Analysis section (below) presents the range of such incidents.

Results

During the three search sessions, 13 participants (44.83%) performed different search tasks while eight participants (27.59%) did the same task twice. Eight participants (27.59%) did the same task three times. To analyze the effect of the three search sessions on performance variables and search actions, an ANOVA test was conducted. The results showed no difference among three search sessions. Because the performance and other searching variables in general were not associated with a search session, the researcher treated each search session as an independent case. By doing so, the total number of cases increased to 87 instead of the originally planned 29; this improved the reliability of the statistical analysis.

Search Task Goals

There were three types of search task goals identified: academic-related task goals, work-related task goals, and personal activities or interests (Table 3). More than half of the search goals of the participants accounted for an academic-related task (60.92%). The participants also performed searches for various nonacademic tasks.

<table>
<thead>
<tr>
<th>Task goal</th>
<th>Example</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Academic task</td>
<td>Preparing a PowerPoint presentation or a project for a class; writing a research paper for a class</td>
<td>53 (60.92%)</td>
</tr>
<tr>
<td>Work-related task</td>
<td>Creating a slideshow on the production of ethanol and other biofuels for internship work; preparing a publication for incoming freshmen students; preparing a college newspaper article or a yearbook; making a Web site for the university career services; volunteering work for an attorney general campaign</td>
<td>16 (18.39%)</td>
</tr>
<tr>
<td>Personal interest/projects</td>
<td>Blog writing; bike building; e-shopping; activity participation; collage making for Mother’s Day gift; getting to know a place for a mission trip</td>
<td>18 (20.69%)</td>
</tr>
</tbody>
</table>

TABLE 3. Search task goals.
TABLE 4. Descriptive summary of search moves and tactics.

<table>
<thead>
<tr>
<th>Tactic</th>
<th>Move</th>
<th>Mean</th>
<th>Maximum</th>
<th>Sum</th>
<th>%</th>
<th>Tactic sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Querying</td>
<td>Web_query</td>
<td>4.21</td>
<td>28</td>
<td>366</td>
<td>3.59</td>
<td>1,178 (11.56%)</td>
</tr>
<tr>
<td></td>
<td>Image_query</td>
<td>5.55</td>
<td>24</td>
<td>483</td>
<td>4.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site_query</td>
<td>1.48</td>
<td>14</td>
<td>129</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>URL</td>
<td>2.30</td>
<td>8</td>
<td>200</td>
<td>1.96</td>
<td></td>
</tr>
<tr>
<td>Navigating</td>
<td>Back</td>
<td>31.22</td>
<td>127</td>
<td>2,716</td>
<td>26.64</td>
<td>3288 (32.25%)</td>
</tr>
<tr>
<td></td>
<td>Forward</td>
<td>0.41</td>
<td>10</td>
<td>36</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>0.05</td>
<td>2</td>
<td>4</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Image_tab</td>
<td>2.67</td>
<td>17</td>
<td>232</td>
<td>2.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Web_tab</td>
<td>1.22</td>
<td>15</td>
<td>106</td>
<td>1.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Menu</td>
<td>1.37</td>
<td>34</td>
<td>89</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Button</td>
<td>1.75</td>
<td>22</td>
<td>105</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>Scanning</td>
<td>SEG_Next</td>
<td>0.53</td>
<td>13</td>
<td>46</td>
<td>0.45</td>
<td>1,604 (15.73%)</td>
</tr>
<tr>
<td></td>
<td>SEI_Next</td>
<td>11.78</td>
<td>104</td>
<td>1025</td>
<td>10.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local_Next</td>
<td>6.50</td>
<td>109</td>
<td>533</td>
<td>5.23</td>
<td></td>
</tr>
<tr>
<td>Extracting</td>
<td>Image_clicking_SE</td>
<td>11.30</td>
<td>74</td>
<td>972</td>
<td>9.53</td>
<td>4,125 (40.46%)</td>
</tr>
<tr>
<td></td>
<td>Image_clicking_local</td>
<td>11.01</td>
<td>297</td>
<td>958</td>
<td>9.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE_Result_click</td>
<td>4.82</td>
<td>28</td>
<td>419</td>
<td>4.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PageLinking</td>
<td>5.86</td>
<td>29</td>
<td>510</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saving</td>
<td>5.05</td>
<td>28</td>
<td>439</td>
<td>4.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enlarging</td>
<td>9.17</td>
<td>48</td>
<td>798</td>
<td>7.83</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local_text_finding</td>
<td>5.80</td>
<td>18</td>
<td>29</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>10,195</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 5. Sources in generating search queries.

<table>
<thead>
<tr>
<th>Source</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queries via General Search Engine (e.g., Google Web)</td>
<td>365</td>
<td>37.32</td>
</tr>
<tr>
<td>Queries via Image Search Engine (e.g., Google Images or Yahoo Images)</td>
<td>483</td>
<td>49.39</td>
</tr>
<tr>
<td>Queries in a specific Web site</td>
<td>130</td>
<td>13.29</td>
</tr>
<tr>
<td>Total</td>
<td>978</td>
<td>100.00</td>
</tr>
</tbody>
</table>

new tab functionality among the participants in this study. Overall, the participants in this study did not seem to fully utilize many browser features when searching and navigating the Web.

Search Queries

A total of 978 queries (a mean of 11.24) were obtained as the entire string of terms submitted by the participants. Table 5 shows the distribution of search queries on a search engine, a search engine’s image search, and other specific sites. As found, Google Images search was the most frequent source for forming a search query. It is also noticeable that the participants actively submitted their queries in a specific site to interact with a local site. An average word per query was 3.25 ($SD = 1.69$). This finding of short queries is similar to that of previous studies on Web image queries (e.g., Cunningham & Masoodian, 2006; Goodrum & Spink, 2001; Jörgensen & Jørgensen, 2005).

Web users frequently modify their queries (Jansen, Booth, & Spink, 2009). This study found a similar trend. However, it is interesting to note that the average of the length in words of all queries in a search session was in this study much higher than that (7.7 queries with 25 minutes; the average number of search terms per query was 3.3) in Aula and Kaki’s (2003) study. Given that the participants in Aula and Kaki’s study were seven researchers in computer science conducting searches for their own work-related tasks, it is possible to conclude that image searches with words can lead to more frequent query changes than textual information searches, or searches involved with science-related tasks. In addition, relying on keywords to search nonverbal items may result in frequent query changes. With the fact that typing a query is one of the most frequent actions in image searching, as mentioned in the previous section, an investigation of pattern, query formulation, and change must be a focus on the image information-seeking process.

Six participants used a browser-built-in Google search box for 14 queries (1.43%). Only three participants used Boolean operators in 22 queries (2.25%). Eleven participants used a quotation mark in 89 queries (9.10% of 978 queries). Twenty-eight queries (2.86%) were based on a query suggestion by Google and a YouTube site.

Web pages directly accessed by typing a URL in an address box were as follows: Google ($n = 111, 55.5%$); other search engines ($n = 14, 7.0%$); YouTube ($n = 12, 6.0%$); image or photo sharing sites, (e.g., flickr.com, pixels.com) ($n = 11, 5.5%$); a course Blackboard site ($n = 6, 3.0%$); and other sites ($n = 46, 23.0%$). Google was thus the most frequent direct access point.

Relevance Judgment

During the presearch interview the participants were asked about the most important factor in image usefulness. Some of
the factors mentioned were related to the format of an image, credibility or reliability of images, time period of images, the size and quality of an image, accuracy, uniqueness, and topical relevancy. Below are examples of the participants’ comments.

- “The images need to be cartoons. I am going to be comparing them eventually with the cartoons in Dr. Seuss and they need to allow some sort of semiotic analysis.”
- “In order for the images to be useful, they need to come from a credible source. Therefore, I will be looking for citations of the image or Web site where I found my images.”
- “It must be an image that has many aspects to it so I can have enough to say in a five-page paper.”
- “The most important factors will be accuracy and quality of the image.”
- “The pictures for my melodrama class are supposed to be actual shots from the movie not just after-the-fact staged shots. This can be hard [to find].”
- “The most important factors would be that the images are clear and could support what my thesis is in the paper assignment. I would also hope the image came from a reliable source.”
- “The most important factors are things such as originality and whether they are real or manipulated.”
- “How closely they relate to my topic.”

While performing a search, the participants seemed to apply similar relevance criteria to a found target. For example, one participant said, “I like this one because I guess it’s older looking so I feel like it somehow fits the time period, although that one is primarily women, which might be a problem.” In addition, the participants were cautious about copyright issues in using a digital image. Credibility is a critical relevance criterion in deciding usage of a found digital image, as shown below.

- “It is [from]. edu site. So that means it is a very good source.”
- “This seems like it’s an AP picture that would be trusted.”
- “This seems like a good site to use any other time, too, because it has good questions and answers. But I don’t really know who made the site.”
- “This is a really good survey, I just want to go look back at the Web page a little more, and see if it’s credible enough to use… Looks like this is posted on a blog. Even if it’s good—if it’s posted somewhere else I’ll use it, but I don’t want to use something from the unexplained mysteries blog.”

At the end of the search session the participants were asked to assess the level of satisfaction, usefulness, and confidence with search results using a 7-point Likert scale (e.g., 1 = “not useful,” 7 = “very useful” for usefulness). Three relevance assessments were operationalized as follows (Kelly, 2006b; Vakkari, 2003):

- Usefulness—the extent the subjects believed retrieved images (an image) were (was) in helping to complete the task.
- Satisfaction—the extent of how satisfied the subjects were with the search results.
- Confidence—the extent the subjects were confident with the completion of the image search results.

<table>
<thead>
<tr>
<th>Measure</th>
<th>F</th>
<th>P</th>
<th>Academic task (N = 53)</th>
<th>Work task (N = 16)</th>
<th>Personal interest (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time duration</td>
<td>5.63</td>
<td>0.01*</td>
<td>1,253.55</td>
<td>1,002.88</td>
<td>675.72</td>
</tr>
<tr>
<td>Querying</td>
<td>8.58</td>
<td>0.00*</td>
<td>16.55</td>
<td>9.88</td>
<td>8.00</td>
</tr>
<tr>
<td>Navigating</td>
<td>4.12</td>
<td>0.02*</td>
<td>44.72</td>
<td>31.25</td>
<td>23.22</td>
</tr>
<tr>
<td>Scanning</td>
<td>1.62</td>
<td>0.21</td>
<td>17.85</td>
<td>27.00</td>
<td>12.56</td>
</tr>
<tr>
<td>Extracting</td>
<td>1.25</td>
<td>0.29</td>
<td>48.30</td>
<td>59.00</td>
<td>34.50</td>
</tr>
<tr>
<td>Total action</td>
<td>2.05</td>
<td>0.14</td>
<td>124.40</td>
<td>127.12</td>
<td>78.28</td>
</tr>
<tr>
<td>Usefulness</td>
<td>3.77</td>
<td>0.03*</td>
<td>5.72</td>
<td>6.12</td>
<td>6.56</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1.25</td>
<td>0.29</td>
<td>5.57</td>
<td>5.69</td>
<td>6.17</td>
</tr>
<tr>
<td>Confidence</td>
<td>0.62</td>
<td>0.54</td>
<td>5.47</td>
<td>5.50</td>
<td>5.89</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

As Table 6 shows, the search results were “highly considered useful and satisfied,” while the level of confidence was relatively lower than those of “usefulness and satisfaction.”

Effects of Contextual Factors on Performance, Search Tactics, and Relevance Judgments

Statistical analysis was performed to detect significant differences in image searching tactics, performance, and relevance judgments among contextual factors (task goal, topic familiarity, searching expertise, work task stage, task duration, and frequency of a search), using ANOVA with the significance level at 5%. It appears that “types of task goals” had an effect on performance time, querying, navigating, and usefulness of search results. Descriptive means between the groups of different goals showed that the participants performing a search for an academic task goal tended to have a long search session and modified queries frequently. The participants searching for images for an academic task felt that search results were less useful (Table 7). This study supports the concept that information work tasks play a role in users’ interactions. This concept is also found in the work by Kellar et al. (2007) and Thatcher (2008), which suggested an impact of task type on an interaction.

Regarding searching expertise, the participants with a lower level of searching expertise tended to spend more time performing a search, employ more querying tactics and navigating tactics, and rate usefulness and satisfaction with search results lower than those who had a higher level of searching expertise (Table 8).

Domain knowledge (expertise) has implications for the retrieval method and specification such as search tactics and
TABLE 8. Effects of searching expertise on performance, search tactics, and relevance.

<table>
<thead>
<tr>
<th>Measure</th>
<th>F</th>
<th>P</th>
<th>1 (N = 15)</th>
<th>2 (N = 36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time duration</td>
<td>1.01</td>
<td>0.42</td>
<td>12.00</td>
<td>18.50</td>
</tr>
<tr>
<td>Querying</td>
<td>0.44</td>
<td>0.85</td>
<td>41.50</td>
<td>31.50</td>
</tr>
<tr>
<td>Navigating</td>
<td>0.10</td>
<td>0.00</td>
<td>21.25</td>
<td>25.00</td>
</tr>
<tr>
<td>Scanning</td>
<td>0.44</td>
<td>0.85</td>
<td>66.75</td>
<td>58.50</td>
</tr>
<tr>
<td>Extracting</td>
<td>0.34</td>
<td>0.92</td>
<td>141.50</td>
<td>133.50</td>
</tr>
<tr>
<td>Total action</td>
<td>0.85</td>
<td>0.80</td>
<td>4.25</td>
<td>6.00</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

TABLE 9. Effects of topic familiarity on performance, search tactics, and relevance.

<table>
<thead>
<tr>
<th>Measure</th>
<th>F</th>
<th>P</th>
<th>4 (N = 15)</th>
<th>5 (N = 36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time duration</td>
<td>6.09</td>
<td>0.00*</td>
<td>1,606.20</td>
<td>944.03</td>
</tr>
<tr>
<td>Querying</td>
<td>6.05</td>
<td>0.00*</td>
<td>20.67</td>
<td>12.39</td>
</tr>
<tr>
<td>Navigating</td>
<td>5.57</td>
<td>0.01*</td>
<td>60.20</td>
<td>31.78</td>
</tr>
<tr>
<td>Scanning</td>
<td>2.19</td>
<td>0.12</td>
<td>26.27</td>
<td>12.53</td>
</tr>
<tr>
<td>Extracting</td>
<td>0.21</td>
<td>0.81</td>
<td>49.27</td>
<td>43.64</td>
</tr>
<tr>
<td>Total action</td>
<td>1.99</td>
<td>0.14</td>
<td>156.40</td>
<td>100.33</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

It is interesting that work task stage had a significant difference in the participants’ searching tactics for repeated searches over time. In the study, there were three groups involved because each participant conducted three searches during three separate sessions as follows:

- Group One—conducting three different searches for different goals during three sessions (13 participants × 3 sessions = total 39).
- Group Two—conducting two searches for the same goal and one search for a different goal (8 participants × 2 sessions for the same goal + 1 session for a different goal = total 24).
- Group Three—conducting three searches for the same goal during three sessions (8 participants × 3 sessions for the same goal = 24).

The first analysis examined the difference between the three groups. As Table 12 shows, extracting tactic was significantly different between the two groups (Group Two and Group Three) conducting searches for the same task twice and three times. The mean (64.12) of Group Two (performing a search twice for the same goal) was higher than the overall mean (47.08) while the mean (31.00) of Group Three

TABLE 10. Effects of working stage on performance, search tactics, and relevance.

<table>
<thead>
<tr>
<th>Measure</th>
<th>F</th>
<th>P</th>
<th>1 (N = 32)</th>
<th>2 (N = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time duration</td>
<td>4.08</td>
<td>0.00*</td>
<td>850.66</td>
<td>1,212.93</td>
</tr>
<tr>
<td>Querying</td>
<td>4.43</td>
<td>0.00*</td>
<td>9.94</td>
<td>13.86</td>
</tr>
<tr>
<td>Navigating</td>
<td>5.07</td>
<td>0.00*</td>
<td>28.56</td>
<td>42.07</td>
</tr>
<tr>
<td>Scanning</td>
<td>4.51</td>
<td>0.00*</td>
<td>12.94</td>
<td>18.07</td>
</tr>
<tr>
<td>Extracting</td>
<td>1.36</td>
<td>0.24</td>
<td>41.50</td>
<td>63.57</td>
</tr>
<tr>
<td>Total action</td>
<td>3.53</td>
<td>0.00*</td>
<td>92.94</td>
<td>137.57</td>
</tr>
<tr>
<td>Usefulness</td>
<td>0.74</td>
<td>0.62</td>
<td>6.22</td>
<td>5.50</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1.46</td>
<td>0.20</td>
<td>6.03</td>
<td>5.64</td>
</tr>
<tr>
<td>Confidence</td>
<td>0.64</td>
<td>0.70</td>
<td>5.62</td>
<td>5.36</td>
</tr>
</tbody>
</table>

= not very familiar; 7 = very familiar.
*The mean difference is significant at the 0.05 level.

= not very familiar; 7 = very familiar.
*The mean difference is significant at the 0.05 level.

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TABLE 11. Effects of task duration on performance, search tactics, and relevance.

<table>
<thead>
<tr>
<th>Measure</th>
<th>$F$</th>
<th>$P$</th>
<th>1 ($N = 12$)</th>
<th>2 ($N = 11$)</th>
<th>3 ($N = 19$)</th>
<th>4 ($N = 28$)</th>
<th>5 ($N = 8$)</th>
<th>6 ($N = 6$)</th>
<th>7 ($N = 3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time duration</td>
<td>0.89</td>
<td>0.51</td>
<td>837.17</td>
<td>993.45</td>
<td>1,148.11</td>
<td>1,057.57</td>
<td>1,442.12</td>
<td>1,340.33</td>
<td>889.33</td>
</tr>
<tr>
<td>Querying</td>
<td>0.87</td>
<td>0.52</td>
<td>10.17</td>
<td>10.91</td>
<td>13.21</td>
<td>14.64</td>
<td>17.88</td>
<td>16.17</td>
<td>11.67</td>
</tr>
<tr>
<td>Navigating</td>
<td>0.75</td>
<td>0.61</td>
<td>29.67</td>
<td>39.36</td>
<td>31.95</td>
<td>39.39</td>
<td>54.62</td>
<td>43.83</td>
<td>26.67</td>
</tr>
<tr>
<td>Scanning</td>
<td>1.09</td>
<td>0.37</td>
<td>20.00</td>
<td>12.09</td>
<td>11.42</td>
<td>23.29</td>
<td>25.38</td>
<td>26.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Extracting</td>
<td>1.42</td>
<td>0.22</td>
<td>42.67</td>
<td>41.45</td>
<td>36.21</td>
<td>47.96</td>
<td>53.38</td>
<td>95.50</td>
<td>42.00</td>
</tr>
<tr>
<td>Total action</td>
<td>1.08</td>
<td>0.38</td>
<td>102.50</td>
<td>103.82</td>
<td>92.79</td>
<td>125.29</td>
<td>151.25</td>
<td>181.50</td>
<td>84.33</td>
</tr>
<tr>
<td>Usefulness</td>
<td>0.83</td>
<td>0.55</td>
<td>6.50</td>
<td>5.91</td>
<td>5.74</td>
<td>5.79</td>
<td>6.00</td>
<td>6.17</td>
<td>6.67</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.65</td>
<td>0.69</td>
<td>6.00</td>
<td>6.27</td>
<td>5.53</td>
<td>5.71</td>
<td>5.38</td>
<td>5.17</td>
<td>5.67</td>
</tr>
<tr>
<td>Confidence</td>
<td>0.68</td>
<td>0.67</td>
<td>5.67</td>
<td>5.82</td>
<td>5.42</td>
<td>5.68</td>
<td>5.88</td>
<td>4.83</td>
<td>4.67</td>
</tr>
</tbody>
</table>

1 = one day; 2 = several days; 3 = one week; 4 = several weeks; 5 = one month; 6 = several months; 7 = 6+ months.

TABLE 12. Group differences on performance, search tactics, and relevance.

<table>
<thead>
<tr>
<th>Measure</th>
<th>$F$</th>
<th>$P$</th>
<th>Group One ($N = 39$)</th>
<th>Group Two ($N = 24$)</th>
<th>Group Three ($N = 24$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time duration</td>
<td>0.77</td>
<td>0.47</td>
<td>989.46</td>
<td>1,186.38</td>
<td>1,149.38</td>
</tr>
<tr>
<td>Querying</td>
<td>2.93</td>
<td>0.06</td>
<td>11.08</td>
<td>16.54</td>
<td>14.58</td>
</tr>
<tr>
<td>Navigating</td>
<td>1.12</td>
<td>0.33</td>
<td>35.74</td>
<td>45.50</td>
<td>33.42</td>
</tr>
<tr>
<td>Scanning</td>
<td>0.18</td>
<td>0.84</td>
<td>20.05</td>
<td>17.79</td>
<td>16.46</td>
</tr>
<tr>
<td>Extracting</td>
<td>3.32</td>
<td>0.04*</td>
<td>47.23</td>
<td>64.12</td>
<td>31.00</td>
</tr>
<tr>
<td>Total action</td>
<td>1.71</td>
<td>0.19</td>
<td>114.10</td>
<td>143.92</td>
<td>95.46</td>
</tr>
<tr>
<td>Usefulness</td>
<td>1.83</td>
<td>0.17</td>
<td>6.23</td>
<td>5.71</td>
<td>5.79</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.29</td>
<td>0.75</td>
<td>5.82</td>
<td>5.71</td>
<td>5.54</td>
</tr>
<tr>
<td>Confidence</td>
<td>0.46</td>
<td>0.64</td>
<td>5.67</td>
<td>5.33</td>
<td>5.62</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.05 level.

(performing a search three times for the same goal) was lower than the overall mean (47.08).

This difference may be related to a search session goal. In other words, when the same search is repeated the second time, the participants might want to retrieve as much relevant items as possible by actively following the links to an item and viewing it for relevance assessment and retrieval. On the other hand, on the third attempt for the same task their search session goal might be to check on additional relevant information or images to confirm or supplement previously found items. Thus, rather than actively clicking on individual items, their tactic might focus on browsing and navigating, in order to look for a different set of search results. In another case, as their knowledge and searching experience grew, they might be able to formulate precise queries to yield relevant items quickly because the total number of actions during the third search session was significantly lower than the second session, as described below. Vakkari (2000a) illustrated an increase of search terms used as the participant’s knowledge of the problem grew. Further analysis should be examined for differences of interaction activities to identify how a growth of knowledge and searching experience affect query formulation and navigation strategies while using the same information retrieval system.

To observe the effect of repeated searches over time on search performance and tactics, the paired samples $t$-test was done for Group Two and the repeated measures ANOVA test was done for Group Three (Table 13). The only variable showing a difference for Group Three (conducting the same goals three times) was the total number of actions (Session 1, 98.25; Session 2, 189.25; Session 3, 75.62). The first round and the last round of the searches produced a lower number of actions while the middle round produced a higher number of actions. For Group Two (performing two sessions for the same goal), the effect of ongoing searches over time was shown on the level of confidence ($t = 2.55, p = 0.04$). The confidence level of Group Two went up in the second session. The mean of the first session was 5.12, whereas the mean of the second session was 6.25. This finding is in direct contrast to Vakkari et al.’s (2003) study in which they found a decrease in the confidence level between the two sessions of the undergraduate students’ search using a bibliographic database (PsychINFO).

Findings Based on the Qualitative Analysis

In this section, results from the qualitative analysis are discussed to support an influence of contextual factors in searching process.

Querying. In a course of action to form a search query or identify an appropriate source, participants’ topic-related knowledge and search intention influenced their choice of a
The study also observed that system knowledge and searching experience of the participants affected query formulation and choice of an appropriate Web services. Here are a few examples:

- "Um, I’m really familiar with Google images. So, I’ll go to google.com, and click on images. And I think it’s really important to know which titles to use when you’re, um, searching. So I put in parentheses Resources . . . make sure it’s spelled right.” Toward the end of the search session this participant used another search engine, MSN, with the same query typed in Google. “Let me see if I’m gonna look . . . MSN. Because they have image search as well. Sometimes they have descriptions.”

- "Google allows you to have, to put the size of the image you want, so you can stay in that pattern, and I want the very big images."

- "Last time, I remember I put in specifically what I was researching, and I didn’t really get a lot of information, especially when it came to images. So what I’m gonna do is actually try the type of search that I’m hoping to find, which is images. So I’m just gonna type image search. And basically the reason why I’m doing that is sometimes you have Web sites that are dedicated specifically to images, and if I can find one, then I can research my topic through that.”

- "I haven’t searched yet, but I am wondering the actual book has a Web site with photos.” This participant initiated a Google Web search by entering a book title (sidewalk) as a search query. Then, from the search results, she found an author name, added it to a query, and moved to Google Image search results page via clicking on Image tab. Again, she said, “This is a picture in the book so that’s good.” In this case, it is very interesting to observe that the participant started a search on Google Web not directly on Google Images search. It seems that the participant wanted to gather additional information regarding what she was looking for in order to identify a precise search query to get to the target. This may represent a semantic gap in describing an image in words as well.

In forming a query, participants often used a search engine as a reference source to find a vocabulary or to check spelling. For example, a participant wanted to look for pictures on euthanasia for a course with a PowerPoint presentation. She began her search with euthanasia as her search query on Google Images search. After spending about 8 minutes on Google Images and saving nine pictures, she switched her search topic to look for more relevant images related to her search goal. In switching the topic, her topic knowledge enabled her to identify characteristics of things she was looking for: “Let’s look up the woman, Terri, I can’t remember her last name right now.” She clicked on Google’s Web tab and entered a query, terri life support. Then, from a search results page’s description, she found the full name (Terri Schiavo), and typed a search query in Google’s search query box. Without clicking on any link on the results page, she clicked on the Google Images tab to continue to browse image search results, indicating, “And I’m going back to images, because I’m talking about her story a little, too. Just for a minute, though, so I just want one picture.”

Navigating and scanning. It is reported that one of the well-known strategies in the searching process is moving through small steps from a general (broad) boundary to a more targeted boundary. This enables searchers to use information from their current situation to help determine where to go next. The approach is known as “orienteering” (Teevan et al., 2004). Orienteering behavior was apparent during the image searching process in the study. The participants applied orienteering when they started with a specific source related to a search topic rather than looking for the target directly. This search tactic resulted in a few steps of modifying queries and navigating for information access. The following is an example of such a case.

One participant wanted to find pictures of housing in a university for study abroad during summer: “Um, I’ve been accepted to a summer school this summer in Belfast, Northern Ireland. And I haven’t been on the campus, so I want to see what the housing’s going to be like.” She began with a Google Web search, typed the name of the university, clicked on one of the search results leading to the university’s Web site, proceeded to browse the site, and then typed a search term, virtual tour, on a local site search query box. Another participant employed a similar approach: “I will try to search a few other images. I will go to the official Port Rhode Island site to see what they have.” She clicked on Google Web tab, browsed a search results page without changing a query, and followed a link to an official Web site. Then she went on to browse the local site, saying, “They seem to have slide show. I will click on it.”

When the participants built different search strategies based on information and context gathered via search results, task goals and topic knowledge clearly guided this
orienteering behavior. The following are examples from three different participants’ searching process:

- “I am going to search for images of two U.S. Senate candidates . . . um . . . from my home state of Montana . . . and I’ll probably start with just their name and if that doesn’t turn up what I’m hoping for . . . which so far doesn’t appear to be [laughs], um, then I’ll use their name combined with either Montana . . . something that will, uh, help me narrow it down, so . . . .” (In this case, the task goal was categorized as work-related task.)
- “The one I just found is on a blog from the 2007 world Air Guitar Championships in Finland [after reading description on a blog]. This is not what I am looking for. I am looking for United States.” She clicked on the Back button to go back to the search results page, and then revised her query from air guitar to United States air guitar championships.
- “I found that after putting in . . . uh . . . what did I enter? ‘Mudd brand’ . . . okay . . . um, but this is 2006. I guess that doesn’t matter. I can still look at these. It’s interesting. (Her reading aloud) ‘The campaign, Mudd Girls Move the World, is designed to inspire teens to make a difference in their community while boosting the Mudd brand.’ See, this is exactly what I’m talking about. That’s an interesting article to read. I’ll take a look at that later. So, I’m just going to copy this [a URL of the Web page]. And now I’m going to put in 2008, and see if that gets me anything.” (During this process, the participant’s topic knowledge impacted her search strategy and further searches.)

Extracting and relevance judgment. In order to extract the appropriate sources or resources, users consistently evaluate search results for decision making to meet their information needs. In this process, topic knowledge, a working stage, and task goal seem to have an impact on interpreting the meanings of an image and relevance judgment. Often, the participants encountered or generated interesting ideas based on what they found. Furthermore, in assessing relevance of the found image, the participants seemed to rely on text within context of a page where an image presents its meaning. It is clear that the participants interacted with image content and assessed the relevance of it within both their own context and image content context in a page. Below are examples:

- “I’m going to save this one. Well, I can’t tell from this image alone that it’s from the century that I want, but it says over here that it is, and then also I’m talking about paper about how the poverty would sow disease, and this is, like, a cartoon on how the public, or the public policy dealt with finding out how to deal with the cholera. So, I haven’t really written about that, but since I have that image, maybe I’ll be able to.”
- “This is a good cartoon. Because it says this woman died of overwork, and in the mirror she’s dead. So I think that—I talk a lot about people who make garments and why they were so underpaid, and I think I’ll be able to at least just get a sentence or two out of that.” . . . [The participant read text on the Web page of an image] . . . “This link was helpful. It came from the picture Web site. So I ended up not using the picture that was on Google, but I used a couple others from the same Web site it came from.”

- “I’m going to be searching for, uh, images of the Coptic Orthodox Church for a class. So, I will look for a broad range of images on . . . I’ll start by searching Coptic Church . . . I think I might include this, because Saint Mark is the father of the Coptic Church, and so . . . having a picture of him I think would be good. . . . This one’s kind of cool, because it shows like . . . this . . . because it’s the old . . . we were learning about this one . . . it’s the old church and they rebuilt the new one next to it, so, the old one is now just a museum and that’s kind of cool, I like the street signs and everything around it.”

It appears that the participants were cautious about the credibility, reliability, and quality of Web resources. The participants checked information quality before final relevance judgment. In this process, a chaining action following links to other pages (Choo et al., 2000) was ensued, as shown in the examples below:

- “Maybe this . . . BMA, what’s that stand for? . . . I can google BMA. Because I don’t know what that is.” This participant opened another tab, typed google.com, went back and forth between two tabs to gather information about BMA (British Medical Association), and inserted a query of BMA united kingdom.
- “It is a good graph. They say it is from Renewable Fuels Association. I am going there to see if they have more.” This participant typed a new search query (Renewable fuels association) in a query box on the upper right corner on the browser and clicked on the first link on the search results page.

While following a link to Wikipedia via Google Web, one participant said, “I use Wikipedia, which . . . even though Wikipedia is not a credible source, because anybody can really put information on here, and they don’t have any images, really, they . . . it tells me the owner of Diesel, so I can find out now his opinion of that . . . and also, um, maybe there’s a link to his global warming site which I’m trying to find . . . um . . . .” Then she copied text from the Wikipedia page, typed in the Google Web URL, and pasted the copied text as a new query. She next reviewed the first page, then clicked on Google Image tab.

Theoretical models of information searching address the importance of the social/organizational environment in understanding the interaction of users with information systems (Järvelin & Inngwersen, 2004). However, little is known of its impact on information-seeking behavior. The study observed that the social/organizational environment was another factor in determining ways of information searching—query formulation, relevance judgment, and source selection. The following example shows the effect of the social/organizational environment on Web-searching behavior:

- “This is one of the movies that we had to watch in class, and, um . . . maybe I’ll try to type this into IMDB. A lot of people in my class, they’re using movies, . . . they’re going to get pictures of specific scenes from here, so, I don’t know, like, that’s going to be their method of searching, I think the majority of people in my class know about the site, and . . . .”
TABLE 14. Summary of the effect of contextual factors on measures of information searching process.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Task goal</th>
<th>Level of searching expertise</th>
<th>Topic familiarity</th>
<th>Working stage</th>
<th>Task duration</th>
<th>Repeated search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search time</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Querying</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navigating</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scanning</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extracting</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total action</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>*(From a group performing three searches for the same task goal)</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*(From a group performing two searches for the same task goal)</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. An asterisk symbol (*) means a significant difference was observed; empty cell means no significance.

- “This project is a group project, and I know somebody’s focusing on the turmoil that’s going on, so I think that would be good for his slide.”
- “I’m going to try a new search. I’m searching for the author of the book that we read. That is sparking my teacher to have us write this paper. . . . I want to take this one. The author that we read used it, so I might be able to use his ideas and say, ‘As he included it in this image . . . ’ I can show it too and use it for my own writing.”

**Summary of Results**

Based on the theoretical frameworks that suggest search processes occur within contexts, this study examined an impact of the contextual factors on image searching processes on the Web. In terms of general Web-searching behavior, the findings of this empirical study were consistent with those of previous studies—dominant Google search, short query, rare use of Boolean operators, little use of advanced search options, and heavy backtracking. Key interaction activities influenced by contextual factors were search time, querying, navigating, and usefulness, whereas scanning, extracting, number of actions, satisfaction, and confidence were less affected by the contextual factors (Table 14). The most prominent searching tactics showing variation by different contextual factors were querying and navigating. Usefulness among different relevance aspects was significantly different based on the contextual factors. Among the contextual factors examined, task goals, work task stages, and searching expertise appeared to be the most influential factors in information searching and retrieval, while task duration did not have any effect on interaction. Topic familiarity appeared to be associated with only usefulness and confidence. It appears that text around an image was also important for relevance judgment since it provided the context of the image. Content analysis also demonstrated that social/organizational aspects affected information searching strategies and orienteering strategies were noticeable during an interaction on the Web.

**Discussion**

The findings of this study confirm that information searching is context-dependent and specific contextual variables can be examined in the search process. Among those variables, this study indicates an effect of work task types and work task stage on seeking process. Work task types and work task stage have hardly been explored in information seeking and IR (Ingwersen & Järvelin, 2005; Kelly, 2006; Vakkari & Hakala, 2001). It is also assumed that a work task yields a sequence of the activities a person has to perform in order to accomplish a goal, either work-related tasks or leisure-related tasks (Hansen, 2005). More emphasis of IS&R research should be focused on recognizing how users incorporate their context in searching information according to work task types and its work task stage of task completion.

This study also identified a semantic gap that existed in searching for images. One participant said, “We’ve studied some of this in class, so I kind of have an idea of, you know, when I see something that is what I want . . . .” Also, the participants expressed difficulties in coming up with search terms even if they had something in mind. The Web interaction, combining direct image search and related textual search, helped the participants overcome such a gap by generating multiple queries to specify information need and through performing cross-searches between different Web sources. In this interaction, various contextual attributes played an important role for search strategy and interaction. As the significance of querying tactics seems clear in image searching, more investigations of query formulation and changes in image seeking and retrieval process are desirable to provide insights on whether different search queries can lead searchers to a different searching process. Additionally, studies are needed to identify any relationship between querying/navigation and various task attributes so as to better understand how users actively utilize the Web as an information retrieval system for keyword-based image search.

While there is an indication that information-seeking behavior is an iterative process, previous research mainly examined individual search sessions. In observing information seeking, studies should take into account the iterative and repetitive nature of seeking behavior and examine different characteristics of multisearch sessions. However, this study found that repeated searches (multiple search sessions) only differed on extracting tactics, total actions, and confidence.
Another participant demonstrated a similar approach: “I’ve
Web users eliminate unwanted sources or expand pools of
This would ideally encourage a searcher to easily try to mod-
addition, as many libraries and cultural organizations digitize
or a contextual understanding of the image found or further
image. Such metadata on the Web page inspired new ideas
contextual information or key metadata associated with an
image. Such metadata on the Web page inspired new ideas
and deliver their special image collections online, library profes-
sionals need to focus more attention on metadata practices
and various information services for their digital image col-
llections. The meanings and content of images rendered in
metadata descriptions become contextual content for images
and help users evaluate its use in a decision-making process.
In addition, when digital images and their metadata from
a local collection are exported to image search sites such as
Flickr, careful planning and assessment of metadata elements
is necessary to examine what types of contextual metadata
are most meaningful. Only then can they provide the appro-
propriate content and context of images necessary to support
the possible information needs wherever they are hosted and
accessed.

Google is the most common starting point when it comes
to Web searching. As expressed by one participant, “I don’t
think Google is that credible ... good, but ... it gets you
started on where to begin.” The participant’s comment reflects
that a searcher has a lack of knowledge on different sources
when searching for images on the Web. Also, users’ percep-
tion on Web searching contributes to their searching process.
This was best exemplified by one of the participants: “I usually
don’t like to spend too much time on one Web site, if
I can’t see what I’m looking for, at the first look, I usually
change, because I don’t want to spend too much time on it.”
Often, they expected that a library would offer relevant guid-
ance or sources for image resources related to their tasks.
These findings suggest implications for image information
literacy programs or library services when identifying and
guiding a wide selection of image sources and search tools
for local community users.

Conclusion

This study examined undergraduates’ image-searching
processes on the Web in order to identify how contextual
factors relate to image-seeking processes and interaction on
the Web. A variety of techniques were employed to collect
qualitative and quantitative data. The study found that a Web
user’s searching process was impacted by contextual factors.
They also influenced searching tactics and strategy in the
way that Web users are able to learn and process what they
have found. The participants carried their task-related char-
acteristics and the context of their needs during the search
process to fulfill their information objective. Those character-
istics gave rise to subsequent needs for further searching and
navigation.

The results of the study provide empirical data on the
behavior of users’ image searching on the Web. This research
thus enhances our understanding of how contextual elements
are linked to a particular information-searching process. It
stimulates further research on the role of context and builds
more robust theories of information seeking in context. Addi-
tionally, the study identifies interaction activities that should
be factored into system designs as well as tools that can better
optimize a user’s image-searching process on the Web.
The study was intended to provide insights into different spectrums of Web interaction in the course of searching different types of information (visual information). In order to collect an empirical data of image searching, the study relied on undergraduate students mainly majoring in Media Studies at a single, higher educational institution. Thus, the scope of this study should be regarded as a limitation to generalizing the findings in information-seeking behavior. This limitation suggests that future research should focus on finding similarities and differences among visual information-seeking behavior with different disciplines in various work environments in order to help build a model of image information seeking in context.

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References


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