Investigating failures in information seeking episodes

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Abstract

Purpose – People face barriers and failures in various kinds of information seeking experiences. These are often attributed to either the information seeker or the system/service they use. The purpose of this paper is to investigate how and why individuals fail to fulfill their information needs in all contexts and situations. It addresses the limitations of existing studies in examining the context of the task and information seeker's strategy and seeks to gain a holistic understanding of information seeking barriers and failures.

Design/methodology/approach – The primary method used for this investigation is a qualitative survey, in which 63 participants provided 208 real life examples of failures in information seeking. After analyzing the survey data, ten semi-structured interviews with another group of participants were conducted to further examine the survey findings. Data were analyzed using various theoretical frameworks of tasks, strategies, and barriers.

Findings – A careful examination of aspects of tasks, barriers, and strategies identified from the examples revealed that a wide range of external and internal factors caused people's failures. These factors were also caused or affected by multiple aspects of information seekers' tasks and strategies. People's information needs were often too contextual and specific to be fulfilled by the information retrieved. Other barriers, such as time constraint and institutional restrictions, also intensified the problem.

Originality/value – This paper highlights the importance of considering the information seeking episodes in which individuals fail to fulfill their needs in a holistic approach by analyzing their tasks, information needs, strategies, and obstacles. The modified theoretical frameworks and the coding methods used could also be instrumental for future research.

Keywords Information seeking, Strategies, Barriers, Failures, Information seeking in context, Tasks

Paper type Research paper

1. Introduction

Information seeking is an essential element of individuals' everyday lives. Individuals may use many different strategies to seek information that accomplishes different goals. Their queries are generally heterogeneous, though there are areas in which people have information needs more frequently than others (Savolainen, 1995). Among the factors that influence people's information needs and information seeking strategies (ISSs) are task complexity (Byström and Järvelin, 1995), familiarity with information sources (Savolainen, 1995), temporal factors (Savolainen, 2006), and convenience (Connaway *et al.*, 2011). While individuals' information seeking behaviors and the factors that influence their behaviors, such as barriers, have gained considerable attention, people's experiences of information seeking failures (hereafter ISFs) and reasons for these failures have been understudied. Among the limited amount of such studies, most focus on one aspect, tool, or method of information seeking, such as web searching (e.g. Mansourian and Ford, 2007b).

A careful examination of the link between information seeking barriers and failures is needed to go beyond current modes and modalities of information access. Specifically, the contexts in which ISFs arise could be instrumental in designing and implementing new and better services and systems. The findings presented in this paper are from an exploratory qualitative study on individuals' ISFs. This study looks for a holistic picture of the instances

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in which individuals fail to entirely fulfill their information needs in all contexts and situations, and the reasons for their failures in real life scenarios. The remainder of this paper is structured as follows. The next section reviews relevant literature regarding information seeking barriers and failures. This is followed by a description of the data collection and analysis methods, which involved a survey of 63 people expressing a total of 208 instances of ISFs, and interviews with ten participants. Results are reported afterwards, followed by a discussion of findings. This paper ends with a conclusion and a future research agenda.

2. Literature review

2.1 Information seeking barriers

Research has shown that individuals constantly face barriers and constraints when looking for information across various disciplines and professions, such as medicine (Kumpulainen and Järvelin, 2012), education (Julien, 1999; Seyedarabi, 2011), and computer science and engineering (Kraaijenbrink, 2007; Dorn *et al.*, 2013), as well as in their everyday lives (Savolainen, 1995). Researchers have used varying terminology when defining and classifying barriers. Świgoń (2011b) synthesized the literature to propose a universal typology of information seeking barriers divided into four groups: barriers connected with personal characteristics, interpersonal barriers, environmental barriers, and barriers connected with information resources. Barriers connected with personal characteristics and interpersonal barriers made up the most frequently encountered problems in the academic environment (Świgoń, 2011a). Savolainen (2015) categorized barriers into internal barriers, which originate from inside an individual (e.g. affective and cognitive barriers), and external barriers, which are imposed on an individual from outside (e.g. temporal and spatial barriers). For instance, among the external barriers, socio-cultural barriers – like social stigma and bureaucratic inertia of organizations – hinder, delay, or prevent access to information, and also cause negative emotional reactions such as frustration and fear (Savolainen, 2016).

Researchers often tie information seeking barriers to specific populations. In Attfield and Dowell's (2003) inquiry of journalists' information seeking, two types of constraints emerged: product constraints (e.g. deadline, word count) and resource constraints (e.g. personal contacts, accumulated subject knowledge). These constraints were volatile due to the uncertain nature of writing for news or feature article, and thus brought challenges to information seeking. Kraaijenbrink (2007) produced a systematic categorization of 79 different types of gaps associated with engineers' information identification, acquisition, and utilization. The study revealed plenty of room for improvement in web design and the author argued that a website's functionality – rather than its appearance – is the key issue. Szymanski and Davis (2015) focused on the wine industry and uncovered that time constraints usually caused frustrations among wine makers or growers when they were interacting with information resources. Also, information might not be specific to their regions, or might be difficult to read, and desired information could be buried within irrelevant information.

Although barriers are mostly believed to negatively impact information seeking, they do not always result in unfavorable outcomes. While individuals are sometimes frustrated by time constraints and too much information, most are not actively prevented from learning from information resources (Szymanski and Davis, 2015). Moreover, barriers and uncertainty may also encourage creativity and innovation (Chowdhury *et al.*, 2011), and contribute to positive consequences, such as developing filtering behavior, which encourages people to access a few relevant sources rather than time-consuming comprehensive results (Savolainen, 2015). A close examination of the connections between information seeking barriers and failures and how people interpret their failures is necessary.

2.2 ISFs

Successes and failures in information seeking were first presented in Wilson's (1981) model of information behavior. Users seek information from systems or other sources (e.g. people) and may experience either successes or failures of locating the information. Successes may subsequently lead to the use of the information, which may or may not satisfy the perceived need. Users may fail to satisfy their information need and reiterate the search process. Kuhlthau (1991) specified in her model of the information search process that information search may lead to satisfaction or disappointment in the presentation stage (i.e. the stage in which the search is completed with a new understanding). Although disappointment may indicate the unsuccessfulness of the search, Kuhlthau did not discuss this aspect in detail. Research that specifically explored ISFs is relatively limited and has been mostly carried out in library environment. Early efforts on library catalog search failures discovered high failure rates (30-50 percent) (Peters, 1989; Lynch, 1989). Some common reasons of failing included lack of user perseverance, navigational or query formulation problems (Drabenstott and Weller, 1996; McCray and Tse, 2003), insufficient understanding of the catalog (Peters, 1989; Dwyer *et al.*, 1991), as well as other system usability issues. Later studies suggested that a main contributor of failures was users' lack of understanding of the complexity of library databases as they expected library search to be similar to other online searches that did not require precision searching (Kress *et al.*, 2011; Sadeh, 2008). Rosman *et al.* (2016) discovered that not only students with little experience of searching on complex database interfaces encountered difficulties in searching, but students with high information seeking knowledge might also have unsuccessful outcomes if they cannot not put their knowledge into practice. Specifically, students with high information seeking knowledge were more likely motivated to search in complex databases and to use advanced features. Meanwhile, their lack of practical experience (e.g. not knowing the specific terms used in advanced search fields) might prevent them from getting sufficient results. In contrast, students with higher levels of information seeking knowledge were more likely to succeed in popular search engines that have simple interfaces.

Mansourian *et al.* (2008) are among the first researchers who addressed the types and attributes of ISFs in search engines. Mansourian (2008) defined ISF as a "situation in which users attempt to satisfy their information needs, but they fail to do so" (p. 29). Mansourian *et al.* (2008) classified episodes of unsuccessful information seeking into three categories: unexpected failure, unexplained failure, and predicted failure. This model emphasized users' perception of whether the information was indexed in search engines. Mansourian and Ford (2007a) also listed some factors that caused users' search failures, such as information overload and discomfort with using computers.

To summarize, the literature has demonstrated a broad range of barriers that have emerged in individuals' information seeking activities across various disciplines and domains. Barriers are primarily considered to negatively impact information seeking outcomes, though they may also have positive influences. Some researchers have worked to further uncover the connections between information seeking barriers and their negative outcomes (ISFs). However, the literature presented an insufficient understanding of ISFs – particularly the contexts in which they are constructed – for two main reasons. First, existing studies have dominantly focused on the online environment or on one particular system, resource, or environment. However, failing on the web does not equal to a failure in locating the information. In some cases, search engines may not be the ideal or even correct places to look for information. One exception that involved the offline context is Shenton's (2007) study of youngsters' ISFs. Although some or all of his findings may also drive adults' ISFs, one cannot assume that they are applicable to adults' information seeking because they were drawn from studies of students from 4 to 18 years of age. Second, ISF research has been restricted to heavy information users such as academic

participants who may not be representative of the general population. To overcome these limitations, this study will look at where and why information seeking episodes fail and how those failures relate to the greater context of people's tasks, strategies/methods, and barriers/challenges both online and offline with participants recruited outside the academic circle.

To commence the investigation, this research will first examine information seeking episodes based on their outcomes, and isolate those instances in which people are unable to find the information they need. Next, the motivators behind information seeking (e.g. tasks), information needed, strategies used, and barriers confronted will be carefully extracted to obtain holistic pictures of how individuals fail. In other words, instead of studying how people find information, this study hopes to investigate how people fail to find information. Unlike previous studies on Web searching failures in which some participants were unsuccessful on the web but found the information through other channels (e.g. locating print materials), many participants in this study already employed multiple strategies (online and offline) before giving up. Specifically, the following research questions will be addressed:

RQ1. What are the categories of ISFs?

RQ2. What are the factors that make information seeking episode fail?

RQ3. How do information seeking barriers impact ISFs in the context of tasks and strategies?

3. Methods

3.1 Data collection

3.1.1 Survey. The data collection for this study was carried out in two stages. The main method included a qualitative survey on Amazon's Mechanical Turk (hereafter MTurk) in which 252 real life examples of ISFs were collected from 63 participants. MTurk is an online crowdsourcing site on which users (also known as Requesters) can post tasks that require human intelligence (e.g. surveys, usability testing) and make them available to the public for participants (who could be anyone with an internet access) to finish and be compensated. MTurk has been increasingly used to recruit participants for conducting behavioral research because of its subject pool diversity, fast theory/experiment cycle, and low cost (Mason and Suri, 2012). Hauser and Schwarz (2016) found out that MTurk workers are more attentive to instructions than are college students and are suitable for social science research. This study targets the general population, making MTurk an appropriate recruiting tool because it provides access to one of the largest and most diverse participant pools available (Mason and Suri, 2012). MTurk users are arguably more representative of the general population than academic participants (Erickson *et al.*, 2017), who are usually recruited for research on information seeking barriers and failures.

The survey sample consisted of 58.7 percent males and 41.3 percent females. Their average age was 32.6 (SD = 9.7) and ranged from 21 to 65 years. In total, 85.7 percent resided the USA when they completed the survey. In all, 60.3 percent had at least a bachelor's degree. The survey was designed to take about 25-30 minutes and the majority of the participants finished within that time range. Each person was paid $2 for finishing the survey. There is no general agreement on the hourly payment for MTurk workers, though it is commonly believed that studies conducted on MTurk pay less than those taking place in physical labs because MTurk studies require less efforts than lab experiments (e.g. efforts of traveling and scheduling) (Mason and Suri, 2012). Payment reported by existing studies ranged from $1-5 per hour (e.g. Buhrmester *et al.*, 2011). The literature also suggested that the level of compensation only affects participants' motivation for completing the study, not the quality of data contributed (e.g. Horn *et al.*, 2013; Mason and Suri, 2012). The rate of

compensation in this study ($4 per hour) was determined based on academic studies about or using MTurk (e.g. Mason and Suri, 2012; Shapiro *et al.*, 2013) and academic surveys available on MTurk that took a similar amount of time. Prior to the main study, a pilot test with six participants was conducted on MTurk to verify that the amount of pay was sufficient and the survey questions could be understood.

The survey adopted the critical incident technique (CIT) (Flanagan, 1954) in which participants were asked to describe four examples of when they failed to find the information they needed to finish a task or to accomplish a goal at work, at school, or in their everyday lives (e.g. health, travel). They were instructed to briefly narrate the tasks that generated their information needs, their ISSs, and their conceptions of why they were unsuccessful. Past research proved that the CIT is a valid and reliable method to collect qualitative retrospective data of memorable situations (Kraaijenbrink, 2007; Urquhart *et al.*, 2003). Most answers to each question were concise, but contained enough details to explain their experiences (30-50 words), with the exception of a few answers in which participants wrote more than 100 words and were very thorough in describing their information seeking episodes. In addition to the open-ended questions, a list of 15 broad types of information seeking barriers gathered from the literature was included (i.e. Świgoń, 2011b; Savolainen, 2015; Chowdhury *et al.*, 2011; Mansourian and Ford, 2007a) to allow participants to check any or all problems that they encountered. The list was used along with other answers to further specify information seeking obstacles. For example, one participant marked "information was unreliable" and wrote "different doctors say different opinions" in her narration to clarify her selection.

3.1.2 Interview. Based on the survey findings, ten semi-structured half-hour individual interviews were conducted with another group of participants in the second stage to complement and further investigate the survey findings. Most questions included in the interviews were similar to those in the surveys with some changes that were tailored to further examine the survey findings. This study utilized convenience sampling by sending e-mail invitations to several academic departments with which the authors have personal connections (communication, computer science, information science, and biotechnology). Two undergraduate students and eight graduate students were interviewed in person. Each participant described two to three recent unsuccessful information seeking experiences. Interviewing as a secondary method obtained a deeper understanding of ISFs and a richness beyond what the survey data could have provided.

This study has been approved by the Institutional Review Board in Rutgers University. All MTurk participants read and agree on an online consent form before proceeding to start the survey. MTurk participants remained completely anonymous throughout the study as they were only identified by their MTurk ID. Interview participants signed an informed consent when coming in for the interview.

3.2 Data analysis

The MTurk survey initially yielded a total of 252 ISF cases, from which 208 were selected for data analysis. Responses that were invalid (e.g. "can't really think of one"); provided exceedingly vague descriptions (e.g. "how to apply for an open position"); represented task failures instead of ISFs (participants found the information but were unable to complete their tasks); and described failures that were not recent, were excluded from data analysis. Narrations of tasks, strategies, and failures were then coded using four different coding schemes in Nvivo. All of the interviews were audio recorded and transcribed. The transcripts were then coded using the same classification schemes utilized for survey coding. At the same time, points that complemented or contradicted survey findings were given special attention. The four schemes for coding are introduced in the following sub-sections.

3.2.1 Classification of failures. A revised version of Mansourian *et al.*'s (2008) extended model of information visibility was adopted to categorize ISFs, which emphasizes participants' expectation of whether the information they needed was available. Mansourian *et al.* classified failures into three categories: unexpected, unexplained, and predicted failures. After analyzing a portion of the data, the original classification was modified and reorganized into two dimensions to conceptualize failures: expected vs unexpected; and explained vs unexplained.

This reorganization occurred for two purposes. First, the data show that participants could not clearly explain the reasons of failing in 37.5 percent of the cases. It was necessary to make the distinction between the failures that could be explained through participants' own words and those that could not be explained. Second, this study classified instances in which participants either believed that the information existed (unexpected failures in Mansourian *et al.*, 2008) or were unsure of whether the information existed (unexplained failures in Mansourian *et al.*) into one category because the 2 percent of participants who held the latter belief still somewhat felt that their desired information existed. Regarding whether the information was available, participants' expectations were captured during their post-information seeking reflections. For example, if a participant expected to find something but later failed and realized the information was not available, it would be considered an expected failure. Although the result contradicted their expectation before information seeking, it was consistent with their realization after searching, and thus was expected. Each category is defined in Table I.

3.2.2 Classification of information seeking barriers. Each type of failure was further coded by its contributing factors. External factors (e.g. time constraints), internal factors (e.g. lack of subject knowledge), or both could cause failures. Any barriers that did not purely arise from inside of a person – such as interpersonal barriers (e.g. lack of help from people) – were categorized as external factors in this study. Coding began with a list of information seeking barriers collected from the literature (i.e. Świgoń, 2011b; Savolainen, 2015; Chowdhury *et al.*, 2011; Mansourian and Ford, 2007a) and new codes were inductively drawn from the data.

3.2.3 Classification of tasks. This study applied a faceted classification of tasks developed by Li and Belkin (2008) to code the tasks that motivated information seeking. Li and Belkin addressed the limitations of previous task classifications (e.g. focusing only on one or a few task facets), and proposed a new scheme that can be used for classifying all levels of tasks (i.e. work, information seeking, and search). The scheme captures various facets including source, task doer, time, outcome, process, and goal; as well as common attributes such as interdependence, urgency, and difficulty. It is suitable in this study because it holistically contextualizes the information needs and failures into their generative tasks.

	Expected	Unexpected
Explained	The participant felt the information was not available so that their failure was expected, and they could explain why it was not available (EE)	The participant felt the information was available somewhere, yet they did not manage to find it, or they were not sure if the information was available; and they could explain why they did not find it. This type of failure is contrary to the individuals' expectations (EU)
Unexplained	The participant felt the information was not available so that their failure was expected, and they could not explain why it was not available (UE)	The participant felt the information was available somewhere, yet they did not manage to find it, or they were not sure if the information was available; and they could not explain why it was not available. This type of failure is contrary to the individuals' expectations (UU)

Table I.
Coding scheme for information seeking failures

Most of the attributes and facets were manually coded according to participants' responses, though survey participants rated the salience, difficulty, complexity, and level of topical knowledge on a five-point Likert scale. A few minor modifications were made to the scheme according to the data available. For instance, the task stage facet was removed from survey coding because the large majority of the reported tasks in the survey data were short-term with unclear stage divisions.

Li and Belkin's (2008) classification can be used to categorize both search tasks and the underlying tasks that trigger search tasks. In this study, only the tasks motivating search tasks were coded. Here is an example of the task coding: A participant responded: I received a pet bird as a present, and had to research fast what to feed it. This can be classified as an internal-generated, unique (first time), and long-term task (feeding a bird for its lifetime); it will produce a decision or solution (have the bird fed) and it has a specific goal. This is a single-goal (feeding the bird), urgent (need to feed the bird soon) and multi-time task (feeding the bird more than one time) with moderate interdependence (the participant asked friends about feeding the bird).

3.2.4 Classification of strategies. This study utilized Belkin *et al.*'s (1993) four dimensions of ISSs to classify the step-by-step strategies reported by participants. This model was chosen here because of its strength in placing ISSs in a multi-dimensional space. Belkin *et al.* suggested that information seeking interaction as a complex activity can be categorized based on a relatively small set of dimensions. Strategies were categorized according to the combination of one factor from each of the four dimensions (16 combinations in total). For example, an individual may use the scanning (browsing) method (i.e. method of interaction) to select information items or to learn new knowledge (e.g. keywords) to assist in searching (i.e. goal of interaction). Compared to other models that solely emphasized on the method dimension or did not differentiate between different dimensions, Belkin *et al.*'s scheme allows a flexible and finer-grained classification of ISSs. Also, seekers may move from one strategy to another during the course of an information seeking episode. The ISSs model provides a means to understand not only each single strategy adopted by seekers, but also the movement from strategy to strategy. Factors from each dimension can be combined freely to form ISSs, which arguably represent most ISSs employed by users. The four dimensions are as follows:

(1) method of interaction: scanning, searching;

(2) goal of interaction: learning, selecting;

(3) mode of interaction: recognition, specification; and

(4) resource considered: information, meta-information.

For instance, a participant wrote: I googled for books regarding the subject. This could be categorized as searching (performing search on Google) – selecting (selecting links to go through) – specification (having a specific subject in mind) – meta-information (used Google as a resource).

3.2.5 Coding. In the beginning, the data that pertained to failures, tasks, and strategies were separated for coding. However, it became apparent that each component of an information seeking episode needed to be analyzed in the context of the whole information seeking process to achieve a holistic understanding. The tasks and strategies all offered rich, interconnected contexts so that it was almost impossible to separate them solely for coding purposes. This realization reinforced the assumption that information seeking should be interpreted as a whole. The first author first coded 96 cases, after which another coder joined the study. The author and the coder then coded the first 20 cases out of the other 112 cases independently (cases were ordered by the time of submission). Inter-coder reliabilities were

calculated for all four schemes using Cohen's kappa (see Table II for the inter-coder reliability of each category) and they were determined to be satisfactory. Most disagreements were due to unclear descriptions in the survey data. After resolving the disagreements, the coder finished the rest of the data while the author coded the interview data and reviewed and revised her previous coding (first 96 cases in survey data) based on new discussions.

4. Results

4.1 Expected failures

Among the 208 survey cases, participants were able to explain 62.5 percent of their failures. In about half of the cases ($n = 101$), they believed that the information they needed was not visibly available (expected failures) for a number of mutually non-exclusive reasons, such as the information needs were too unique or specific ($n = 40$), the information was not up-to-date ($n = 22$), or the information was not officially released or shared ($n = 17$). Non-existence of the information could often be further attributed to human factors because the people who had the information failed to or intentionally did not disclose. For example, one participant was preparing for a job interview when she could not locate a piece of information and later found out that the information was not released by the company:

> (No. 25) [The company] (as I found out after I got the job) goes to rather extensive lengths to keep its digital footprint to an absolute minimum. The pieces of information I ultimately couldn't find simply are not available to your average non-hacking-genius web-surfer[1].

The above case represents an example in which the participant was certain about the non-existence of the information. In some cases, participants speculated the unavailability of the information but did not try to prove it:

> (No. 63) I asked various people at the agency if they had the information I needed. No one had access to it, but they supposed it might exist at the higher levels of the organization. I did not go beyond middle management.

In quite a few examples, participants were able to find general information about the topic they were working on, but the information was not specific or personalized enough to support them in completing their task*s* (e.g. "I kept getting just generic information about virtual memory, and not an answer to my question."). Information needs of that kind often required personalized help that existing information on the web could not satisfy. In 14 instances, there were simply no solutions to participants' questions (No. 10: there was not at the time a way to read the layer groups of PSD files without Photoshop). Scenarios, in which information did not exist, however, did not always negatively impact participants' search experiences. Sometimes, they just needed an excuse to move on:

> (No. 162) If the assessor's office had been clearer that the file was lacking information because the assessor did not have it, it would have been easier to move on.

Reasons behind failures were unclear in 35.6 percent of the expected failures. In such situations, although participants felt certain that there was not any information, they could not articulate why or they did not know why. Their answers were usually short (e.g. No. 18: I was looking for information that was not readily available).

Table II.
Inter-coder reliabilities for four categories of coding

	Failure types	Barriers	Tasks	Strategies
Cohen's kappa	0.75	0.79	0.61	0.91

4.2 Unexpected failures

Unexpected failures – in which participants expected the information to visibly exist, yet were unable to locate it – constituted 51.4 percent of the total failures in survey responses. They blamed themselves – at least partly – for not finding information in most of the cases. Being unable to articulate information needs was the most common internal factor ($n = 33$) that contributed to unexpected failures. They either did not know enough about their topic (e.g. No. 169: I had no background in programming languages) or their information needs were difficult to describe, such as non-textual information (e.g. images) or math problems. Multiple participants mentioned their troubles in identifying an item in an image, for example:

> (No. 92) I saw a picture on Pinterest of a nail polish that I really liked, but I couldn't figure out what color it was. It was just a picture without any information included.

In some cases, even though participants were familiar with their topics, they still had trouble formulating search queries. One interview participant said this when she described her difficulty in finding programming scripts: I was familiar with the topic, but I did not know the keywords (to search). Participants did give up just because they lacked patience ($n = 27$), but they usually did this for non-work-related tasks (e.g. playing DOTA2, baking croissants).

The aforementioned findings partly correspond to Mansourian *et al.* (2008), who stated that participants who had unexpected failures blamed themselves for their failures. Amidst this study's findings, it is notable that in 92.5 percent of unexpected failures, participants also felt their lack of success was at least partly due to external factors. Among the external factors, time constraint ($n = 49$) was the most predominant factor leading to unexpected failures, likely because almost 40 percent of the tasks were urgent short-term tasks. Participants frequently believed that the information existed and they would have retrieved it if more time were given. They used various wording to indicate that they were "consistently in a time-crunch" and could not locate desired information "within a reasonable timeframe". Time could also cause internal anxiety, and together both factors negatively impacted information seeking efforts, as described by an interview participant:

> Time was one of the reasons definitely, but it was kind of connected to my internal anxiety because I had to get an apartment before I came to (name of the city).

Factors were not mutually exclusive and often showed up together. For instance, time constraint and too much information ($n = 18$) or scattered information ($n = 26$) sometimes co-existed, possibly because the limited amount of time making digesting a lot of information impossible, and thus led to the failure in locating the needed information. It is understandable that survey participants liked to describe short-term tasks, as they could answer in just a few lines. In contrast, interview participants were more inclined to discuss long-term tasks for which time constraints were less salient.

Accessibility was another issue (sometimes the only issue) that resulted in unexpected failures. Both the survey and the interview participants recalled examples of being restricted from accessing information in libraries, which was defined by Savolainen (2016) as an institutional barrier; this type of barrier is often linked to legal and financial information. For example, one interview participant sounded very frustrated about being rejected from accessing a court document because she knew of the document's existence and location:

> I wasn't given a good explanation as to why they wouldn't provide me a copy, because it was technically in the public record. If the document contained names or social security numbers that they couldn't release, at least we would have a reason. I spent so much time tracking down this document; to be told "no" without a reason was very frustrating.

In total, 39.2 percent of unexpected failures could not be clearly explained. Similar to those who could not explain their expected failures, participants either did not express a clear reason for their failures, or indicated their uncertainty by using words like "probably" and/or frequently remarking on their knowledge gaps or inability to articulate their information needs (e.g. No. 113: I just was not sure of exactly what I was looking for).

Frequencies of barriers that resulted in ISFs are summarized in Table III (only broader categories are included for simplicity). A majority of the failures were caused by either external factors or internal factors. In total, 59 other cases were driven by both, 71.2 percent of which belonged to unexpected failures. For example, lack of outside help (external) was often related to insufficient topical knowledge (internal) because participants who did not know much about their topics tended to turn to others for information:

> (No. 20) Mom's information was not detailed enough for me to learn much more than I knew before I called her. My general lack of knowledge is the roadblock in this situation. My aging mother's memory was a roadblock.

4.3 Tasks and strategies

In the cases reported in this study, participants' information needs and tasks were quite diverse, though there were a few topics that occurred more frequently than the others (e.g. computer crash, health, apartment/house hunting). The largest portion of tasks in the survey data related to intellectual products ($n = 87$) such as research papers or program proposals. It is followed by tasks that delivered decisions or solutions ($n = 71$) such as solutions to computer problems or purchasing decisions. Tasks could also supply physical products ($n = 50$) such as replacement parts for cars or an old toy. In total, 60.5 percent of the tasks involved repeating a similar procedure multiple times, for instance, continuously revising a research paper. While 88.5 percent of the tasks

Table III. Frequencies of information seeking barriers reported in survey[a]

	EE	EU	UE	UU
External barriers				
Information was not available (e.g. not officially released, unique information needs)	52	29	20	21
Time constraint	14	14	29	20
Information was unreliable (e.g. conflicting)	15	6	17	13
Information was too scattered	10	8	17	9
Information was not up-to-date	16	6	4	7
Too much information	2	3	13	5
Lack of help from people	6	3	7	4
Problematic information organization or documentation by others	10	1	4	1
Financial constraint	2	2	3	3
Institutional barriers	1	0	1	3
Technical problem (e.g. no internet connection)	0	0	1	1
Internal factors				
Unable to articulate information needs	2	2	17	16
Unaware of the relevant information sources	6	4	13	13
Lack of patience	2	2	22	5
Poor search skills	3	1	9	11
Physical constraints (e.g. unable to travel)	0	1	6	1
Problematic time management	0	1	5	0
Problematic information organization or documentation	1	0	2	2
Not good at using technology	1	0	1	1

Note: [a]Only broader categories are included for simplicity

collected through surveys were short-term tasks, there were tasks spanning relatively long periods of time or still going on (e.g. redeveloping a company's intranet). It is not surprising that participants rated 59.6 percent of the tasks as highly difficult and 54.3 percent as highly complex, as more difficult and intricate tasks decrease information seeking endeavors' success rates (Byström and Järvelin, 1995; Aula *et al.*, 2010). Table IV presents the frequencies of various task characteristics and Table V shows the ratings of the tasks.

While most tasks had specific goals like finishing a clearly defined assignment, there were also times when participants worked toward a flexible or vague goal (e.g. No. 106: to make a piece of journalism stronger) or they did not have a goal in mind and broadly sought information (e.g. No. 20: I feel I suffer with issues related to social anxiety and I wanted to enlighten myself). Nearly a half of the tasks were unique and performed by doers for the first time ($n = 103$). Unique tasks sometimes generated uncommon or new problems that few people had encountered, and thus brought barriers like "no solution" and left participants with a limited amount of information. However, completing a task for the first time by no means implied unfamiliarity with the topic, or vice versa. Participants considered themselves to be highly familiar with their topics in 73 cases. For example, a participant could be very familiar with violins in general, but failed to locate the measurements of some specific violin models. In 79 examples, participants had occasionally done the tasks before but not on a regular basis. Tasks of this type often involved some special incidents, such as computer software crashes or getting sick.

	Task characteristics	EE	EU	UE	UU
Urgency	Urgent	27	14	27	14
	Moderately urgent	31	21	34	23
	Not urgent	7	1	4	5
Goal – quality	A task with an amorphous goal	0	2	4	2
	A task with mixed goals	37	8	12	8
	A task with a specific goal	28	26	49	32
Goal – quantity	A task with only one goal	62	34	58	35
	A task with two or more goals	3	2	7	7
Product	A task that produces decisions or solutions	28	11	22	10
	A task that produces intellectual products	22	16	28	21
	A task that produces physical products	15	9	15	11
Source of Task	A task motivated by task setters	29	20	25	16
	A task motivated by task doer	36	16	40	26
Frequency	A routine task (a task conducted frequently)	13	5	7	1
	An intermittent task (a task conducted more than one time but not frequently)	16	18	29	16
	A unique task (a task conducted at the first time)	36	13	29	25
Length	Long-term (a task that could not be finished in less than a month)	3	4	10	7
	Short-term (a task that could be finished in less than a month)	62	32	55	35

Source: Categories modified from Li and Belkin (2008)

Table IV. Frequencies of task characteristics

	Familiarity	Importance (salience)	Difficulty	Complexity
Low	67	27	30	38
Moderate	68	45	54	57
High	73	136	124	113

Table V. Ratings of task characteristics

Only 26 tasks in the survey data were routine tasks that were frequently conducted by the participants, mostly as part of their jobs, for example:

> (No. 8) It was part of my job at the reference desk to answer reference questions for information. The customer wanted information about a local item called the New Jersey Ax.

Some types of information that support decision making were difficult for participants to obtain, especially when there was not an objective answer or review, such as the performance of certain products. For example, a participant spent hours and tried different strategies to learn about the keyboards on sale, yet did not find the information that could have helped him make a purchase. One interview participant faced a similar dilemma when he was comparing two game-developing engines and looked for objective reviews for both:

> [I want to hear from] someone that has used both engines. I think my friend had only used one. He was recommending that one because he has used [it], but he didn't have [an] objective opinion because he hasn't used the other one.

As a few other participants who had similar selection dilemmas, this participant wished to consult someone whose experience or hobby resemble his and is experienced in this kind of situation:

> I mean I did have someone who had some knowledge, but I don't think he knew the situation I was in. If there's another person who is a hobbyist […] had gone through what I have gone through, thought one engine would be better than the other. That would be helpful.

As expected, participants adopted more than one strategy in most cases, which generated a total of 398 ISSs for coding. In general, participants relied heavily on search engines (mostly Google) and close acquaintances or professionals (e.g. doctors). They usually started with search engines, which led them to other resources. A typical step was the No. 16 ($n = 148$) in Belkin *et al.*'s (1993) ISSs – "search (on search engines) – select (links) – specify (i.e. with specified topics in mind) – meta-information (i.e. using meta-information sources)" – which was manifested mostly as "Googling." Participants who were making purchasing choices also searched on review websites such as Yelp and online forums. One interview participant made an interesting comment on using Google:

> We are all, at this point, indoctrinated by Google into the, "type a sentence into one bar and hit enter," and in the 50,000 results that come up, something is gonna work. It's probably just gonna be in the top ten, because that's what you actually look at.

Some survey and interview responses reflected the notion that participants rarely went beyond the second search result page. This echoes Wu and Kelly (2014), who state that users depended on the first search result page to determine whether they will proceed with their queries. One participant also recognized that databases are complex compared to search engines, and therefore it is difficult for people to make extra efforts and successfully locate information within databases. This mirrors Rosman *et al.*'s (2016) conclusion that database searching is less likely to be successful than search engine searching.

Apart from ISS No. 16, No. 3 (Scan – Learn – Specify –Information, e.g. "I started from the company website, explored everything there") and No. 11 (Search – Learn – Specify – Information, e.g. "searched insurance website") appeared frequently. These two usually took place when participants browsed (No. 3) the content or searched (No. 11) in an informational item (e.g. eBooks, websites) with a specific subject in mind. Although searching was the most common strategy, there were times when people could not start by searching, particularly when they did not know how to express their information needs in search queries. Thus, strategies beginning with scanning were frequently associated with the barrier of articulating information needs caused by a lack of knowledge or indescribable needs. Also, when searching was not appropriate or enough for locating information

regarding non-textual items, browsing was often the choice. For instance, when a participant tried to decide the prices for a few items coming into her store, she found out that "the items were a little odd, as far as rarity goes", and thus chose to browse "some collectors' websites to see if someone had made a sale or had offers put in on items that were either the same or very similar."

Belkin *et al.*'s (1993) framework does not capture inquiring behavior. Participants frequently recounted their experiences with asking friends, family members, or doctors for information, and posting in online forums or Q&A websites. These tactics belong to neither scanning nor searching. This study did not extend the framework due to its relatively small sample. Instead, consulting people was considered a searching behavior because asking a person or a group is comparable to querying a database (Byström and Hansen, 2005).

Although the survey did not directly ask if the participants had exhausted all of their options before giving up, most seemed to have tried everything to the best of their knowledge. Some participants made this very clear in their responses; for example, the following participants were looking for housing information and tried everything she knew:

> (No. 48) Every realtor's website I could find, phone calls, Zillow, Trulia, Craigslist, physical weekend trips to look at houses, you name it, I tried it.

It is worth noting that using only one strategy does not necessarily mean that participants quickly gave up, but may indicate that they did not know what else they could do. One participant admitted that he did not want to only use search engines, but did not know of other available solutions. Participants who put down "unaware of relevant sources" as an information seeking barrier generally used fewer strategies, possibly because they did not know of other available resources. Not having enough knowledge about the topic ($n = 25$) often caused participants' unawareness of relevant sources. Only one participant wrote "I didn't look hard enough" as the single reason for his failure. Participants sometimes also developed coping strategies – such as changing the original goal – to work around their ISFs and complete their tasks.

ISS No. 2 and No. 4 in Belkin *et al.*'s (1993) framework did not show up at all in the survey data (i.e. scan – learn – recognize – meta-information; scan – learn – specify – meta-information). It is not entirely surprising because people usually choose to search on meta-information sources such as search engines. Searchers may rarely learn through scanning alone rather than clicking on links. This issue will be further investigated in future research. In the process of examining the data, the observation was made that learning and selecting may not be dichotomous, as proposed by Belkin *et al.* (1993), but can happen simultaneously. For example, multiple participants reported that they usually searched on Google to select resources, and simultaneously learned new keywords or factual information from the result pages while researching unfamiliar topics. In these cases, it was difficult to analyze one mode independent of the other.

5. Discussion

Although participants seemed to have a good idea of the factors behind most of their ISFs, the extents to which they could explain their failures were wide-ranging. Some participants provided concrete reasons – such as the information was not officially released, documented, or indexed by the information sources (e.g. organizations) – that explained their failures. Some participants were able to logically speculate to make sense of their failures, while others only provided their observations (e.g. not enough research done in the field) rather than explanations. In the third type of scenario, it was not determined if the information really was available/unavailable, or if the participants were pessimistic/overconfident in their information seeking skills. Ford and Mansourian (2006) defined this as cognitive invisibility (i.e. the invisibility was perceived by participants, and did not necessarily correspond to the reality of whether the information was available).

Participants who had expected failures concluded that the information they were looking for was not visibly available, and thus they usually completely attributed their failures to external factors that were out of their control. In only 23 instances, the survey participants who had expected failures acknowledged their own lack of patience or skill in addition to external forces. This finding echoes Mansourian *et al.*'s (2008) stance that participants of this type considered failures inevitable. In contrast, participants who experienced unexpected failures anticipated that the information existed somewhere. As a result, they were more inclined to blame themselves for their failures. However, compared to the cases of expected failures in which participants infrequently mentioned internal factors, unexpected failures were often perceived as originating from both external and internal factors. Knowing of information's existence while being unable to obtain it because of external reasons, such as institutional restrictions, could be more frustrating than other situations. Participants' perception of ISFs may relate to their perception of relevance because several participants mentioned the non-existence of relevant information. This study did not specifically ask about their criteria for relevance judgment, and thus was unable to examine the connection between their interpretation of failures and relevance. This may be a direction for future research. These findings addressed the *RQ1* and *RQ2*.

Individuals' ISFs were usually not caused by one single reason, but triggered by various interconnected contextual factors starting with the tasks, which could bring external barriers such as time constraint and influence people's seeking strategies. These then further stimulated other external and internal barriers (e.g. lack of knowledge or help), and affected subsequent strategies and information seeking outcomes. Reported tasks that triggered information seeking varied to a great extent, ranging from short-term tasks with single and specific goals to long-term tasks with multiple and mixed goals. Tasks that involved decision making were remarkably difficult because they normally required the information that was not readily available and objective information from more than one side. Unique tasks also created obstacles for information seeking not only because task doers were not knowledgeable about those tasks, but also because they presented novel challenges. Even those participants who had similar information needs were in different situations. For example, one participant who sought health information went to her doctors, while another who did not have health insurance had to search online and treat himself. In the latter case, the difficult task coupled with financial constraint added to the person's barrier in asking for help from professionals, and thus led to his ISF. The findings again emphasize on the significance of contexts in information seeking, as information could be much less meaningful for each individual if it lost the context in which it was needed.

In total of 16 of Belkin *et al.*'s (1993) ISSs 14 were uncovered in the data. It is not surprising that the majority of the participants predominantly used search engines. They sometimes went directly to other sources (e.g. company's website) if they knew which source would be more likely to contain the information or they were unsure about which query to use. In some cases, even though participants did not start with search engines, they returned to them after having no luck with other sources. One participant did point out that he sometimes did not want to use Google as his only source because it did not offer personalized information, but he could not find other solutions that better suited his information needs. The unawareness of relevant information sources, particularly offline sources (e.g. human sources), is one of the participants' major internal barriers, as quite a few participants commented that they "solely relied on the Internet" and "didn't really know where else to look". This calls for a system that can not only bring users to information resources, but also connect them to human sources that can offer personalized help in a timely manner. Interestingly, although quite a few participants brought up their difficulties in finding other people to ask for help, they almost never mentioned pursuing support from information professionals such as librarians, particularly in the examples of working on

research papers in which librarians could have been helpful. Only one participant stated that she regretted not asking a librarian when working on a class paper. These findings addressed *RQ3*.

This study has several implications for information system/service design. First, individuals' information needs were often too specific and situational to be fulfilled by searching for existing information. They often wished to directly consult people who are knowledgeable of a topic (e.g. "someone that has used both engines") and get personalized answers. However, those people may not be in their personal network. This presents an opportunity for designing systems that can accurately match information seekers to people who have the knowledge and the willingness to help in a timely manner. Systems of that kind may also provide reasonable rewards for users to contribute. Existing online forums and Q&A sites are efforts toward that direction, though they still have limitations in fulfilling complicated or specific information needs. Second, individuals should be informed about relevant information sources, particularly human sources such as librarians who may be easily accessible. Participants rarely contacted librarians who would very likely have the time and willingness to help, especially for research-related work. Third, new methods may be designed to enhance the communication between system developers and users as some barriers encountered online may easily be fixed by adding proper features. The types of support that would have prevented individuals' failures (e.g. system features, services) and practical implications were discussed in greater detail in a separate paper (Wang and Shah, 2016).

This study is not without limitation. First, data collection via a survey method gathered fewer long-term tasks than short-term tasks because participants were prone to reporting short-term ISFs that could be summarized in a few lines. Second, although the large majority of participants tried to describe their experiences in a concise but thorough manner, they sometimes unavoidably left out important details since they could not have known exactly what they were expected to document. Due to these limitations, semi-structured interviews were conducted to further investigate questions that arose from the surveys, which did reveal some nuances and findings that were not elaborated on in the survey results. Also, due to the relatively small sample size, statistically constructed patterns were not developed. Although MTurk attracted participants from diverse backgrounds, the extent to which this method could represent the general population is unknown. However, this research's sampling was sufficient for an exploratory study that built a basic understanding of a wide range of ISFs and opened various possibilities for future research. Because of the limitations, this work cannot propose more specific implications for system/service design. Instead, it serves as the first step toward understanding the aspects that went wrong in individuals' information seeking.

6. Conclusion

The work reported in this paper drew on multiple theoretical frameworks to examine and demonstrate a variety of people's ISFs in a holistic way. Failures were nearly evenly distributed into expected failures where individuals assumed the non-existence of their desired information and unexpected failures where they believed that they failed to find existing information. In general, people were found to be more inclined to attribute their failures to purely external causes or a combination of external and internal causes. Their information needs were often very situational and contextual. However, the information they found was sometimes not specific or personalized enough, and this problem was intensified by other factors, such as time constraints, that were beyond people's control. People's information needs were generated by tasks covering all types of characteristic and topic. In particular, tasks that required decision making and tasks which people performed for the first time presented unique challenges. Difficult tasks subsequently led to not being aware of relevant sources (particularly human sources) as participants frequently reported

on using Google as the only channel for information. Also, there may be a gap between people's perceptions of information availability and actual available information. The exploratory work described here provided interesting insights into how people perceive and address challenges in information seeking, and possible support that could be facilitated to address those challenges and failures. In addition, this research contributes to a methodology and a set of frameworks that can be used to study information seeking barriers and failures in the larger context of tasks and various search strategies. It adds to existing information seeking literature by considering both online and offline environments.

In the future, the newly developed approach presented here will expand related research on ISFs. First, interviews will be conducted to further examine some of the issues arising from survey data. Next, as it was mentioned in an earlier section, the connections between individuals' perceptions of relevance and ISFs should be examined as these two concepts are closely related. This research will also grow to a larger scale and be used to construct overall patterns of people's information seeking behavior or failures. In addition, the affective aspect (e.g. emotions) of ISFs is worth exploring, particularly in regard to how people feel about their failures. Future research will tackle these challenges one by one and subsequently develop a deeper understanding of often-ignored elements of information seeking processes. As a result, it will have even more practical implications for information systems and services design.

Note

1. Numbered quotes are from the survey data. Quotes without a case number are from the interview data.

References

Attfield, S. and Dowell, J. (2003), "Information seeking and use by newspaper journalists", *Journal of Documentation*, Vol. 59 No. 18, pp. 187-204.

Aula, A., Khan, R.M. and Guan, Z. (2010), "How does search behaviour change as search becomes more difficult?", *Proceedings of the 28th SIGCHI Conference on Human Factors in Computing Systems*, pp. 35-44.

Belkin, N.J., Marchetti, P.G. and Cool, C. (1993), "Braque: design of an interface to support user interaction in information retrieval", *Information Processing and Management*, Vol. 29 No. 3, pp. 325-344.

Buhrmester, M., Kwang, T. and Gosling, S.D. (2011), "Amazon's Mechanical Turk: a new source of inexpensive, yet high-quality, data?", *Perspectives on Psychological Science*, Vol. 6 No. 1, pp. 3-5.

Byström, K. and Hansen, P. (2005), "Conceptual framework for tasks in information studies", *Journal of the American Society for Information Science and Technology*, Vol. 56 No. 10, pp. 1050-1061.

Byström, K. and Järvelin, K. (1995), "Task complexity affects information seeking and use", *Information Processing & Management*, Vol. 31 No. 2, pp. 191-213.

Chowdhury, S., Gibb, F. and Landoni, M. (2011), "Uncertainty in information seeking and retrieval: a study in an academic environment", *Information Processing and Management*, Vol. 42 No. 2, pp. 157-175.

Connaway, L.S., Dickey, T.J. and Radford, M.L. (2011), "'If it is too inconvenient I'm not going after it': convenience as a critical factor in information-seeking behaviors", *Library & Information Science Research*, Vol. 33 No. 3, pp. 179-190.

Dorn, B., Stankiewicz, A. and Roggi, C. (2013), "Lost while searching: difficulties in information seeking among end-user programmers", *Proceedings of the 76th ASIS&T Annual Meeting*, Vol. 5 No. 1, pp. 1-10.

Drabenstott, K.M. and Weller, M.S. (1996), "Failure analysis of subject searches in a test of a new design for subject access to online catalogs", *Journal of the American Society for Information Science*, Vol. 47 No. 7, pp. 519-537.

Dwyer, C.M., Gossen, E.A. and Marin, L.M. (1991), "Known-item search failure in an OPAC", *RQ*, Vol. 31 No. 2, pp. 228-236.

Erickson, J., Mackenzie, C.S., Menec, V.H. and Bailis, D.S. (2017), "The effect of time perspectives on mental health information processing and help-seeking attitudes and intentions in younger versus older adults", *Aging & Mental Health*, Vol. 21 No. 3, pp. 259-271.

Flanagan, J.C. (1954), "The ciritical incident technique", *Psychological Bulletin*, Vol. 51 No. 4, pp. 327-358.

Ford, N. and Mansourian, Y. (2006), "The invisible web: an empirical study of 'cognitive invisibility", *Journal of Documentation*, Vol. 62 No. 5, pp. 584-596.

Hauser, D.J. and Schwarz, N. (2016), "Attentive Turkers: MTurk participants perform better on online attention checks than do subject pool participants", *Behavior Research Methods*, Vol. 48 No. 1, pp. 400-407.

Horn, R.G., Karim, M.N., Behrend, T.S., Sharek, D.J. and Wiebe, E.N. (2013), "Mechanical Turk: compensation rate and data quality", *25th Annual Meeting of the Association of Psychological Science, Washington, DC, May*.

Julien, H.E. (1999), "Barriers to adolescents' information seeking and career decision making", *Journal of the American Society for Information Science*, Vol. 50 No. 1, pp. 38-48.

Kraaijenbrink, J. (2007), "Engineers and the web: an analysis of real life gaps in information usage", *Information Processing & Management*, Vol. 43 No. 6, pp. 1368-1382.

Kress, N., Bosque, D.D. and Ipri, T. (2011), "User failure to find known library items", *New Library World*, Vol. 112 Nos 3/4, pp. 150-170.

Kuhlthau, C.C. (1991), "Inside the search process: information seeking from the user's perspective", *Journal of the American Society for Information Science*, Vol. 42 No. 5, pp. 361.

Kumpulainen, S. and Järvelin, K. (2012), "Barriers to task-based information access in molecular medicine", *Journal of the American Society for Information Science and Technology*, Vol. 63 No. 1, pp. 86-97.

Li, Y. and Belkin, N.J. (2008), "A faceted approach to conceptualizing tasks in information seeking", *Information Processing and Management*, Vol. 44 No. 6, pp. 1822-1837.

Lynch, C.A. (1989), "Large database and multiple database problems in online catalogs", in Dillon, M. (Ed.), *OPACs and Beyond*, Online Computer Library Center, Dublin, OH, pp. 51-56.

McCray, A.T. and Tse, T. (2003), "Understanding search failures in consumer health information systems", *Proceedings of the AMIA Annual Symposium*, pp. 430-434.

Mansourian, Y. (2008), "Coping strategies in web searching", *Program: Electronic Library and Information Systems*, Vol. 42 No. 1, pp. 28-30.

Mansourian, Y. and Ford, N. (2007a), "Search persistence and failure on the web: a 'bounded rationality' and 'satisficing' analysis", *Journal of Documentation*, Vol. 63 No. 5, pp. 680-701.

Mansourian, Y. and Ford, N. (2007b), "Web searchers' attributions of success and failure: an empirical study", *Journal of Documentation*, Vol. 63 No. 5, pp. 659-679.

Mansourian, Y., Ford, N., Weber, S. and Madden, A. (2008), "An integrative model of 'information visibility' and 'information seeking' on the web", *Electronic Library and Information Systems*, Vol. 42 No. 4, pp. 402-417.

Mason, W. and Suri, S. (2012), "Conducting behavioural research on amazon's mechanical turk", *Behavioral Research Methods*, Vol. 44 No. 1, pp. 1-23.

Peters, T.A. (1989), "When smart people fail: an analysis of the transaction log of an online public access catalog", *Journal of Academic Librarianship*, Vol. 15 No. 5, pp. 267-273.

Rosman, T., Mayer, A.K. and Krampen, G. (2016), "On the pitfalls of bibliographic database searching: comparing successful and less successful users", *Behaviour & Information Technology*, Vol. 35 No. 2, pp. 106-117.

Sadeh., T. (2008), "User experience in the library: a case study", *New Library World*, Vol. 109 Nos 1/2, pp. 7-24.

Savolainen, R. (1995), "Everyday life information seeking: approaching information seeking in the context of 'way of life'", *Library & Information Science*, Vol. 17 No. 3, pp. 259-294.

Savolainen, R. (2006), "Time as a context of information seeking", *Library & Information Science Research*, Vol. 28 No. 1, pp. 110-127.

Savolainen, R. (2015), "Cognitive barriers to information seeking: a conceptual analysis", *Journal of Information Science*, Vol. 41 No. 5, pp. 613-623.

Savolainen, R. (2016), "Approaches to socio-cultural barriers to information seeking", *Library & Information Science Research*, Vol. 38 No. 1, pp. 52-59.

Seyedarabi, F. (2011), "Personalization: an emerging direction for tackling the Web searching barriers faced by teachers when searching for educational resources", *Webology*, Vol. 8 No. 2, available at: www.webology.org/2011/v8n2/a90.html (accessed September 2016).

Shapiro, D.N., Chandler, J. and Mueller, P.A. (2013), "Using mechanical turk to study clinical populations", *Clinical Psychological Science*, Vol. 1 No. 2, pp. 213-220.

Shenton, A.K. (2012), "Causes of information-seeking failure: some insights from an english research project", in Chelton, M.K. and Cool, C. (Eds), *Youth Information Seeking Behavior II*, The Scarecrow Press, Lanham, MD, pp. 313-64.

Świgoń, M. (2011a), "Information barriers in libraries; types, typologies and Polish empirical studies", *Library Management*, Vol. 32 Nos 6-7, pp. 475-484.

Świgoń, M. (2011b), "Information limits: definition, typology and types", *Aslib Proceedings*, Vol. 63 No. 4, pp. 364-379.

Syzmanski, E.A. and Davis, L.S. (2015), "Wine science in the Wild West: information-seeking behaviors and attitudes among Washington state wine makers and growers", *Journal of Wine Research*, Vol. 26 No. 4, pp. 270-286.

Urquhart, C., Light, A., Thomas, R., Barker, A., Yoeman, A., Cooper, J., Armstrong, C., Fenton, R., Lonsdale, R. and Spink, S. (2003), "Critical incident technique and explication interviewing in studies of information behaviour", *Library and Information Science Research*, Vol. 25, pp. 63-88.

Wang, Y. and Shah, C. (2016), "Exploring support for the unconquerable barriers in information seeking", *Proceedings of the Association for Information Science and Technology Annual Meeting*, Vol. 53 No. 1, pp. 1-5.

Wilson, T.D. (1981), "On user studies and information needs", *Journal of Documentation*, Vol. 37 No. 1, pp. 3-15.

Wu, W. and Kelly, D. (2014), "Online search stopping behaviors: an investigation of query abandonment and task stopping", in John, C. (Ed.), *Proceedings of the 77th Annual ASIS&T Meeting*, Wiley and Sons Inc., Hoboken, NJ, pp. 1-10.

Appendix. Survey Questions

Please recall one example of when you failed to find the information you needed to finish a task at work or at school, or when the information you found was incomplete or insufficient for you to finish that task.

1. What information were you looking for?
2. Why were you looking for that information (what was the task that triggered looking for information)?
3. How familiar were you with the topic of this task?

	1 (not at all) (1)	2 (2)	3 (somewhat) (3)	4 (4)	5 (very) (5)
Familiarity	❍	❍	❍	❍	❍

4. Please rate the importance, difficulty, and complexity of this task:

	1 (not at all) (1)	2 (2)	3 (moderately) (3)	4 (4)	5 (very) (5)
Importance	❍	❍	❍	❍	❍
Difficulty	❍	❍	❍	❍	❍
Complexity	❍	❍	❍	❍	❍

5. Please provide a step-by-step description of all the different things you tried to find this information:
6. In your opinion, what are the reasons you failed to find the information you needed?
7. Please check any problems or difficulties you encountered when you were looking for this information (check all that apply):

- ❑ Time constraints
- ❑ Physical constraints (e.g., unable to go to the library)
- ❑ Financial constraints (e.g., couldn't afford a book)
- ❑ Too much information
- ❑ Information was too scattered
- ❑ Information was not up-to-date
- ❑ Information was in poor quality
- ❑ Information was unreliable
- ❑ Information was not available
- ❑ Unable to articulate my information needs
- ❑ Technological problems (please specify) _____
- ❑ Lack of sufficient patience or not wanting to spend time
- ❑ Unaware of relevant information sources (e.g., websites, journals)
- ❑ Poor search skills
- ❑ Unable to understand the information found
- ❑ Others, please specify_____

8. What kind of support do you think would have been helpful for you to find sufficient information for your task?

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