An Exploration of the Relationships Between Work Task and Interactive Information Search Behavior

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This study explores the relationships between work task and interactive information search behavior. Work task was conceptualized based on a faceted classification of task. An experiment was conducted with six work-task types and simulated work-task situations assigned to 24 participants. The results indicate that users present different behavior patterns to approach useful information for different work tasks: They select information systems to search based on the work tasks at hand, different work tasks motivate different types of search tasks, and different facets controlled in the study play different roles in shaping users' interactive information search behavior. The results provide empirical evidence to support the view that work tasks and search tasks play different roles in a user's interaction with information systems and that work task should be considered as a multifaceted variable. The findings provide a possibility to make predictions of a user's information search behavior from his or her work task, and vice versa. Thus, this study sheds light on task-based information seeking and search, and has implications in adaptive information retrieval (IR) and personalization of IR.

Introduction

Various types of tasks have been discussed, such as work task, information-seeking task, information search task, and information retrieval task in information science (Byström & Hansen, 2005). Among these types of tasks, work task is viewed as a motivation of other types of tasks and has been defined from different perspectives. For instance, Ingwersen (as cited in Hansen, 1999) defined it as an underlying problem of a person’s actual work from a cognitive perspective. Byström and Hansen (2002) viewed work tasks as “separable parts of a person’s duties towards his/her employer” (p. 242).

For the purpose of this study, work task refers to an activity people perform to fulfill their responsibility for their work, such as a work-related task.

Different levels of information behavior also have been addressed. Wilson (1999a, 1999b) presented a nested model of information behavior to depict information-seeking and information search research areas. This model includes the following three levels: information behavior, information-seeking behavior, and information search behavior. Wilson (1999a) defined information behavior as a general area; information-seeking behavior should be its subset with the focus on “the variety of methods people employ to discover, and gain access to information resources” (p. 263); information search behavior was defined as a subset of information-seeking behavior, which is concerned with the interactions between users and information systems. Therefore, the difference between information seeking and information search is that users conduct information search through information systems only, but they may seek information from other sources such as people or printed documents. In this study, “interactive information search behavior” was used to emphasize the interaction between users and information systems and between users and their work task at hand, such as query formulation, iteration, scanning, selecting, evaluating, systems selection, and so forth.

Work task has been a starting point to examine information-seeking and search behavior. Its effect on information-seeking behavior has been investigated in different contexts (Algon, 1999; Byström, 1999; Landry, 2006). To articulate the relationships between work tasks and information-seeking behavior, some studies have focused on how users seek information in a certain work-task context or situation (Hjørand & Christensen, 2002; Vakkari, Pennanen, & Serola, 2003). Some have directly examined work task as an independent variable and its impact on human information-seeking and search behavior. This group
of studies investigated: (a) how task characteristics, such as task complexity (Byström, 2002; Byström & Järvelin, 1995), task stage (Wang, 1997), task interdependence (Cross, Rice, & Parker, 2001), and so forth, impact information-seeking or search behavior; (b) how work task shapes users’ information-seeking and search behavior (Algon, 1999; Pharo, 2002, 2004; Solomon, 1997); and (c) how work task affects users’ interaction with a specific document genre (Freund, Toms, & Clarke, 2005; Freund, Toms, & Waterhouse, 2005).

While most of these studies have focused on how work task shapes users’ information-seeking behavior, much fewer empirical studies have been conducted to explore how work task affects a user’s interaction with information systems (Hansen, 2005). One exception is Pharo’s (2002, 2004) empirical demonstration that work task is an influential factor in shaping the interaction between users and systems. Moreover, previous studies have focused more on investigating how search task affects a user’s information search behavior (e.g., Hsieh-Yee, 1998; Lorigo et al., 2006; Marchonini, 1989; Qiu, 1993) and have ignored the role of work task. Therefore, this study placed work task in a central role of information search to investigate its effects on users’ interactive information search behavior.

Several theoretical frameworks have been proposed to inform empirical studies on work task and information-seeking or search behavior. Leckie, Pettigrew, and Sylvain (1996) developed an information-seeking model of professionals, within which work roles and associated tasks are the motivation of professionals’ information seeking. Hansen (1999) and S. Kim and Soergel (2005) summarized different task characteristics. Their studies have suggested that it is still necessary to exert great effort in clarifying how task characteristics shape information-seeking behavior. Vakkari (2003) extensively reviewed the studies on task-based information search and retrieval aimed at informing empirical studies in this area. Järvelin and Ingwersen (2004) discussed the direction of information-seeking research and proposed a model to incorporate information seeking and interactive information retrieval (IIR) into a framework. This model involves different levels, including socioorganizational and cultural context, work-task context, seeking context, and IR context. Byström and Hansen (2002, 2005) put forward a three-level model to clarify the relationship between work task, information-seeking task, and information search task. Freund, Toms, and Waterhouse (2005) identified the contextual parameters of information behavior (e.g., consultant, engagement, work task, and problem) through interviewing the software engineers.

To make predictions of search task and information behavior via work task, Li (2004; Li & Belkin, 2008) took a faceted approach to conceptualizing tasks. Based on an extensive review of literature discussing task types or classification schemes in organizational management, social psychology, and information science, Li and Belkin (2008) identified different facets, subfacets, and values of tasks to develop a faceted classification of tasks. This classification is composed of categories, facets, subfacets, and values. The categories include “generic facet of task” and “common attributes of task.” The former includes different facets, such as source of task, task doer, time, product, process, and goal; the latter includes task characteristics and user’s perception of task. Li (2008) conducted an empirical study to refine the classification and make it more applicable to classifying real work tasks and search tasks. Li (2009) employed it to explore the relationships between work tasks and interactive information search. It also provides a holistic approach to conceptualizing tasks. Work tasks could be described based on different facets, subfacets, and values, by which it is possible to investigate the relationships between multifaceted work tasks as well as different facets of work tasks and interactive information search behavior (Li, 2008).

Therefore, this study explored the relationships between work task and interactive information search behavior in two ways: (a) by examining the relationships of work task as an integrated, multifaceted variable and interactive information search behavior; and (b) by examining the relationships of different facets of work task and interactive information search behavior. This article reports the results of the former relationships, and a separate article will report the results of the latter relationships.

**Literature Review**

**Work Tasks and Information-Seeking and Search Behavior**

Li (2009) extensively reviewed the studies related to work tasks and information-seeking and search behavior. This section gives a summary of these studies.

Byström (1996, 1999, 2002, 2005) and colleagues (Blomgren, Vallo, & Byström, 2004; Byström & Järvelin, 1995) found that with the increase of the task complexity, people needed more types of information, were less likely to predict the types of information they need, and were more dependent on experts to provide useful information. Algon (1999) indicated that verbalizing as an information-related behavior (IRB) occurred most often; IRBs and tasks were associated with each other either positively or negatively; and, personal and/or situational factors (PSFs) served as a filter between tasks and IRBs. To investigate the role of information seeking in an international oil and gas company, Ellis and Haagan (1997) found that R&D project phases and types led to different information-seeking behavior. In different project phases, team members conveyed information in different ways and gathered information from different channels. The study indicated that information systems are an important information source only for some tasks. Landry (2006) investigated the effects of work roles and associated tasks on dentists’ selection of information sources, based on Leckie et al.’s (1996) information-seeking model of professionals. The results have indicated that the type of work role-related tasks significantly affected information-source selection of the dentists.
The aforementioned studies have indicated that work task plays a critical role in shaping users’ information-seeking behavior. However, these studies were much more concerned with the effect of work task on information-seeking behavior than on interactive information search behavior.

Work task was examined as a context of information search or retrieval. Kuhlthau (1991, 1993) proposed a six-stage information search process model (ISP), including initiation, selection, exploration, formulation, collection, and presentation, based on five studies that investigated users’ information search behavior after they were assigned term papers. In a similar vein, Vakkari (2000) and Vakkari et al. (2003) indicated that the problem stages of the students from information science were associated with their search tactics and term selection when they were searching for their master’s thesis.

Work task also was investigated as an independent variable in information search or retrieval. Wang (1997) suggested that work-task stage impacted users’ term selection: Users usually selected basic-level terms at the beginning, and subsequently, broader and narrower terms were introduced. Search Situation Transition Method Schema (Pharo, 2002, 2004) includes five categories that influence people’s information search behavior: work task, search task, searcher, social/organizational environment, and search process (i.e., search transition and search situation). Pharo (2002) showed that work task directly as well as indirectly impacted search process, especially the relevance level (Saracevic, 1996). The study also identified several dimensions of work task, including goal, complexity, resource, size, and stage. The results illustrated that work task and search task play different roles to shape users’ information search behavior, and revealed that work task could be investigated from various dimensions. However, how different dimensions of work task impact information search behavior remains an open issue.

Grounded on the context sphere model (Freund, Toms, & Waterhouse, 2005), Freund, Toms, and Clarke (2005) demonstrated a strong association between tasks and document genres. Different work tasks (e.g., software engineering, consulting, and sales) as well as information tasks (e.g., doing, learning, fact finding, and demonstrating) seemed the major reason leading to the variation among tasks and genres. The findings of this study suggest that it is possible to make predictions of document genres in information retrieval from work tasks users are performing.

**Search Tasks and Information Search/Retrieval Behavior**

The effect of search task on information search behavior has been widely investigated. Marchionini (1989) indicated that the participants took more time and performed more moves for the open-ended task than they did for the closed task. Similarly, Qiu (1993) found that users tended to adopt a more structured search pattern when engaging in the specific task than they did for the general task. Moreover, users preferred to use browsing features for completing the general task, but analytical searching for the specific task. K.-S. Kim and Allen (2002) and K.-S. Kim (2001) found that task type (known item search vs. subject search) significantly affected precision and recall, search time, the number of Web pages viewed by searching, the number of embedded links used, the use of jump tools, and the number of keyword searches completed. Hsieh-Yee (1993) found that when users searched for known items, whether the desired information objects were image or text did not lead to the difference of search tactics, and successful subject search greatly depends on keywords. By identifying the dimensions of tasks, J. Kim (2006, 2009) demonstrated that task types (factual tasks, interpretive tasks, and exploratory tasks) significantly influenced information search interaction in terms of pages saved and the ratio of pages viewed to pages saved as well as information search strategies with respect to method, object, and mode (Belkin, Marchetti, & Cool, 1993). These studies have indicated that search task is an important factor shaping users’ information search behavior. Specifically, a subject-search task, an interpretive task, or an exploratory task required users to exert more effort to interact with the systems than did a known-item search task or a factual task.

Some studies have conceptualized search tasks in different ways to examine their effects on interaction. Toms, Freund, Kopak, and Bartlett (2002) found that there were significant differences between users’ behaviors when they conducted tasks in different domains such as consumer health, general research, shopping, and travel. The findings have suggested that a personalized interface is necessary for different search tasks. Using operationalized task types as navigational tasks and informational tasks, Lorigo et al. (2006) explored the influence of task and gender on users’ search and evaluation behavior when using Google. The study found that different task types influenced time and pupil dilation in general while gender affected the patterns of evaluating the query result abstracts. Xie (2006) found that for a search task, it was necessary to take all three dimensions (i.e., nature of tasks, type of tasks, and time frame) into account. These dimensions greatly affected users’ decision, collaboration, and strategy activities during their interaction with IR systems. Based on a field study, Kellar, Watters, and Shepherd (2007) characterized Web-based information-seeking tasks such as fact finding, information gathering, browsing, transaction, and other. The participants interacted differently with the Web when engaging in different tasks. Many information-gathering tasks were motivated by participants’ course and research work, and these tasks also were most complex in terms of dwell time, pages viewed, and Web browser function used.

From a different perspective, Gwizdka and Spence (2006) examined how users’ behavior could indicate the difficulty of a factual information-seeking task. The results have indicated that higher search effort, lower navigational speed, and lower search efficiency were good predictors of subjective posttask difficulty. Task complexity affected subjective judgment of task difficulty and the relative importance of the predictors of subjective task difficulty.

The aforementioned studies have indicated that search task plays a critical role in shaping information search behavior.
However, the role of work task was ignored, although it is agreed that work task is a motivation of search task.

Interaction With Information and Information Systems

Allen (1996) identified several indispensable actions during the process of interaction, such as scanning, reviewing and evaluating, learning, and planning. All these actions could be viewed as “behavior” in the current study. He further noted that these actions could be a sequence, and any interaction with the system requires users to scan the response, evaluate the response, learn from the response, and plan additional actions. Similarly, Cool and Belkin (2002) recognized four prototypical interactions with information, such as finding a (partially) known information object, recognizing useful information objects by scanning through an information resource, evaluating the usefulness of information objects, and determining the content/structure of a set or collection of information objects. The studies have provided a general description of users’ interaction with information systems and information.

Some studies have conceptualized these actions or behaviors from a faceted approach. Belkin, Marchetti, and Cool (1993) proposed a model of multiple information-seeking strategies (ISSs). This model includes four facets, and each facet has two subfacets: Mode (recognition, specification), Method (scanning, searching), Goal (learning, selecting), and Resource (information, meta-information). Based on this classification, they identified 16 ISSs and designed an interactive interface, BRowsing And QUEry formulation (BRAQUE), and a prototype system MERIT to support ISSs (Belkin, Cool, Stein, & Theil, 1995). To classify users’ Web interaction and improve the model (Belkin, Marchetti, & Cool, 1993), Pharo (1999) proposed a similar one, including three dimensions: Method (scanning, searching, linking), Goal (learn, select, illustrate, or verify), and Resources (documents, surrogates). This updated model leads to 18 ISSs. Compared to Belkin, Marchetti, and Cool’s (1993) model, Pharo (1999) added some new interactive behavior occurring in the Web search, such as “linking.” Also based on Belkin, Marchetti, and Cool’s ISSs, J. Kim (2009) found that different tasks affected users’ manipulation of information-seeking strategies in different degrees.

Users’ interaction with information and information systems were operationalized as more specific behavior for different research purposes. To examine specifically how interface design influenced users’ interactive information search behavior, Belkin and colleagues (Belkin, Cool, Jeng, et al., 2001; Belkin, Cool, Kelly, et al., 2001; Belkin et al., 2002; Belkin, Cool, et al., 2003; Belkin, Kelly, et al., 2003) designed an experimental interactive system each year in a progressive investigation of techniques supporting interactive query reformulation. They measured interactive information search behavior via pages seen, unique pages seen, pages viewed, unique pages viewed, number of documents saved, number of final saved documents, number of iterations by users, and so on. To evaluate the use of automated assistance in IR systems, Jansen (2005) examined different aspects of interaction, such as viewing result pages, viewing assistance, executing query, implementing assistance, navigation, and action indicating relevance. J. Kim (2006) investigated how search tasks influenced information-searching interaction, including time spent, pages viewed, pages saved, pages saved/pages viewed, and query reformulation. The results indicated that search tasks affected the interaction. These studies have explored different types of interactive information search behavior, but did not take into consideration the effects of work tasks.

Building on naturally collected verbal protocol data, Byrne, Jon, Wehrle, and Crow (1999) presented a taxonomy of tasks in which users engage during browsing the Web. Top-level tasks included “use information task,” “locate on page,” “go to page,” “provide information,” “configure browser,” and “react to environment.” Subtasks also are identified; for example, the subtasks of “use information task” involve “read/view/listen, save to disk, display for others, duplicate, and print.” In fact, all these tasks and subtasks are named “behavior” in the present study. The taxonomy involves users’ interactive behavior when searching the Web. It suggests that users’ behaviors are different from interacting with traditional IR systems. With the increasing use of the Web to gather information for work tasks, interaction with information systems will be more complicated.

In summary, previous studies have focused more on how work task affects information-seeking behavior, how search task shapes users’ information search behavior, and how users interact with IR systems. As a starting point, work tasks were mostly classified based on hierarchical classification schemes that are based on one aspect of work task, such as task complexity, interaction, task stage, goal, and so on. This approach is helpful in understanding how work task affects users’ information-seeking and search behavior in terms of one aspect. However, it could not give a holistic picture of work task and how work task as a multifaceted variable shapes users’ interaction with information systems. In addition, empirical studies on work task and interactive information search behavior are still lacking. Few studies have directly examined the relationships between work task and interactive information search behavior. Nevertheless, such studies are important for advancing IIR systems design because (a) work task is a motivation of information search, and it is important to know how this motivation shapes users’ interactive information search behavior; (b) the lack of such studies hinders the capability of making predictions of users’ information search behavior based on their work task at hand; and (c) the lack of such studies makes it hard to adapt IIR systems to users’ work task and personalize search results. Accordingly, a comprehensive investigation of how work task shapes users’ interactive information search behavior can advance the understanding of the role which work task plays during the course of information search as well as help improve IIR systems design to provide better support for users’ work tasks. Thus, this study explored the following
question: How do work tasks relate to users’ interactive information search behavior?

Method

The purpose of this study was to investigate the relationships of work tasks and interactive information search behavior. To examine in depth how and why users behave in certain ways, an experiment was designed to collect data. As with other research methods, an experiment also has drawbacks, such as not using real users’ tasks, not searching in a real context, and so forth. However, because information search is affected by contexts, situations, and even emotion of users, an experiment can limit the influence of these factors. Combined with a set of well-designed work tasks, questionnaires, think-aloud guidelines, and interview questions, an experiment could provide rich data to effectively examine the relationships of work task and interactive information search behavior.

Variables and Measures

Work-task types. Work-task types were operationalized based on the faceted classification of task (Li, 2004; Li & Belkin, 2008). Specifically, work-task types were described as the combinations of different values from different facets or subfacets; however, based on the classification, millions of work-task types could be generated. It was not realistic to test all work-task types in an experiment. Hence, to build up work-task types, some facets could be varied with their values, and some should be kept constant (i.e., kept to one value). Moreover, if too many facets varied in the task types, more participants should be recruited, and more work-task situations should be developed. That will not be realistic in an experiment because of time and budget limitations. For this reason, a study was conducted to identify the most influential facets or subfacets of work task on search task and information search behavior before conducting the present study (Li, 2008). The results indicated that “product” and “objective task complexity” played the most important roles; thus, both could be varied with their values. Some values of the facets or subfacets were not appropriate for testing in this experiment, such as “internal-generated,” “middle,” “final,” “high interdependence;” however, these facets were found to be significantly related to search task and information search behavior (Li, 2008). Hence, they were kept constant to a testable value such as “external-generated,” “beginning,” “low interdependence,” and so on. Because some generic facets and subfacets of work task cannot be controlled in an experiment (e.g., “time,” “process,” and some subfacets of “users’ perception of tasks” including “knowledge of task topic,” “knowledge of task procedure,” “subjective task complexity,” and “difficulty”), the experiment participants were asked to assess them during the experiment. Some facets or subfacets were not significantly related to search task and information search behavior, such as “task doer” and “goal (quality).” These facets and subfacets were not taken into account. In sum, work-task types were varied with the values of “product” and “objective task complexity” in the experiment, and some facets or subfacets were kept constant whereas some were assessed by the participants.

“Product” has the following three values: physical (P), intellectual (I), and decision/solution (D). “Objective task complexity” also has three values: high (H), moderate (M), and low complexity (L). To operationalize, a work task with high, moderate, and low objective complexity involved at least five subtasks; at least three, but less than five, subtasks; and less than three subtasks, respectively. Because the experiment was conducted at a state university, where “physical” product tasks are not as frequently performed as “intellectual” and “decision/solution” product tasks, the value “physical” was dropped. Hence, two values of “product” and three values of “objective task complexity” were used to construct the work-task types. As a result, six work-task types were constructed for the experiment: IH, IM, IL, DH, DM, and DL (see the Appendix). Considering the way work-task types were constructed, the study also probed the following question: How do the two facets of work task, product and objective task complexity, affect users’ interactive information search behavior, respectively?

Work tasks and search tasks. After identifying the work-task types, another important issue is to develop work-task situations. Because it is hard to compare the participants’ interactive information search behavior if they conduct different work tasks during the experiment, the experiment did not use their real work tasks. Instead, several simulated work-task situations (Borlund, 2000; Borlund & Ingwersen, 1997) were developed based on the work-task types identified earlier. These simulated work-task situations were revised from the real work tasks collected by Li (2008). The participants needed to identify search tasks by themselves based on simulated work-task situations. The Appendix shows the facets or subfacets and values involved, work-task types, and simulated work-task situations.

Participants were asked to assess the values of the facets and subfacets that were not embedded in the task types in the questionnaires. For the generic facets of work task and search task, they were asked to select the statements that appropriately describe work-task situations. In addition, they were required to assess the work task and search task attributes from “Totally disagree (1)” to “Extremely agree (7),” or from “Extremely simple (1)” to “Extremely complex (7),” or from “Extremely unknowledgeable (1)” to “Extremely knowledgeable (7).”

Interactive information search behavior. Various interactive information search behaviors were categorized under different aspects of interaction, such as general interaction efforts, interaction with Web resources, interaction with library resources, and query-related interactive behavior. Some measures of interactive information search behavior were derived from Belkin, Cool, Kelly, et al. (2001), Jansen (2005), and J. Kim (2006). Table 1 lists these aspects of interaction and their measures and operational definitions.
<table>
<thead>
<tr>
<th>Interaction</th>
<th>Measures</th>
<th>Operational definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>General interaction efforts</td>
<td>IR Systems consulted</td>
<td>The mean number of IR systems consulted by the participants for a work task. IR systems here include search engines, OPAC systems, and databases.</td>
</tr>
<tr>
<td></td>
<td>Result pages viewed</td>
<td>The mean number of result pages viewed by the participants for a work task, regardless of whether the result pages were viewed from the Web or libraries.</td>
</tr>
<tr>
<td></td>
<td>Items viewed</td>
<td>The mean number of items viewed by the participants for a work task, regardless of whether the items were viewed from the Web or libraries. Items here refer to Web pages, full-text papers or articles (any format, e.g., .doc, .pdf, and .html), and bibliographic records.</td>
</tr>
<tr>
<td></td>
<td>Items selected</td>
<td>The mean number of items selected by the participants for a work task, regardless of whether the items were selected from the Web or libraries.</td>
</tr>
<tr>
<td>Interaction with Web resources</td>
<td>Search engines consulted</td>
<td>The mean number of search engines consulted by the participants for a work task.</td>
</tr>
<tr>
<td></td>
<td>Web result pages viewed</td>
<td>The mean number of result pages viewed from the Web during the search for a work task.</td>
</tr>
<tr>
<td></td>
<td>Portals visited</td>
<td>The mean number of portals visited for a work task. Portals here refer to any individual Web sites serving as a direct or an indirect entrance for items.</td>
</tr>
<tr>
<td></td>
<td>Web items viewed</td>
<td>The mean number of items viewed by the participants for a work task from the Web.</td>
</tr>
<tr>
<td></td>
<td>Web items selected</td>
<td>The mean number of items selected for further use from the Web. These items are judged as useful, somewhat useful, or possibly useful information to support a work task.</td>
</tr>
<tr>
<td>Interaction with library resources</td>
<td>Library resources consulted</td>
<td>The mean number of library resources consulted. Library resources include OPAC systems, databases subscribed to by a library, and other resources from a library Web site.</td>
</tr>
<tr>
<td></td>
<td>Library results pages viewed</td>
<td>The mean number of result pages viewed during the search for a work task from a library Web site.</td>
</tr>
<tr>
<td></td>
<td>Library items viewed</td>
<td>The mean number of items viewed through the links from a library Web site, per work task.</td>
</tr>
<tr>
<td></td>
<td>Library items selected</td>
<td>The mean number of items selected for further use for a work task from a library Web site. They are judged as useful, somewhat useful, or possibly useful information to support a work task.</td>
</tr>
<tr>
<td>Query-related interactive behavior</td>
<td>No. of iteration</td>
<td>The mean number of queries issued by the participants during the search for a work task.</td>
</tr>
<tr>
<td></td>
<td>Unique queries</td>
<td>The mean number of unique queries issued by the participants during the search for a work task.</td>
</tr>
<tr>
<td></td>
<td>Mean query length</td>
<td>The average length of all queries in the search for a work task (in words).</td>
</tr>
<tr>
<td></td>
<td>Unique non-stop query terms</td>
<td>The mean number of unique non-stop words in all of the queries in the search for a work task. Non-stop words include all words except general stop terms such as prepositions, articles, and conjunctions.</td>
</tr>
</tbody>
</table>

**Data Collection**

Questionnaires administered to the participants during the experiment included (Li, 2008):

- An entry questionnaire was used to collect demographic data, including educational background, age, gender, occupation, search expertise, search experience, and computer experience. It was revised based on Kelly (2004).
- A simulated work-task situation evaluation questionnaire was designed to evaluate the generic facet “time (frequency),” “time (length),” and “process” of the work tasks. It also was used to elicit the participants’ assessment of their perception of the work tasks, including “difficulty,” “knowledge of task topic,” “knowledge of task procedure,” and “subjective task complexity.”
- A presearch questionnaire asked the participants to first describe their search task and then evaluate the generic facet time (frequency), presearch task difficulty, presearch subjective task complexity, and their knowledge levels in terms of search task topic and task procedure.
- A postsearch questionnaire asked the participants’ perception on search results, search process, difficulty, and complexity of the search task. Some measures were derived from Bell and Ruthven (2004), Hornbæk (2006), Maynard and Hakel (1997), Norris (2006), and Scholtz (2006).
- A follow-up interview was conducted to explore the questions related to the relationships between tasks and interactive information search behavior after the participants completed the search for each work-task situation.
• An exit interview focused on the participants’ general perception regarding how work tasks influenced their interaction with the systems. The interview involved several open questions and was conducted after the participants completed all searches.
• A think-aloud guideline was designed to elicit the participants’ cognitive activities during their interaction with the information systems. The participants were required to read the guideline before the experiment and following it during the course of the search.

The software tool Morae 2.0 logged all participants’ activities during the experiment.

Experiment

Design. This experiment was conducted in July 2007. To avoid learning effects and other biases, intellectual tasks (I) (i.e., IL, IM, IH) were separated from each other, as were decision/solution tasks (D) (i.e., DL, DM, DH). In addition, the two low-complexity work tasks (L) were separated from each other, as were the two moderate- (M) and the two high-complexity (H) work tasks. Accordingly, for the first 12 participants, each type of task appears in each position (Task 1–Task 6) twice.

Participants. Students were recruited from a state university to participate in the study. Participants were recruited from 20 majors, including library and information science, political science, media studies, communication, sociology, urban planning and policy, Chinese, anthropology, oceanography, biomedical engineering, computer science, electronic and computer engineering, math finance, and so on. According to the design, at least 12 participants were needed. Twenty-four (10 females, 14 males) participants were recruited. Each participant was paid $25 as compensation. Due to the possible influence of participants’ academic background and educational level (Case, 2002), we recruited 12 (6 undergraduates, 6 graduate students) participants from the social sciences and humanities; the other 12 (6 undergraduates, 6 graduate students) participants were from science and engineering, for a total of 12 undergraduate and 12 graduate students. Twelve participants (50%) were between the ages of 18 and 27 years, 10 (42%) were between 28 and 37 years, and only 2 participants (8%) were older than 37 years.

Search experience. Twenty-one participants (87.5%) rated themselves as an experienced searcher in using search engines; however, only 7 participants (29.0%) rated themselves as an experienced searcher in using library online catalogs. Nineteen participants (79.2%) rated themselves as capable finders. Twenty participants (83.3%) searched for their assignments or work-related projects weekly or daily. Seventeen participants (70.8%) searched for entertainment on a daily or weekly basis. Nineteen participants (79.2%) assessed themselves as expert searchers. None of participants rated themselves as having low expertise in searching online. The participants felt confident in information searching; 4 participants had professional training in information searching. The average number of years the participants had been conducting online searches was 7.29 (SD = 2.66) years. Sixteen participants (67%) reported that they have been conducting online searches over 7 years. All participants listed Google as one of their favorite search engines; 6 participants also listed Yahoo.

In general, participants were experienced with online information searching. They frequently search for information to support their work tasks.

Tasks. Six simulated work-task situations corresponding to the six work-task types were used for the experiment (see the Appendix). As mentioned previously, they were revised based on the real work tasks collected by Li (2008).

Setting. The experiment was conducted in the interactive lab in the School of Communication and Information at Rutgers University. The software Morae 2.0 was installed on the computer and recorded the entire experiment; participants were informed of this before beginning the experiment.

Experimental systems. Participants could select any systems appropriate for the work tasks during the experiment. This is a natural way that users engage in information search for their tasks at hand, and more and more studies have taken this approach (e.g., Kellar et al., 2007; Kelly, 2004).

Procedures. Participants first signed the consent form and filled out the entry questionnaire. After reading the first work-task situation, they filled out a simulated work-task situation questionnaire and then a presearch questionnaire. They then were required to carefully read the “think-aloud guideline.” The search lasted up to 15 min (Thatcher, 2008; Wang, Hawk, & Tenopir, 2000). After finishing the search, they were given a postsearch questionnaire and then a follow-up interview. Participants then moved to the second work-task situation and repeated the same procedure as the first task. After completing all the searches, an exit interview was conducted. After the experiment was over, participants signed a form and received compensation.

Data Analysis

Morae 2.0 recorded 24 experiments and generated 24 recordings. This software allows marks for all interactive information search behavior listed in Table 1 in each recording, and the search for each work task could be identified after the “Start” point and “End” point of the search were marked. After all recordings were marked, the markers were reexamined to ensure accuracy. Based on the characteristics of data collected from the questionnaires and recordings, different statistical tests such as MANOVA, one-factor repeated measures ANOVA, one-way ANOVA, and two-factor repeated measures ANOVA were performed by using SPSS software to examine the relationships between work tasks and users’ interaction with information systems.
Results

Twenty-four participants conducted the search for the six work-task situations. Participants searched for a total of 144 work tasks (6 work tasks × 24 participants). This section reports the results based on the analysis of these work tasks and associated interactive information search behavior.

Completion of information search for work tasks  Two questions in the postsearch questionnaire asked: “1: Did you have enough time to complete the search for the work task?” and “2a: Did you get enough information to support your work task?” For both questions, participants needed to check either “Yes” or “No.” This section reports the completion of the search for the work tasks from these two perspectives (i.e., time sufficiency and information sufficiency). If participants answered “Yes,” they completed the search; if they checked “No,” they did not complete the search for the work task. Figure 1 shows whether in terms of time sufficiency or information sufficiency that most participants answered “Yes” for DL compared to other work tasks. For IH, however, most participants said “No,” with only 8 and 6 participants who completed the search in terms of time sufficiency and information sufficiency, respectively. Chi-square tests indicated that there was a significant difference in the number of participants who reported “N” for the six work-task situations in terms of either time sufficiency, $\chi^2(5, n = 20.78), p < 0.01$, or information sufficiency, $\chi^2(5, n = 15.80), p < 0.01$. This indicates that the six work-task situations were significantly different in terms of difficulty or complexity to the participants.

Work Tasks and General Interaction Effort

Participants could search any IR systems during the experiment, including library Online Public Access Catalogs (OPACs), search engines, databases and indexes, and so forth, for useful information to support their work tasks. MANOVAs were performed. Overall, there was a significant effect of the work tasks on users’ general interaction effort, $F(20, 4) = 13.84, p < 0.05$, Wilks’s $\lambda = 0.014$. To specifically examine the effect of work tasks on each measure of general interaction effort, Table 2 shows the means, SDs, and $F$ values by one-factor repeated measures ANOVA. Significant difference among the six work tasks were detected in terms of each measure of general interaction efforts.

General usage of IR systems and other resources. Further post hoc tests (Bonferroni) indicated that for DL, the participants consulted significantly fewer IR systems than for all other work tasks ($p < 0.01$). They consulted significantly fewer IR systems for IL than for IH ($p < 0.01$) and DM ($p < 0.01$), significantly more IR systems for IM than for DH ($p < 0.01$), significantly more IR systems for IH than for DH ($p < 0.01$), and significantly more IR systems for DM than for DH ($p < 0.01$). Therefore, for different work tasks,

![FIG. 1. Task completion in terms of time sufficiency and information sufficiency.](image)

<table>
<thead>
<tr>
<th>Work tasks</th>
<th>IL</th>
<th>IM</th>
<th>IH</th>
<th>DL</th>
<th>DM</th>
<th>DH</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR systems consulted</td>
<td>1.13 (0.54)</td>
<td>1.92 (0.93)</td>
<td>1.96 (0.91)</td>
<td>0.25 (0.44)</td>
<td>1.87 (0.74)</td>
<td>1.04 (0.36)</td>
<td>23.91**</td>
</tr>
<tr>
<td>Result pages viewed</td>
<td>4.58 (2.60)</td>
<td>4.75 (2.56)</td>
<td>6.38 (3.24)</td>
<td>1.04 (1.30)</td>
<td>6.42 (2.89)</td>
<td>4.67 (2.79)</td>
<td>13.87**</td>
</tr>
<tr>
<td>Items viewed</td>
<td>7.67 (5.05)</td>
<td>8.04 (3.77)</td>
<td>7.92 (5.14)</td>
<td>5.46 (3.67)</td>
<td>9.04 (3.25)</td>
<td>12.00 (7.01)</td>
<td>5.80**</td>
</tr>
<tr>
<td>Items selected</td>
<td>4.04 (2.05)</td>
<td>5.50 (2.30)</td>
<td>5.08 (4.85)</td>
<td>2.75 (1.48)</td>
<td>4.00 (1.72)</td>
<td>5.25 (3.03)</td>
<td>4.78**</td>
</tr>
</tbody>
</table>

IL = Intellectual, Low objective task complexity; IM = Intellectual, Moderate objective task complexity; IH = Intellectual, High objective task complexity; DL = Decision/Solution, Low objective task complexity; DM = Decision/Solution, Moderate objective task complexity; DH = Decision/Solution, High objective task complexity.

** $p < 0.01$. 

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the participants consulted a significantly different number of IR systems. IM, IH, and DM relied more on IR systems; however, among these three work tasks, there was not a significant difference in the number of IR systems consulted.

**Result pages viewed.** In contrast, post hoc tests (Bonferroni) indicated that participants viewed significantly fewer result pages for DL than for all other work tasks \((p < 0.01)\), among which no significant difference was detected.

**Items viewed.** Once participants opened an item during the search, this item was “viewed.” Post hoc tests (Bonferroni) indicated that for DL, participants viewed significantly fewer items than they did for DM \((p < 0.05)\) and DH \((p < 0.01)\), but no significant difference was found between DM and DH.

**Items selected.** For each work task, participants were required to report whether the items they viewed were useful and would be selected for their work tasks. Post hoc tests (Bonferroni) found that for IL, participants selected significantly fewer items than they did for IM \((p < 0.01)\). In addition, they selected significantly more items for IM than they did for DL \((p < 0.01)\) and DM \((p < 0.05)\); for DL, they selected significantly fewer items than they did for DH \((p < 0.05)\).

**Work Tasks and Interaction With Web Resources**

MANOVAs indicated a significant effect in general of the work tasks on users’ interaction with Web resources, \(F(25, 413.85) = 8.05, p < 0.01,\) Wilk’s \(\lambda = 0.23\). To specifically examine the relationships between work tasks and different interactive behavior, Table 3 shows the means, SDs, and \(F\) values by one-factor repeated measures ANOVA. A significant difference was found among the six work tasks in terms of each measure of interaction with Web resources.

Participants visited search engines a total of 147 times for the six work tasks. Google Web (to distinguish from other Google products) was used 116 times (78.9%). Other search engines the participants visited included Google Scholar, Google Book Search, Yahoo.com, Ask.com, Ask Jeeves, and About.com. Post hoc tests (Bonferroni) indicated that for DL, the participants consulted significantly fewer search engines than they did for other work tasks \((p < 0.01)\). In other words, participants may not heavily depend on search engines for completing DL. Post hoc tests (Bonferroni) indicated that for DL, participants viewed significantly fewer result pages than they did for all other work tasks \((p < 0.01)\) when searching the Web. They visited significantly more portals for DL than they did for IM, IH, and DM \((p < 0.01)\); they visited significantly more portals for DL than they did for IM, IH, and DM \((p < 0.01)\); and they visited significantly more portals for DH than they did for IM \((p < 0.05)\), IH \((p < 0.01)\), and DM \((p < 0.01)\). Post hoc tests (Bonferroni) detected that participants viewed significantly more items for DH than they did for IM and DL \((p < 0.05)\). They selected significantly more items for DH than they did for DL \((p < 0.05)\).

**Work Tasks and Interaction With Library Resources**

Because participants used databases and indexes in this study through library Web sites, these resources and library OPAC systems are labeled library resources. To collect supportive information for the work tasks, participants consulted much fewer library resources than Web resources, although they consulted library resources for most of work tasks. Overall, the MANOVA did not detect a significant effect of the work tasks on users’ interaction with library resources. However, one-factor repeated measures ANOVA found significant differences among the six work tasks in terms of the number of library resources consulted, library result pages viewed, and library items viewed. Table 4 presents the means, SDs, and \(F\) values.

Post hoc tests (Bonferroni) indicated that for IL, participants consulted significantly fewer library resources than they did for IM \((p < 0.05)\) and IH \((p < 0.01)\), but for IM and IH, participants consulted significantly more library resources than for DH \((p < 0.01)\). They also consulted significantly more library resources for DM than for DH \((p < 0.05)\). No significant differences across IM, IH, and DM were found. Further post hoc tests (Bonferroni) indicated that for DH, participants viewed significantly fewer result pages than they did for IM and IH \((p < 0.05)\) while they viewed significantly more result pages for IM compared to IL \((p = 0.05)\). However, no significant difference was found among IM, IH, and DM. Moreover, post hoc tests (Bonferroni) found that participants viewed significantly more items for DM than they did for IL and DH \((p < 0.01)\).
TABLE 4. Interaction with library resources in terms of different work tasks.

<table>
<thead>
<tr>
<th></th>
<th>IL</th>
<th>IM</th>
<th>IH</th>
<th>DL</th>
<th>DM</th>
<th>DH</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library resources consulted</td>
<td>0.04 (0.21)</td>
<td>0.79 (0.98)</td>
<td>0.71 (0.75)</td>
<td>0.00 (0.00)</td>
<td>0.46 (0.72)</td>
<td>0.04 (0.20)</td>
<td>10.39**</td>
</tr>
<tr>
<td>Library result pages viewed</td>
<td>0.13 (0.45)</td>
<td>1.21 (1.69)</td>
<td>1.58 (2.57)</td>
<td>0.00 (0.00)</td>
<td>0.96 (1.60)</td>
<td>0.21 (0.72)</td>
<td>6.22**</td>
</tr>
<tr>
<td>Library items viewed</td>
<td>0.04 (0.20)</td>
<td>1.46 (2.81)</td>
<td>1.50 (2.62)</td>
<td>0.00 (0.00)</td>
<td>1.63 (1.72)</td>
<td>0.08 (0.41)</td>
<td>6.48**</td>
</tr>
<tr>
<td>Library items selected</td>
<td>0.00 (0.00)</td>
<td>1.08 (2.04)</td>
<td>1.67 (4.05)</td>
<td>0.00 (0.00)</td>
<td>0.92 (1.77)</td>
<td>0.04 (0.20)</td>
<td>3.28</td>
</tr>
</tbody>
</table>

Items that are italicized are not included in ANOVA tests. IL = Intellectual, Low objective task complexity; IM = Intellectual, Moderate objective task complexity; IH = Intellectual, High objective task complexity; DL = Decision/Solution, Low objective task complexity; DM = Decision/Solution, Moderate objective task complexity; DH = Decision/Solution, High objective task complexity.

**p < 0.01.

TABLE 5. Query-related interactive behavior in terms of different work tasks.

<table>
<thead>
<tr>
<th></th>
<th>IL</th>
<th>IM</th>
<th>IH</th>
<th>DL</th>
<th>DM</th>
<th>DH</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iteration</td>
<td>3.83 (2.10)</td>
<td>4.38 (2.76)</td>
<td>4.92 (2.34)</td>
<td>1.04 (1.46)</td>
<td>5.67 (2.20)</td>
<td>4.04 (2.97)</td>
<td>11.79**</td>
</tr>
<tr>
<td>Unique queries issued</td>
<td>3.00 (1.38)</td>
<td>3.46 (2.34)</td>
<td>3.88 (2.71)</td>
<td>1.00 (1.35)</td>
<td>4.33 (1.63)</td>
<td>3.83 (2.81)</td>
<td>8.84**</td>
</tr>
<tr>
<td>Mean query length</td>
<td>2.91 (0.92)</td>
<td>2.69 (0.73)</td>
<td>3.63 (0.96)</td>
<td>1.10 (1.40)</td>
<td>3.05 (1.26)</td>
<td>3.15 (1.21)</td>
<td>16.41***</td>
</tr>
<tr>
<td>Unique non-stop terms used</td>
<td>4.87 (2.21)</td>
<td>4.83 (3.33)</td>
<td>7.00 (3.62)</td>
<td>2.00 (3.04)</td>
<td>6.92 (3.86)</td>
<td>6.87 (4.06)</td>
<td>9.41***</td>
</tr>
</tbody>
</table>

IL = Intellectual, Low objective task complexity; IM = Intellectual, Moderate objective task complexity; IH = Intellectual, High objective task complexity; DL = Decision/Solution, Low objective task complexity; DM = Decision/Solution, Moderate objective task complexity; DH = Decision/Solution, High objective task complexity.

**p < 0.01.

Work Tasks and Query-Related Interactive Behavior

A MANOVA indicated a significant effect of the work tasks on users’ query-related interactive behavior, F(20, 4) = 7.37, p < 0.05; Wilks’ λ = 0.026. Table 5 lists the means, SDs, and F values by one-factor repeated measures ANOVAs. The results indicated a significant effect of the work tasks on each measure of query-related interactive behavior.

Post hoc tests (Bonferroni) indicated that the participants issued significantly fewer queries, unique queries, and shorter queries for DL than for all other work tasks (ps < 0.01). Participants issued significantly fewer unique, non-stop query terms for DL than they did for IL (p < 0.05), IH (p < 0.01), DM (p < 0.01), and DH (p < 0.01). They also issued significantly shorter queries to the systems for IM than they did for IH (p < 0.05).

Product and Objective Task Complexity of Work Tasks and Interactive Information Search Behavior

Two facets were varied across their values to construct the simulated work tasks in this study. The facet product has two values: decision/solution (D) and intellectual (I). The facet objective task complexity has three values: low (L), moderate (M), and high complexity (H). This section is devoted to examining how these two facets affect the participants’ interaction with the systems.

Product and objective task complexity on the general interaction effort. Table 6 shows product main effects for the number of IR systems consulted and result pages viewed. Participants consulted significantly more IR systems and viewed significantly more result pages for the intellectual work tasks than they did for the decision/solution work tasks; however, there were not product main effects for the number of items viewed and items selected.

In terms of participants’ general interaction effort, objective task complexity main effects were found for the number of IR systems consulted, number of result pages viewed, and number of items viewed.

Post hoc tests (Bonferroni) found that participants consulted significantly fewer IR systems for the low-complexity work tasks than they did for the moderate- (p < 0.01) and high-complexity work tasks (p < 0.01). They consulted significantly more IR systems for the moderate-complexity work tasks than they did for the high-complexity work tasks (p < 0.01). Participants viewed significantly more result pages for the moderate- (p < 0.01) and high-complexity work tasks than they did for the low-complexity work tasks (p < 0.01). They also viewed significantly fewer items for the low-complexity work tasks than they did for the moderate- (p < 0.01) and high-complexity work tasks (p < 0.01). Results showed that the significant difference occurred between the low-complexity work tasks and the moderate- and high-complexity work tasks.

The analysis yielded a significant interaction between product and objective task complexity in terms of the number of IR systems consulted, F(1.54, 35.47) = 6.46, p < 0.01 (Greenhouse–Geisser), number of items viewed, F(2.46) = 6.77, p < 0.01, and number of items selected, F(1.59, 36.87) = 10.34, p < 0.01 (Greenhouse–Geisser). Therefore, these two facets significantly interacted with each other and interactively affected the participants’ general interaction effort with the systems.
TABLE 6. Mean (SD), main effects, and interaction: “Product,” “OTC,” and general interaction effort.

<table>
<thead>
<tr>
<th>Facets</th>
<th>Values</th>
<th>IR systems consulted</th>
<th>Result pages viewed</th>
<th>Items viewed</th>
<th>Items selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>I (n = 72)</td>
<td>1.67 (0.89)</td>
<td>5.24 (2.90)</td>
<td>7.88 (4.63)</td>
<td>4.88 (3.33)</td>
</tr>
<tr>
<td></td>
<td>D (n = 72)</td>
<td>1.06 (0.85)</td>
<td>4.04 (3.30)</td>
<td>8.83 (5.56)</td>
<td>4.00 (2.39)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>26.01**</td>
<td>7.42*</td>
<td>1.24</td>
<td>0.28</td>
</tr>
<tr>
<td>Objective task complexity (OTC)</td>
<td>L (n = 48)</td>
<td>0.69 (0.66)</td>
<td>2.81 (2.71)</td>
<td>6.56 (4.51)</td>
<td>3.40 (1.89)</td>
</tr>
<tr>
<td></td>
<td>M (n = 48)</td>
<td>1.90 (0.83)</td>
<td>5.58 (2.84)</td>
<td>8.54 (3.52)</td>
<td>3.75 (2.15)</td>
</tr>
<tr>
<td></td>
<td>H (n = 48)</td>
<td>1.50 (0.92)</td>
<td>5.52 (3.12)</td>
<td>9.96 (6.42)</td>
<td>4.31 (3.40)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>40.09**</td>
<td>22.25**</td>
<td>8.45**</td>
<td>2.59</td>
</tr>
</tbody>
</table>

* p < 0.05. ** p < 0.01.

TABLE 7. Mean (SD), main effects, and interaction: “Product,” “OTC,” and interaction with Web resources.

<table>
<thead>
<tr>
<th>Facets</th>
<th>Values</th>
<th>Search engines consulted</th>
<th>Portals visited</th>
<th>Web result pages viewed</th>
<th>Web items viewed</th>
<th>Web items selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>I (n = 72)</td>
<td>1.15 (0.55)</td>
<td>3.89 (3.83)</td>
<td>4.14 (2.78)</td>
<td>6.88 (5.03)</td>
<td>3.96 (2.90)</td>
</tr>
<tr>
<td></td>
<td>D (n = 72)</td>
<td>0.89 (0.68)</td>
<td>5.74 (6.35)</td>
<td>3.68 (3.14)</td>
<td>8.22 (5.71)</td>
<td>3.68 (2.40)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>13.33**</td>
<td>1.23</td>
<td>8.33**</td>
<td>2.33</td>
<td>0.28</td>
</tr>
<tr>
<td>Objective task complexity (OTC)</td>
<td>L (n = 48)</td>
<td>0.67 (0.63)</td>
<td>8.79 (6.22)</td>
<td>2.75 (2.71)</td>
<td>6.50 (4.58)</td>
<td>3.40 (1.89)</td>
</tr>
<tr>
<td></td>
<td>M (n = 48)</td>
<td>1.27 (0.61)</td>
<td>1.67 (1.89)</td>
<td>4.50 (3.01)</td>
<td>6.98 (3.81)</td>
<td>3.75 (2.24)</td>
</tr>
<tr>
<td></td>
<td>H (n = 48)</td>
<td>1.13 (0.49)</td>
<td>3.98 (4.05)</td>
<td>4.48 (2.87)</td>
<td>9.17 (7.01)</td>
<td>4.31 (3.53)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>18.61**</td>
<td>45.75**</td>
<td>8.48**</td>
<td>5.03*</td>
<td>2.59</td>
</tr>
</tbody>
</table>

* p < 0.05. ** p < 0.01.

Product and objective task complexity on interaction with Web resources. Table 7 shows product main effects for the number of search engines consulted and the number of Web result pages viewed. Participants consulted significantly more search engines and viewed significantly more result pages on the Web for the intellectual work tasks than they did for the decision/solution work tasks.

Table 7 shows that objective task complexity main effects also were found for the number of search engines consulted, number of portals visited, number of Web result pages viewed, and number of items viewed; however, no objective task complexity main effect was found for Web items selected. Post hoc tests (Bonferroni) showed that for the low-complexity work tasks, participants consulted significantly fewer search engines than they did for the moderate- and high-complexity work tasks (p < 0.01), and viewed significantly fewer Web items than they did for the high-complexity work tasks (p < 0.05).

The analysis yielded significant interactions between product and objective task complexity for the number of search engines consulted, $F(2, 46) = 15.79$, $p < 0.01$, number of portals visited, $F(1.43, 37.76) = 6.05$, $p < 0.01$, number of Web result pages viewed, $F(2, 46) = 17.28$, $p < 0.01$, number of Web items viewed, $F(2, 46) = 11.68$, $p < 0.01$, and number of Web items selected, $F(1.59, 36.67) = 10.34$, $p < 0.01$.

Product and objective task complexity on interaction with library resources. Table 8 shows significant product main effects for the number of library resources consulted and the number of library result pages viewed via two-factor repeated measures ANOVA. Participants consulted significantly more library resources and viewed significantly more library result pages for the intellectual work tasks than they did for the

TABLE 8. Mean (SD), main effects, and interaction: “Product,” “OTC,” and interaction with library resources.

<table>
<thead>
<tr>
<th>Facets</th>
<th>Values</th>
<th>Library resources consulted</th>
<th>Library result pages viewed</th>
<th>Library items viewed</th>
<th>Library items selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>I (n = 72)</td>
<td>0.51 (0.79)</td>
<td>0.97 (1.88)</td>
<td>1.00 (2.30)</td>
<td>0.92 (2.67)</td>
</tr>
<tr>
<td></td>
<td>D (n = 72)</td>
<td>0.17 (0.48)</td>
<td>0.39 (1.08)</td>
<td>0.57 (1.25)</td>
<td>0.32 (1.10)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>13.94**</td>
<td>5.59*</td>
<td>2.27</td>
<td>4.07</td>
</tr>
<tr>
<td>Objective task complexity (OTC)</td>
<td>L (n = 48)</td>
<td>0.02 (0.14)</td>
<td>0.06 (0.32)</td>
<td>0.02 (0.14)</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td></td>
<td>M (n = 48)</td>
<td>0.63 (0.87)</td>
<td>1.08 (1.64)</td>
<td>1.54 (2.31)</td>
<td>1.00 (1.89)</td>
</tr>
<tr>
<td></td>
<td>H (n = 48)</td>
<td>0.38 (0.64)</td>
<td>0.90 (1.20)</td>
<td>0.79 (1.99)</td>
<td>0.85 (2.95)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>14.73**</td>
<td>9.78**</td>
<td>11.52**</td>
<td>4.79*</td>
</tr>
</tbody>
</table>

* p < 0.05. ** p < 0.01.
decision/solution work tasks. No significant product main effects were found for the number of library items viewed and selected.

The analysis showed significant objective task complexity main effects for the number of library resources consulted, number of library result pages viewed, number of library items viewed, and number of library items selected. Post hoc tests (Bonferroni) showed that participants consulted significantly fewer library resources for the low-complexity work tasks than they did for the moderate- (p < 0.01) and high-complexity work tasks (p < 0.01). They viewed significantly fewer library result pages for the low-complexity work tasks than they did for the moderate- (p < 0.01) and high-complexity work tasks (p < 0.01). Significantly fewer library items were viewed for the low-complexity work tasks than those viewed for the moderate- (p < 0.01) and high-complexity work tasks (p < 0.01). In addition, participants selected significantly fewer items from library resources for the low-complexity work tasks than they did for the moderate-complexity work tasks (p < 0.01). Note that the significant differences usually occurred between the low-complexity work tasks and the moderate- and high-complexity work tasks.

The analysis detected a significant interaction between product and objective task complexity for the number of library resources consulted, F(1, 60) = 5.59, p < 0.01 (Greenhouse–Geisser), number of library result pages viewed, F(2, 46) = 5.13, p < 0.01, number of library items viewed, F(2, 46) = 5.48, p < 0.01, and number of library items selected, F(1, 99) = 3.48, p < 0.05 (Greenhouse–Geisser). The results indicate that product and objective task complexity significantly interacted with each other and interactively affected the participants’ interaction with library resources.

**Product and objective task complexity on query-related interactive behavior.** Two-factor repeated measures ANOVA also were employed to investigate how product and objective task complexity affected query-related interactive behavior. Table 9 shows a significant product main effect for mean query length. Overall, participants issued significantly longer queries for the intellectual work tasks than they did for the decision/solution work tasks.

Additionally, significant objective task complexity main effects were found for the number of iterations, number of unique queries issued, mean query length, number of unique query terms used, and number of unique non-stop query terms used. Post hoc tests (Bonferroni) indicated that participants conducted significantly fewer times of iteration, significantly fewer unique queries, significantly shorter search queries, and used significantly fewer non-stop unique query terms for the low-complexity work tasks than they did for the moderate- (ps < 0.01) and high-complexity work tasks (ps < 0.01).

The analysis yielded significant interactions between product and objective task complexity for the number of iterations, F(2, 46) = 9.76, p < 0.01, number of unique queries issued, F(1, 53), 35.24 = 5.86, p < 0.01, mean query length, F(2, 46) = 12.62, p < 0.01, and number of unique non-stop terms used, F(1, 25), 28.66 = 6.73, p < 0.01 (Greenhouse–Geisser). Therefore, although the work tasks were at the same level of complexity, due to different products they pursue, the participants engaged in different query-related interactive behaviors.

**Discussion**

To explore the relationships between work task and interactive information search behavior, an experiment with 24 participants was conducted. Six work-task types were constructed based on the faceted classification of task (Li, 2004; Li & Belkin, 2008), and six simulated work-task situations were developed and assigned to the participants in the experiment. The results indicated a significant difference of the effect of different work tasks on the participants’ interactive information search behavior.

This study demonstrated significant differences in the number of IR systems consulted, result pages viewed, and items viewed and selected across the six work tasks. The results suggest that work task plays an important role in users’ interaction with information systems, and furthermore, different work tasks required users to exert different efforts and needed different quantities of information to address.

**Work tasks and selection of information systems.** Previous studies usually have examined task and information search behavior against one system (e.g., Lorigo et al., 2006;
Marchionini, 1989; Qiu, 1993); thus, how tasks affect selection of information systems was not probed in depth. This study allowed participants to select appropriate systems for the work tasks. Based on the significant differences in the number of IR systems consulted, the six work tasks could be categorized into three groups: high dependence on interaction with IR systems (e.g., IM, IH, and DM), moderate dependence on interaction with IR systems (e.g., IL and DH), and low dependence on interaction with IR systems (e.g., DL). All work tasks in the first group are typical course assignments, and therefore named schoolwork-related work tasks. In contrast, others could be named non-schoolwork-related work tasks.

In terms of the usage of library resources, for the schoolwork-related work tasks, participants consulted significantly more library sources than they did for other work tasks. Moreover, for IM and IH, they viewed significantly more library result pages than they did for DH, and for DM, they viewed significantly more library items than they did for IL and DH. This is because participants preferred to use library resources when doing their coursework, especially for research-project assignments (e.g., IH task). As Participant 14 (P14) stated, the Web resources, like Google or Wikipedia, were not appropriate for this kind of assignment because Wikipedia and Google usually provide more general information while more specific and academic-related information was necessary for the graduate students’ project.

However, significantly more Web portals were visited for IL, DL, and DH than for IM, IH, and DM. Meanwhile, for DL and DH, the participants consulted significantly fewer library resources and viewed significantly fewer library items than they did for the schoolwork-related work tasks. Thus, the non-schoolwork-related work tasks did not need library resources too much; Web resources may provide more useful information for them. This illustrates that work tasks affect users’ selection of different types of information resources, as Landry (2006) found. Moreover, since portals basically provide a browsing function and DL and DH are typical decision-making work tasks, it is possible that decision-making work tasks relied more on browsing to locate useful information than did the schoolwork-related work tasks. In addition, the work tasks that are dependent on browsing to pinpoint useful information may not heavily rely on library resources.

The results demonstrated that for the work tasks, the participants consulted more IR systems in general, and they also consulted more library resources. In this study, the number of IR systems consulted was the sum of the number of search engines consulted and library resources consulted. Because there was no significant difference in consulting search engines for IL, IM, IH, DM, and DH, it could be concluded that the significant difference in the number of IR systems consulted between the schoolwork-related and non-schoolwork-related work tasks was mostly caused by consulting a significantly different number of library resources. Therefore, if a work task requires the consultation of library resources, the participants need to exert significantly more interaction effort to locate useful information for it. In other words, consulting library resources could be an indicator of more interaction effort exerted.

During the search for the six work tasks in the experiment, participants consulted more resources from search engines than they did from library resources. It appears that more and more students tend to seek information from search engines, as P15 said: “Whenever I am thinking of looking for a topic or anything, I go straight to Google. I pretty much Google everything.” As well, when asked why he started the search with Google, P18 stated: “Oh, I have been using it for years, and it’s always been effective. I always find information from it.” In addition, 87.5% of participants rated themselves as experienced searchers in using search engines whereas only 29% of participants rated themselves as experienced searchers in using OPACs. This may be another reason why participants conducted searches more often by using search engines than by using libraries for the work tasks.

Work tasks and associated search tasks. Different work tasks motivate different search tasks. The first group of work tasks (i.e., IM, IH, and DM) required intellectual knowledge (e.g., ideas, research designs, and research findings) to be accomplished; thus, the participants mostly performed an exploratory search or a subject search for gathering useful information. This group of work tasks was among the work tasks to which the participants answered “no” for the question of enough time for the search and “no” for the question of enough information gathered to support the work tasks. When engaging in the exploratory search, participants perceived difficulty in starting the search and were less confident. As P14 said when conducting the search for IH:

I am not sure how to design a research. I also don’t know how I would look for information of this. Because I don’t know whether there is a lot of information about research project on the Internet. I am sure there are in more specialized search engines, but I don’t know how to start this.

The information to support this group of work tasks is not easy to locate. During searching for DM, P16 commented:

I think it is hard because some of the issues are not that popular, you know. Not that many people look at this stuff or read this stuff.

Because the information is not used that often, it is hard to find it.

This supports the view that an exploratory search task that searches to learn and to investigate is a more challenging search task (Marchionini, 2006).

The second group of work tasks, IL and DH, needed facts to be accomplished, but the participants did not know exactly where the sources were. The associated search tasks basically were exploratory, but because the participants needed to explore for “facts,” the useful information was easier to locate compared to that for the first group of work tasks. For such search tasks, the participants had specific goals. For example, when searching for DH, P18 said: “My goal here
is to try to find something like to have profile of having the whole bunch of MBA program where have the tuition listed.” Similarly, P19 said: “First of all, I would like to find a list of places [that] offer MBA programs.” When searching for IL and DH, participants exerted less interaction efforts than they did for IM, IH, and DM. This suggests that if a work task motivates a search task with a specific search goal and a user carries an “image” in his or her mind about the targets, the interaction efforts of an exploratory search task may be alleviated. This also indicates different levels of exploratory search tasks motivated by work tasks. In addition, the results show that participants planned their search and set up their search goal based on the nature of a work task and not only based on the nature of a search task (Navarro-Prieto, Scaife, & Rogers, 1999).

For DL, the participants needed the facts to help them make decisions. Most participants clearly knew where the necessary information was. As P16 stated, DL is the easiest task because the sources for information are known. He just had to go there and locate and download it. Therefore, DL motivated a known-item search task. Participants viewed significantly fewer result pages and items for DL in contrast to other work tasks. Most participants needed to locate the URL of the Web site providing supportive information for DL. Such search tasks were named navigational search tasks (Broder, 2002), which is a search task type frequently conducted in the Web search. In addition, as previously mentioned, DL motivated a known-item search, which is an easier search task than is a subject search or an exploratory search task, as addressed by Hsieh-Yee (1998), K.-S. Kim (2001), and K.-S. Kim and Allen (2002). For such search tasks, participants did not need to conduct too many searches and thus viewed significantly fewer result pages and items.

Work tasks and query-related interactive behavior. Even though there were significant differences in all measures across the six work tasks, the significant differences mostly occurred between DL and other work tasks. This means that only to work tasks such as DL, a decision/solution work task at a low-complexity level, the users possibly issued significantly fewer queries, shorter queries, and fewer query terms. As previously stated, this may be because for this type of work task, a known-item search task or navigational search task was carried out. In addition, between IM and IH, two intellectual work tasks with different complexity levels, participants issued significant shorter queries for IM than they did for IH. This suggests that different levels of complexity may be the reason for different lengths of queries in terms of the intellectual work tasks. This supports the idea that task complexity is an influential factor leading to different information-seeking behavior patterns (Byström, 2002). However, for the decision/solution work tasks, no significant difference was detected. This may suggest that the facets product and objective task complexity did play different roles in users’ query formulation.

Compared to the effects of work tasks on other interaction efforts, work tasks may be not a critical factor in shaping query-related interactive behavior because not as many significant differences were found among such behavior across the work tasks, except for DL. However, previous studies have indicated that search task affects different aspects of information search behavior, such as query reformulation (J. Kim, 2006), number of Web pages viewed (K.-S. Kim & Allen, 2002), and keywords used (Hsieh-Yee, 1998). In this study, however, no such significant differences were found across the work tasks, except for DL. This may suggest that search task is a more powerful factor in shaping query-related interactive behavior than is work task, and both of them may play different roles during the course of users’ interaction with information systems (Pharo, 2002). However, further investigation is necessary.

Product and objective task complexity of work task on interactive information search behavior. Two facets of work tasks were controlled in this study: product and objective task complexity. By varying the values of these two facets, six work-tasks types were tested in this study. The results indicated that these two facets affect interactive information search behavior to different degrees. Objective task complexity of work tasks affected almost all aspects of interactive information search behavior, except the number of items selected, Web items selected, and time/item selected. That may be because when different numbers of subtasks were involved in a work task, it was necessary to view significantly different numbers of Web and library items as well as to select significantly different numbers of library items. The results suggest that users may behave very differently in interacting with information systems when they are conducting work tasks that involve different quantities of subtasks or activities.

The facet product also was found to significantly affect some aspects of interactive behavior, such as the number of IR systems consulted, result pages viewed, search engines consulted, Web result pages viewed, library resources consulted, library result pages viewed, and mean query length. Compared to the facet objective task complexity, product affected much fewer aspects of interactive information search behavior. Therefore, objective task complexity seems more strongly in shaping users’ interactive behavior than does the product.

The significant interaction between product and objective task complexity was found almost in all aspects of interactive information search behavior. This indicates that although work tasks were at the same level of complexity, if the products they pursue are different, users may interact significantly differently with information systems. In addition, even if work tasks pursue the same product, different levels of complexity may lead to significantly different behavior patterns; therefore, work tasks should be considered as a multifaceted variable. Only considering one facet of work tasks cannot reveal the real relationships between work tasks and interactive information search behavior.

The results also indicated that there were not too many significant differences detected between the moderate- and high-complexity work tasks with respect to participants’
interactive information search behavior. One reason may be the measure for objective task complexity. It is possible that this measure based on quantities of activities or subtasks involved cannot sufficiently address the nature of moderate- and high-complexity work tasks. Moreover, it was found that 35% of moderate-complexity work tasks was assessed as “need to search more times” whereas 63% of high-complexity work tasks need to search more times. Further analysis of the follow-up interviews indicated that for the high-complexity work tasks, participants usually needed to search several times; thus, for their initial search (in the experiment), their purpose was to explore a search pattern. As P19 said, in the initial search, her purpose was to know “how to search” for this work task and to “create profile then search” later. But for the moderate-complexity work tasks, most participants needed to search merely one time, and during this search, they tried to locate all necessary information. This means that the search was a comprehensive one. Further analysis also indicated that for more complex work tasks, more times of information searches were necessary, \( r_{ij} (144) = 0.43, p < 0.01 \). Therefore, participants seemed to conduct different types of search tasks during the experiment for the moderate-complexity and high-complexity work tasks (i.e., a comprehensive search and an initial exploratory search, respectively). They exerted almost the same effort to interact with information systems for these two types of searches in the experiment. Thus, it could be inferred that a user should exert more efforts for gathering information for high-complexity work tasks involving multi-time searches than for moderate-complexity work tasks involving a one-time comprehensive search.

Work task as a single-faceted or a multifaceted variable? The analysis also yielded a significant difference in the number of items selected for the six work tasks, especially between IM and other work tasks. However, further analysis examining how different facets affect interactive information search behavior (Li, 2008) did not find any facets of work tasks that were significantly associated with it. This means that although the single facet was not the reason leading to a significant difference in items selected, a work task as a multifaceted variable that combined all these single facets may be the reason. In addition, as addressed earlier, the significant interaction between product and objective task complexity indicates a necessity to consider work task as a multifaceted variable. Previously, work task was usually viewed as a single-faceted variable. In Bystrom (1999), work tasks were described based on different levels of task complexity, which were defined based on users’ a priori determinability of the process to complete a work task. Algon (1999) classified work tasks by the interaction among people in a project team. Although Xie (1998) viewed work task as a variable with different levels, task goal was the facet based on which she classified work tasks. These studies did help people understand how work tasks affect users’ information search behavior from a specific aspect of work task. However, because of the limitation of a single aspect of work task, a better understanding of the effects of work task on users’ interaction with information systems could not be achieved. Hence, a multifaceted work task should be taken into consideration in such studies. This study provides empirical evidence to support this view.

In addition, significant differences were found between DL and DH in the number of both Web items viewed and selected. This indicates that different complexity levels of decision/solution work tasks may require viewing and selecting significantly different numbers of Web items; however, no significant differences were found between different complexity levels of intellectual work tasks in the number of Web items viewed and selected. They require a similar number of Web items to support. Additionally, as previously mentioned, for the intellectual work tasks with different levels of objective task complexity, participants issued significantly shorter queries. For the decision/solution work tasks, however, no such significant difference was revealed. This suggests that the two facets, product and objective task complexity, did play different roles in affecting users’ interaction with information systems. The finding is consistent with results found by Pharo (2002), who also noted that those different aspects of work task played different roles during the user’s interaction with the Web. Therefore, it is imperative to investigate work task as a multifaceted variable for a more comprehensive understanding of the effect of work task on information-seeking and search behavior.

Limitations and Implications

In this study, only two facets, product and objective task complexity, were varied to construct work-task types. It is possible that more interesting results may not be revealed. In addition, only one simulated work-task situation was developed for each work-task type. It is hard to pinpoint whether it was work-task types or the specific situations that affected interactive behavior, although the simulated work-task situations did help detect the significant difference in users’ interactive information search behavior. The small sample size is another limitation of the study. Only 24 participants were recruited, even though these participants were recruited from different majors and levels in a state university and their search for 144 work tasks did provide enough data to analyze. In addition, the effect of users’ knowledge of information systems on users’ information search behavior has been well documented (Belkin, 1980; Marchionini, 1995; Sutcliff & Ennis, 1998; Thatcher, 2008); however, because different information systems were selected in this study, this factor has not been taken into account. In addition, the simplified operationalization of objective task complexity (i.e., only to count the number of activities involved for a work task) may not precisely measure its attributes. All these limitations may bias the results in this study. Finally, the results may not be generalizable to other contexts (e.g., a business environment) because this research was conducted in a specific context (i.e., a university community).
However, the implications of this study also are salient. Many previous studies have concentrated on examining how search task affects information search behavior and ignores the influence of work task. Although work task has been explored at the information-seeking level, empirical studies examining the role of work task during information search are still lacking and thus are needed (Hansen, 2005; Vakkari, 2003). This study helps fill that gap by empirically examining the relationships between work tasks and interactive information search behavior. The results indicated that the same participants presented different behavior patterns when searching for different work tasks. They selected information systems to search based on their work tasks at hand. The participants were significantly more dependent on browsing the portals when searching for the decision/solution work tasks than they were for the intellectual work tasks. Different work tasks relied on IR systems to different degrees. For example, the schoolwork-related work tasks were significantly more dependent on library resources than were the non-schoolwork-related work tasks. Different work tasks motivated different types of search tasks. Low-complexity work tasks led to less interaction with information systems. In terms of shaping interactive information search behavior, the two varied facets used to construct work task types in this study played different roles. The results also support the view that work task and search task may play different roles in shaping users’ interaction with information systems (Pharo, 2002). These findings pave the way to develop theories on work task and users’ interactive information search behavior.

Practically, the relationships between work task and interactive information search behavior revealed in the study could help make predictions of users’ interactive information search behavior from their work tasks at hand. This could help design IIR systems and make them more adaptive to users’ work tasks, and thus better support users’ interaction with the systems. Moreover, the study indicated that users’ interactive information search behaviors could be indicators of the characteristics of work tasks. For example, if users heavily consult library resources, that may indicate a high-level, complex intellectual work task. Based on the results of this study, this type of work task is usually associated with exploratory search tasks. This has implications for adaptive IR systems design and personalization of IR. Based on automatically recording and analyzing users’ behavior, the systems could identify the characteristics of work tasks and associated search tasks and provide some techniques to better support users’ interaction with the systems by, for example, ranking result pages or clustering or classifying the search results.

With the increased attention on exploratory search (He et al., 2008; Marchionini, 2006), it is necessary to examine the way to construct exploratory search tasks for IR research. Kules and Capra (2008) proposed a two-step approach by examining log data and developing a task template. The current study presents another approach that is based on the faceted classification of task (Li, 2004; Li & Belkin, 2008). For developing work-task types tested in the experiment, the values of two facets were varied; other facets were kept constant or assessed by the participants. This also could be used to build up exploratory search task types for IR research. Additionally, researchers could manipulate the facets of task and various values to construct different types of tasks for adapting to a specific study; therefore, the faceted classification offers a flexible approach.

Many studies have examined a single facet of work tasks (Algon, 1999; Byström, 1999; Byström & Järvelin, 1995; Wang, 1997) and how the specific aspect affected users’ information-seeking or search behavior. This study employed the faceted classification (Li, 2004; Li & Belkin, 2008) to conceptualize work task, and work-task types were described as a combination of different values of the facets. Although only two facets were varied in the work-task types whereas others were kept constant, the results provide empirical evidence to support that it is necessary to consider work task as a multifaceted variable. It may be a better approach to comprehensively reveal the effects of work task on interactive information search behavior.

Different from previous studies that have focused on search tactics and search strategies (Thatcher, 2008; Vakkari, 2000; Vakkari et al., 2003; Wang, 1997), this study examined interactive information search behavior as a multidimensional variable. It categorized users’ interaction with information systems into general interaction effort, interaction with Web resources, interaction with library resources, and query-related interactive behavior. In this way, this study attempted to describe interactive information search behavior from different aspects. These aspects of behavior and corresponding measures could be used in other studies that intend to investigate information search behavior and user-computer interaction.

Conclusion

This study explored the relationships between work task and interactive information search behavior. Work-task types were constructed based on the faceted classification of task (Li, 2004; Li & Belkin, 2008). Simulated work-task situations (Borlund & Ingwersen, 1997) were developed for each work-task type tested in the study. Twenty-four participants searched for a total of 144 work tasks, and the recordings were analyzed. The results demonstrated that as a search task, work task is an influential factor in shaping user’s interactive information search behavior. It is necessary to consider work task as a multifaceted variable to more precisely pinpoint its effects on information-seeking or search behavior. The study found that for different work tasks, users engage in different search tasks and present different behavior patterns to approach useful information. Work task and search task may play different roles in shaping users’ interaction with information systems. In addition, users tend to gather information from multiple information systems for moderate- and high-complexity work tasks. All these findings make contributions to the knowledge in this field as well as shed light on task-based information seeking and search or retrieval.
Future studies will continue to investigate interactive information search behavior patterns in terms of different work-task types: More varied facets will be involved, more participants will be recruited, and different experimental designs (e.g., between subjects) will be employed. The sample size will be enlarged to reexamine the results in this study for more robust conclusions. The effect of work task on interactive information search behavior in other contexts, such as business environments, will be investigated. The faceted approach to conceptualizing work tasks also will be used. Based on the results, the faceted classification will be reexamined and refined. Due to the importance of the objective task complexity of work task, it is necessary to examine how to conceptualize and effectively measure this factor, especially how to effectively measure moderate- and high-complexity work tasks. Ultimately, future studies will continually make important contributions to task-based information seeking and information search and retrieval.

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References


Appendix

<table>
<thead>
<tr>
<th>Type</th>
<th>Value involved</th>
<th>Scenario</th>
<th>Instructions</th>
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<tbody>
<tr>
<td>IH</td>
<td>Intellectual</td>
<td>Work task: Imagine you are a graduate student working on a research project titled “Global warming and human life.” You would like to investigate how global warming would affect people’s everyday life. For this project, you need to review previous studies, design your research, collect data, analyze the data, and write a research report. You are now just starting on this project.</td>
<td>Instructions: You need to search for any information that could help you understand the general research topic and the different ways in which the project would be designed.</td>
</tr>
<tr>
<td>IM</td>
<td>Intellectual</td>
<td>Work task: Imagine you are planning to apply for an MBA program in the United States. You need to decide the appropriate programs to apply for. You also need to consider the location of these programs, compare their tuition, investigate their academic reputation, consider your GMAT score (Imagine you got 700 points, a good score.), then make the decision and prepare your application package (including writing your personal statement, cover letter, and your request for references, etc.).</td>
<td>Instructions: You need to search for any information that could help you to complete your work task.</td>
</tr>
<tr>
<td>IL</td>
<td>Intellectual</td>
<td>Work task: Imagine you are taking a course about preparing for job hunting. One of your assignments is to write a résumé. You decide to write a résumé which is appropriate and strong for applying for jobs in journalism, but you have no ideas what should be included in this type of résumé. You should read the relevant materials and begin writing your résumé.</td>
<td>Instructions: You need to search for any information that could help you to complete your work task.</td>
</tr>
<tr>
<td>DM</td>
<td>Decision/Solution</td>
<td>Work task: You are doing a take-home exam and need to answer several questions related to a cognitive bias “endowment effect.” (1) What is “endowment effect?” (2) List at least three experiments conducted by researchers regarding this bias. (3) List at least one researcher who disagrees with this bias and his/her views. You need obtain and read the related materials, and write down the answers.</td>
<td>Instructions: You need to search for any information that could help you to complete your work task.</td>
</tr>
<tr>
<td>DL</td>
<td>Decision/Solution</td>
<td>Work task: You need to start your work task.</td>
<td>Instructions: You need to search for any information that could help you to complete your work task.</td>
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