

**Users' Help-Seeking Behaviors within the Context of Computer Task
Accomplishment: An Exploratory Study**

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Dedication

To my mother, my father, my step-father, and my husband

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unconditional support in every aspect of my life, which became the source for my greatest power in accomplishing the work.

Abstract

This study investigated computer users' help-seeking behaviors within the context of accomplishing a novel and challenging computer task. In addition, this study examined how different help-seeking behavioral variables relate to both personal factors and outcome measures in an exploratory manner. Finally, a structural model examined the effect of personal factors on task performance through the mediating function of help-seeking effectiveness. A total of 67 undergraduate students participated in the study. Participants were asked to perform a challenging task in Microsoft Word. The usability software MORAE was used to record the interactions between participants and computer systems. Participants had access to five help sources: "F1 help," "reference book," "the Web," "video tutorial," and "lab assistant," which differ in media type (electronic vs. non-electronic) and interactivity levels (high vs. low).

This study found that participants showed a wide range of help-seeking behaviors. Some participants were more active in seeking help than others. Participants also engaged in different help-seeking patterns when using different help sources. A dominant help-seeking strategy was to stay with the same source used in the previous help-seeking episode. Help-seeking behavior affected task performances, but personal factors had no significant effect on help seeking or task performances. Based on the findings, the research value of this study, its practical implications, its limitations, and future research directions are discussed.

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Chapter 1

Introduction

A lasting concern in human-computer interaction (HCI) has been how to assist users in accomplishing computer tasks using a particular computer system. Computer users frequently encounter problems that hinder their completion of the task at hand. These real-time problems include: a lack of awareness of the available function needed to support the task, a failure to find the function, or an inability to interpret the messages from the system designed to prompt the user to take the correct action. These situations require users to employ problem-solving strategies quickly to overcome the difficulty and make progress on the task. Users in need of help can either explore the system themselves, or seek assistance from external sources. Help seeking in HCI problem-solving situations refers to users' requests for assistance to overcome problems they encounter in order to move forward toward task completion. Effective help seeking can improve task performance and reduce the users' stress. A better understanding of users' help-seeking behaviors within the context of accomplishing a computer task is vital to informing the design of useful help sources and the improvement of user-system interactions.

The conceptualization of help-seeking as a problem-solving strategy by several researchers (DePaulo, Brown, & Greenberg, 1983; Karabenick & Knapp, 1998; Nelson-Le Gall, 1981, 1985) has inspired help-seeking studies in various contexts where seeking help serves different purposes. There is a substantial body of literature on help-seeking behaviors in learning contexts observed in traditional classroom settings or in computer-assisted interactive learning settings. The majority of the help-seeking studies in these two kinds of settings focused on learners of a particular discipline, such as chemistry, mathematics, or botany, for example. The main purpose of these studies was to understand how seeking help could improve learners'

understanding of the subjects. In order to facilitate better learning outcomes, these researchers examined how learner-related or system-related factors influenced help-seeking behaviors (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Aleven, McLaren, Roll, & Koedinger, 2004; Dutke & Reimer, 2000; Nelson-Le Gall, 1985; Ryan, Gheen, & Midgley, 1998; Ryan, Patrick, & Shim, 2005; Ryan, Pintrich & Midgley, 2001). Other help-seeking studies investigated this phenomenon within the context of information retrieval (IR), to support users' interactions with IR systems, enabling them to find information effectively. Help-seeking studies with IR systems focused on help-seeking situations and related factors, problematic IR help features, and users' perceptions of the usefulness of IR help functionalities (Slack, 1991; Trenner, 1989; Xie, 2007; Xie & Browser, 2009; Xie & Cool, 2009).

No studies have investigated help-seeking behaviors by examining the help-seeking process, personal factors of the user, and task performance, in a computer task accomplishment situation. Seeking help in this context is different from the two contexts addressed in the literature. Users need to seek help in order to accomplish the specific task at hand, rather than for locating information or for improving learning outcomes per se. In addition, although research in software engineering proposes modeling user behaviors in order to determine the optimal way to assist users in appropriately using the software in a task process (Delisle & Moulin, 2002), few studies have provided descriptions of how users seek help, and the role of users' help-seeking behaviors within the HCI context. To address the gap in the literature related to help-seeking in this particular context, the purpose of this study is twofold: (1) the examination of users' help-seeking behaviors during the process of accomplishing an unfamiliar computer task, and (2) the exploration of relationships among personal factors, help-seeking behaviors, and the task outcomes.

Overall, this study not only examines help-seeking behaviors in the one particular HCI context of accomplishing a computer task, it also offers theoretical insights on the complexity of help-seeking behaviors within HCI in general. As for research, the findings of this study shed light on possible directions for future empirical study. The results of the current exploratory study form the basis for a future quantitative explanatory study of help-seeking behaviors, to generate more generalizable results. In addition, the current study's results have implications for researchers regarding how to measure help-seeking behaviors, and what factors to include when forming hypotheses for subsequent studies. These results provide guidance for focused investigation of how other aspects of help-seeking behaviors play a mediating role between personal factors and task outcomes. A practical implication of understanding computer users' help-seeking behaviors can improve system design; these results suggest design principles supporting the help-seeking process, which ultimately assist users to complete tasks in a timely and productive manner. Observing the interplay of personal factors, help-seeking behaviors, and task outcomes also informs the design of help systems that adapt to users' characteristics (user modeling) to improve task performance (task modeling).

Chapter 2

Literature Review

This chapter reviews relevant research about help-seeking behaviors, and establishes the conceptual foundations of this study. The first section below presents the definition of help seeking, followed by a systematic review of studies about help-seeking behaviors in different contexts. This explication identifies and establishes the under-explored context for this study. This chapter also reviews Sharon Nelson-Le Gall's Help-Seeking Process (HSP) Model, and Gary Marchionini's Information-Seeking Process (ISP) Model to establish a theoretical base for the new conceptual models presented in the next chapter. Finally, this chapter also discusses features of help sources, personal factors related to help-seeking behaviors, and research methods employed in help-seeking studies.

The Phenomenon of Help Seeking

The act of seeking help is manifested in people's daily lives in various ways. For example, a foreigner asks for directions when getting lost in a city; a patient sees a doctor for a diagnosis; an individual asks a colleague's help by carpooling to work; or a student asks for help from the instructor when she or he cannot understand the textbook. When individuals encounter obstacles and cannot proceed to achieve their goals, they may seek help to cope with their current difficulty. Help-seeking is commonly utilized as a strategy to deal with problematic situations, so Gourash (1978) defined help-seeking as "any communication about a problem or troublesome event which is directed toward obtaining support, advice, or assistance in times of distress" (p. 414).

Help-seeking behaviors are, therefore, problem-driven. Effectively employing help-seeking strategies to obtain help and comprehend help contents contribute to successful problem-

solving (e.g., Ames & Lau, 1982; Karabenick & Knapp, 1991). The conceptualization of help-seeking behaviors as a problem-solving skill has provided an achievement-related framework to explain and predict help-seeking behaviors in various settings: traditional classroom learning situations, computer-assisted learning environments, and electronic information retrieval (IR) systems.

Help-Seeking Studies in Traditional Classroom Settings

The traditional classroom setting provides a formal learning environment, in which the instructor or teacher provides information and emphasizes the goal of learning. Another characteristic of this setting is that students mainly interact with their instructors and peers on a face-to-face basis. In the classroom learning process, students may encounter various problems. Among the variety of potential strategies for solving problems, help-seeking has been shown to be an effective meta-cognitive skill to enhance the learning process and allow students to solve problems efficiently (Karabenick, 1998).

Help-seeking behaviors are not simplified as a dichotomous behavior set (in which the person either seeks help or does not), but rather is a process involving both cognitive and behavioral activities, in which the help-seeker has engaged prior to, during, and after seeking help. Nelson-Le Gall (1981) presented a heuristic model of the help-seeking process (Nelson-Le Gall's HSP model) in a social context (Figure 1, Nelson-Le Gall, 1981, p. 230).

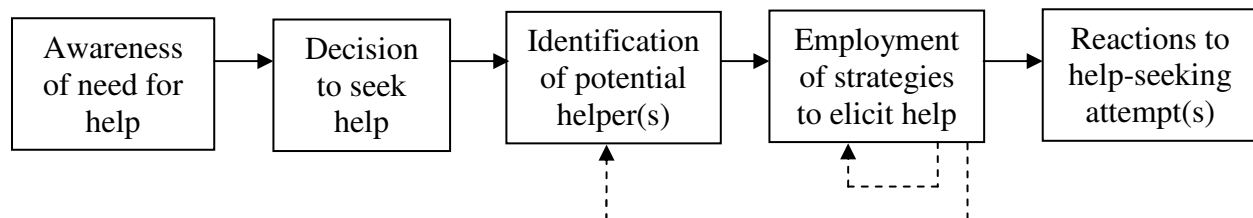


Figure 1. Nelson-Le Gall's help-seeking process model

Figure 1 is a stage or serial process model. The dashed arrows represent the iterative nature of some stages in the help-seeking process. First, prior to any behavioral activity, the learner must become aware of the need for seeking help. For example, the individual must realize a condition of insufficient resources, or his or her insufficient knowledge, to permit reaching a goal, so that the person becomes more likely to utilize help-seeking as a strategy to cope with the problem. Miyake and Norman (1979) suggest that one must know enough to make judgments about whether seeking help is necessary, and where to seek such assistance. Prior experience or knowledge in the specific problem-related area is usually regarded as an important personal factor that affects individuals' attentiveness to the problem (e.g.: Nelson-Le Gall, 1985; Newman & Schwager, 1995).

However, merely acknowledging that the problem exists does not necessarily cause individuals to seek help. A person must acknowledge that there is a problem, and also believe that it is amenable to help. Deciding whether to seek help or not is actually an evaluation of the costs and benefits associated with the behaviors of seeking help (DePaulo & Fisher, 1980). Thus, the second stage concerns the person's decision to seek help or not, which usually involves a subjective assessment of the situation, and reflects individual differences regarding certain personal factors, such as prior knowledge, self-esteem, or efficacy.

In the third phase, after deciding to seek help, the individual needs to identify and select a potential helper or helpers. The selection of a helper may be based on the helper's characteristics (Shapiro, 1983), such as physical attractiveness, the age of the helper, or the role of the helper as either a friend or a stranger. In the next stage of the process, once a helper is selected, the help seeker must pose a request to the helper. Studies have found that some personal factors, such as personal learning goals, or prior achievements, influence the types of help requests that are made

(e.g., Newman, 1998; Newman & Schwager, 1995). Students with a learning goal tend to issue more requests to confirm a final answer, whereas those with performance goals are less likely to submit these confirmation requests, but instead use more process-related requests. Finally, the person who seeks help assesses the help-seeking effort. The results of the evaluation may influence future help-seeking behaviors, i.e., the previous successful experience of seeking help from a particular helper may increase the possibility of seeking help from the same helper in the future.

The goal of help-seeking studies in traditional classroom settings was to improve learning outcomes through the identification of effective help-seeking behaviors. The studies mainly focused on human-human interaction in a social communication context. Therefore personal factors, particularly learner-related factors, have been extensively studied to help educators adapt their teaching strategies, and build classroom norms and climate, conducive to students' developing more appropriate help-seeking strategies. The primary research methods employed in this context included surveys and experiments to test the relationship between personal factors and observed or self-reported help-seeking behaviors.

Help-Seeking Studies in the Human Computer Interaction Context

The development of computer technology and the exponential growth of the availability of information have substantially changed the way people solve problems, accomplish tasks, and search for information for their work or in daily life. More electronic information sources are available for people to search for information to assist them with accomplishing tasks at hand. Help-seeking behaviors are not limited to human-human interactions, but may also involve interactions between help seekers and computer-based help agents. Thus, system-related factors need to be accounted for in help-seeking studies within the context of human-computer

interaction (HCI). In the next three sections, help-seeking studies in computer-assisted learning settings, and those involving the use of information retrieval (IR) systems, are reviewed, followed by a discussion of the specific context on which this study focused – help-seeking in association with computer task accomplishment.

Help-Seeking Studies in Computer-Assisted Learning Settings

The phrase “computer-assisted learning system” refers to interactive learning environments (ILEs) that “offer a task environment and provide support to help novices learn skills or concepts involved in that task” (Aleven, et al., 2003, p. 279). In contrast with a classroom’s formal learning environment, ILEs provide an informal, individual learning setting. Help-seeking behaviors have been studied in ILEs in order to improve the design of help features to facilitate people’s learning experiences in a specific domain. In other words, the objectives of the studies on help functions in ILEs are to support learning, not task performance per se, which is similar to the purpose of help-seeking studies in traditional classroom settings.

Examinations of help-seeking behaviors in ILEs adapted Nelson-Le Gall’s HSP model, but took different elements into account in each step (Aleven et al., 2003). The awareness of the necessity to seek help might be triggered by system feedback, rather than being dependent on learners’ self-monitoring processes as it is in a classroom setting. Second, the decision to seek help in ILEs might be influenced by the features of the available help sources. The use of electronic help sources (as opposed to human helpers) does not pose a threat to individuals’ self-esteem, thus reducing their psychological costs of seeking help, which in turn may increase their tendency to seek help from a computer rather than a human being (Karabenick & Knapp, 1988). The availability of electronic help sources includes various types of computer-based help sources. Learners have more choices: searching or browsing a glossary or hint system in ILEs, or

using a built-in help system in a software package, or seeking help through computer-mediated communication (CMC, e.g., email, discussion forums, or listservs). In addition, the different features of various help sources provide learners with a variety of potential strategies for formulating a help request: keyword searching, natural language searching, browsing, or using a command mode, among others. The ways to access, obtain, and comprehend help content are impacted by the features of help sources. Lastly, the timely feedback in ILEs may decrease learners' motivations to evaluate the help-seeking behaviors. Instead, the feedback will clearly show if learners are ready to proceed with the learning task at hand.

Empirical studies of help-seeking behaviors in computer-assisted learning settings have emphasized the effect of seeking help on learning, by examining both learner-related and system-related factors. Human-computer interaction, rather than human-human interaction, is the central focus of the learner and help features in ILEs. This literature examined an array of system-related factors, including help content (e.g., Dutke & Reimer, 2000), the level of abstraction and interactivity of the hint (e.g., Arroyo, Beck, Beal, Wing, & Woolf, 2001; Arroyo, Beck, Woolf, Beal, & Schultz, 2000), and feedback types (e.g., McKendree, 1990). Another notable type of study about system-related factors evaluated the varied levels of user control over the help contents, based on Vygotsky's (1986) zone of proximal development (e.g., Luckin & du Boulay, 1999), which refers to the differences between what learners have already mastered and what learners can achieve when provided educational support. On the other hand, learner-related factors examined in previous studies included the user's prior knowledge of the domain (e.g., Renkl, 2002; Wood & Wood, 1999), prior knowledge of the learning environment (e.g., Bromme & Stahl, 1999, 2002), self-regulation (e.g., Newman, 1998), age (e.g., Newman & Schwager,

1995; Ryan & Pintrich, 1998), gender (e.g., Arroyo et al., 2001), and epistemological belief (Bartholomé, Stahl, Pieschl, & Bromme, 2006).

Help-Seeking Studies in Information Retrieval Systems

Information retrieval (IR) literature in the library and information science fields is mainly concerned with how to support people's efforts to effectively locate relevant information from digital information resources. During the process of information searching, users may encounter problems and be unable to move forward. Useful help features provided by IR systems can assist users, especially novice users, to overcome these difficulties and make progress in the information searching process. Thus, help-seeking studies of IR systems can provide suggestions on the design of help mechanisms for IR to meet users' needs and help them with search-task completion.

The existing research on help-seeking related studies is generally focused on two directions: (1) the examination of the help features provided by different IR systems, as well as users' perceptions of these help functionalities, and (2) the identification of users' help-seeking situations. The help features in a total of 16 IR systems were found to be inadequate in many cases, leading to the conclusion that the help features design was under-developed, as compared to the design of the overall system (Trenner, 1989). A series of studies by Xie and colleagues (2004, 2006, 2007, & 2009) evaluated help features and inquired about users' opinions about those help features. Two studies by Xie and colleagues (2004, 2006) found that users acknowledged the importance of help features, but also expressed the ineffectiveness of help features in assisting their interactions with IR process. Xie (2007, 2009) later did detailed examinations of help functionalities in selected digital library systems and different online environments. Seven categories of help features were identified in digital libraries: general help,

search-related help, collection-related help, navigation help, terminology help, personalized and customized help, and view-and-use-related help. The author also identified problems in help feature design, which raised questions about whether users ever utilized these help functionalities. Slack (1991) found that only one-third of novice users utilized the help features in five OPACs; the help features did not appear to be effective in assisting these users in searching. The study by Monopoli, et al. (2002) also found that only 35% of digital library users used online help.

Another line of help-seeking studies of IR systems focused on identifying and describing the help-seeking situations in this context. The help-seeking situation was characterized as a circumstance in which “a person is engaging in the process of information searching with an IR system to achieve his or her tasks/goals, and finds him- or herself needing some sort of help in that process” (Xie & Cool, 2009, p.477). The knowledge of the situations in which IR system users need assistance benefited the design of help functionalities. Xie and Cool (2007), in a preliminary study (n=17), identified nine help-seeking situations that led novice users to use help features in digital libraries, including insufficient domain knowledge, unfamiliarity with digital libraries, an inability to use search features, an inability to specify one format for results, an inability to construct a query, an inability to find relevant information, difficulty with reformulating a query, an inability to find specific information, an inability to compare the research results, and an inability to identify appropriate collections. The formal study (n=120) by the same authors (Xie & Cool, 2009) identified 15 help-seeking situations, grouped into 7 categories of actions that the user had an inability to complete without help: the inability to get started, to identify relevant digital collections, to browse for information, to construct search statements, to refine searches, to monitor searches, and to evaluate search results). Further, the

authors examined the impact of various factors on different help-seeking situations. These factors included personal factors (e.g., domain knowledge, system knowledge), task factors (e.g., task type, task complexity), digital library features (e.g., interface design, content coverage), and interaction outcomes (e.g., too many/few results, irrelevant results).

Help-Seeking Studies within the Context of Computer Task Accomplishment

There are situations in which computer users who use IT systems and application programs encounter interaction or conceptual problems that hinder their completion of the task at hand. Users need strategies to identify and rapidly resolve the problem, in order to move on to the completion of the task. Seeking help from external help sources is a potential problem-solving strategy to accomplish the task and reduce negative feelings. Thus, the main purpose of help-seeking in this context is to accomplish the task at hand. This purpose is different from the purpose of help seeking in the aforementioned studies, which were directed toward either enhancing a learning process or improving information search performance. Studies about help-seeking behaviors in the computer task context are scant in the literature. Thus, an exploratory study to better understand users' help-seeking behaviors, specifically within the context of computer task accomplishment, is needed, as it serves as a starting point for future studies to examine the help-seeking behaviors in this context.

Because of the lack of previous studies in the computer task accomplishing context, this study examined computer users' help-seeking behaviors in an exploratory manner. The conceptual models for this study were developed through the review and comparison of Nelson-Le Gall's Help-Seeking Process (HSP) Model and Marchionini's Information-Seeking Process (ISP) Model.

The Help-Seeking Process and the Information-Seeking Process

Information seeking is the act of consciously acquiring relevant information to bridge a perceived gap or inconsistency in cognitive representations (Case, 2007). Thus, information seeking usually involves the activity to search information sources. Within education science, help seeking and information seeking are two distinct learning strategies (Zimmerman & Pons, 1986). Help seeking refers to seeking assistance from another person in a social context, whereas information seeking involves the use of information sources. The two terms create a dichotomous distinction between human vs. non-human sources. However, the boundary between these two behaviors becomes blurred due to the emergence of computer-mediated communication (CMC). Help seeking through the use of new technologies, such as email and online discussion forums, has emerged to replace a face-to-face human helper in some situations, yet still involves seeking assistance from another person, albeit electronically. Simply distinguishing between help-seeking and information-seeking in terms of whether the help source is human or non-human is not adequate for today's information environment (Puustinen & Rouet, 2009). Help-seeking and information-seeking processes show similarities, reflected in the models describing the two processes. Nelson-Le Gall's HSP model (Figure 1) depicts the five stages in which a help-seeker engages, in order to seek assistance from another person. Marchionini (1997, p.50) proposed the information-seeking process (the ISP model), illustrated as a set of sub-processes, as shown in Figure 2

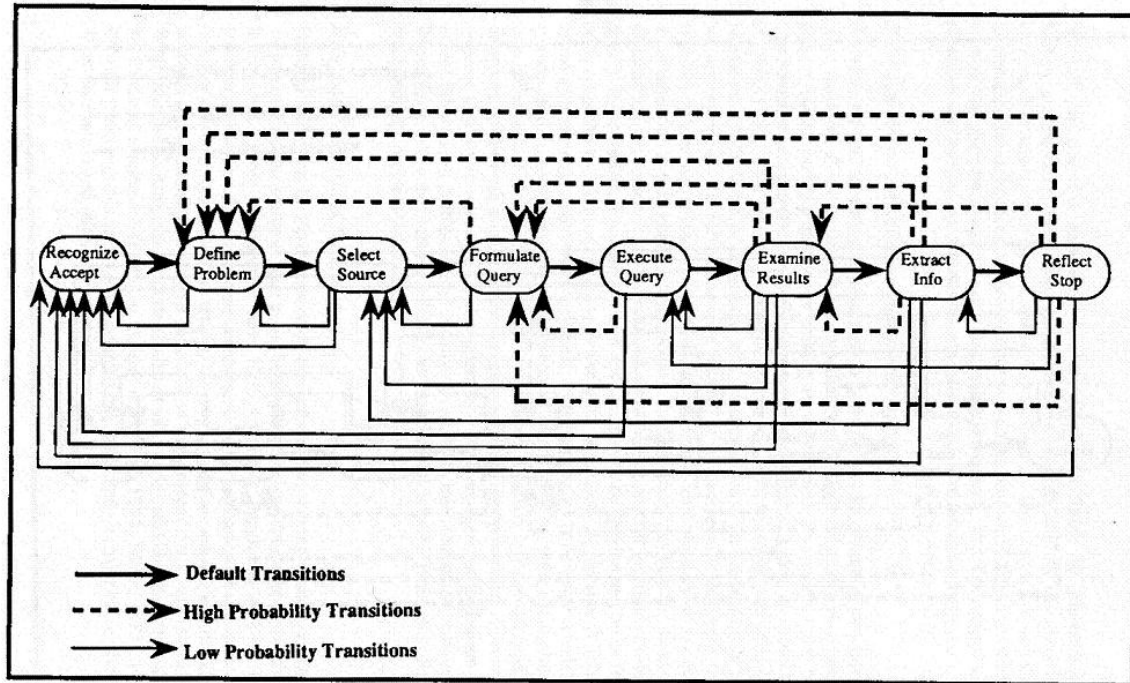


Figure 2. Marchionini's information-seeking process model

Comparing Figures 1 and 2, there is considerable overlapping between Marchionini's ISP model and Nelson-Le Gall's HSP model. Both the HSP and ISP models begin with the recognition of the problem, which is the gap or inconsistency perceived by individuals. This shared cognitive stage is shown in HSP as the "awareness of a need for help" and in ISP as "recognize" (a need for information). The ISP model also describes that individuals should "accept" that the need exists, in order to begin the next step of defining the problem for the searching process. Similarly, the HSP also includes the step "decision to seek help," which reflects an individuals' acceptance of the problem and willingness to seek assistance. The next stage in the ISP is to define the problem, which is a critical step in translating the information need into an expressible request that can later be represented as a query to a search system. However, the HSP model deals with seeking assistance from another human being who is

assumed to have the ability to cope with even vague or ambiguous requests for help, so defining the problem is not depicted as a separate stage in the HSP. Next, according to either the HSP or the ISP, individuals need to select a help source or an information source. Both models acknowledge the options of various sources available to individuals, and the impact of various factors (e.g., prior experience with the source) on people's selection of a source. After the decision is made to choose a particular source to seek help or information, individuals then need to come up with a help request. In particular, this means formulating an appropriate query, depending upon the information source chosen in the ISP. Then, the ISP model shows a series of information-seeking activities, including executing the query, examining the results, and extracting the information. These information-seeking stages are not presented in the HSP model, because not every help-seeking process involves an information component (e.g., asking a friend's help to return a book to the library). Finally, both the HSP and the ISP include a stage in which individuals evaluate the help-seeking or information-seeking effort, an activity which is assumed to have an influence on an individual's choice of a help or information source in his or her future help-seeking or information-seeking activities. In addition, both the HSP and the ISP depict the possibility of iterative loops between certain stages during the whole process, prior to its conclusion.

From the comparison of the HSP and the ISP models above, one can conclude that the HSP and the ISP share certain stages in common, particularly when the HSP involves seeking relevant information from a help source. The context of accomplishing a computer task, which is addressed in this study, bears similarities to both the HSP and the ISP models. As mentioned earlier, help-seeking behaviors are driven by problems that individuals encounter. When computer users encounter a challenging task, and recognize the insufficiency of their existing

skills or knowledge for accomplishing the task, users must then search for relevant information to bridge this cognitive gap. Thus, this study assumes that help-seeking behaviors involve a need for relevant information, which then necessitates an information seeking process. However, the help-seeking process in this study has a distinctive feature that varies from the HSP and the ISP models. In this study, after obtaining the relevant information, computer users need to comprehend and integrate the help content into their task performing behaviors. The impact of the help-seeking behavior is immediately reflected in the task performance outcome, in terms of whether the task was completed successfully or not. The HSP and the ISP models do not describe this immediate effect of help-seeking or information-seeking behaviors on the task performance. Therefore, the help-seeking process in this study is similar to the HSP and the ISP models illustrated in the literature, but it also has its own specific characteristics. Therefore, the researcher has developed new conceptual models and research questions, derived from the HSP and the ISP models, to analyze help-seeking behaviors in this particular context. In addition, the existing literature emphasizes the impact of the user's personal factors on help-seeking behaviors and the impact of help-seeking behaviors on task outcomes. However, previous studies, either in traditional classroom settings or in HCI contexts, separately examine the relationship between personal factors and help-seeking strategies only, or the relationship between help-seeking strategies and learning or information searching performance only. There was an urgent need to integrate the three factors into one study to examine their relationships, so this study focused on the effect of help source features and personal factors on help-seeking behaviors and task outcomes. The next two sections discuss the features of help sources and relevant personal factors for this study.

Features of Help Sources

As discussed above, help seeking in this study involves searching for relevant information from alternative help sources. Thus, help sources are treated as information sources. The discussion of the features of help sources in this study is based on Marchionini's (1997) analysis of information sources and information search systems in his ISP model. The information search system was defined as "a source that represents knowledge and provides tools and rules for accessing and using that knowledge" (Marchionini, 1997, p.38). The two basic components of a search system or information source are the *database* and the *interface*. Information and knowledge are stored in the database, which includes two basic elements: the content and the carrier. The content of a database encompasses characteristics of its elements, such as the topic, the scope, the data type, the quantity, and the quality, among other things. Then, the information and knowledge need to be stored in a carrier that provides access to the content for users. The carrier can be a book, an electronic information system, or a person. The carrier is usually considered to be the type of information source. The types of information sources determine the nature of the interface through which users request and obtain access to the information content. For example, books generally present information sequentially, and users traverse the contents in a linear manner. The electronic information system usually organizes information in network or web style, so users can access the information in non-linear mode by using hypertext. A human being provides a "free-associational" presentation of information, and invites either random or sequential access from users.

The different kinds of information sources determine the varied nature of the interfaces for those sources. The interface serves as a communication channel to connect between the users and the database contents. The format of an information source constrains the degree of

interaction that can occur between the user and that information source. Books provide the least interactivity between the user and the information source. Authors determine the content and users decide how to access the content, with no interaction between the two. Electronic information systems provide users with varied access methods to obtain the information: browsing, searching, and even participating in the generation of the information. The interactivity level between users and electronic information sources is much greater than that of a book. A human information source provides the most flexible level of interaction.

Puustinen and Rouet (2009) reviewed and discussed help seeking and information searching in learning settings. Developing a new and broader integrative framework to categorize help seeking which includes information searching, the authors classified different types of help-seeking behaviors, based on the interactivity level of each help source. The interactivity level refers to the capability of a help source to adapt the answers to the learner's needs. At one end of the spectrum are the help systems, such as books, which have no ability to adapt to the learner's needs. Help systems at the other end of the continuum (e.g., a human expert) offer excellent adaptation to a specific learner. Shedroff (1999) further identified several dimensions of the interactivity continuum that have an effect on a user's interactive experience, including feedback, control, creativity, productivity, communication, and adaptivity. Based on Shedroff's interaction spectra, a human information system rates highly in the interactive level, followed by different kinds of electronic information systems, and finally books.

Users' help-seeking behaviors in using different help sources have rarely been studied. Therefore, this study examines different help sources in terms of two dimensional features of help sources: the media types of help sources (electronic vs. non-electronic), and the interactivity levels (low vs. high). The purpose of including this variety of help sources was to examine how

computer users make use of different kinds of help sources, and to determine the effect of various help source features on help-seeking behaviors and the final task outcomes.

Personal Factors Related to Help-seeking Behaviors

Help-seeking behavior research in traditional classroom learning settings, computer-assisted learning environments, and in conjunction with the use of information retrieval systems have extensively examined various personal factors that may have had an impact on individuals' help-seeking behaviors, learning, and information-searching behaviors. The problem-solving process in a learning context has similarities to problem-solving in computer-based task context. The rich results from the above mentioned contexts can help to identify possible personal factors influencing help seeking in the computer task accomplishment context. Based on findings in the examined contexts from the literature, four personal factors that might have an impact on help seeking were identified.

Gender

Considerable research has examined gender differences across various domains. The overarching purpose of these studies was to explore if there were gender-related effects in certain fields, and to provide explanations for the disadvantages experienced by one gender resulting from the bias in that field. The gender differences related to help-seeking behaviors in traditional classroom and computer-assisted learning contexts has attracted considerable research attention, but no studies in the IR context have examined the relationship between gender and help-seeking behaviors.

Gender differences and their effects on learning and help seeking have been a popular research topic for traditional classroom settings. Findings show that gender has an effect on help-seeking behaviors; male and female learners show different help-seeking tendencies. Ryan, et al.

(1998) distributed a survey to 516 sixth-grade students to examine the reasons for avoiding asking for help in a math class. Results from a hierarchical linear model showed that gender was a significant predictor of reported avoidance of help-seeking ($\gamma = -.227, p < .01$). Boys were more likely than girls to avoid seeking help when needed. This gender-related help-seeking tendency could be explained by the different goal orientations observed in boys and girls. Results from two experiments conducted by Butler (1998) with fifth- and sixth-grade students indicated that pupils, particular boys, who held ability-focused goals (wanting to prove their ability to solve problems), tended to avoid asking for help in the classroom. Boys were shown to care more than girls about not showing their incompetence in class. Other studies showed the gender differences in help-seeking tendencies varied based on the subject students were learning. Newman and Goldin's (1990) study reported that girls showed greater concern than boys about asking for help in mathematics, but not in reading class. Gender differences found in help-seeking studies also showed up in students' help-seeking strategies, such as the different types of help requests. Arbretton (1998) surveyed 384 elementary students about their help-seeking strategies. Boys were more likely than girls to seek the type of help that assisted them to get the job done quickly; boys also reported that they were more likely to skip doing the task to avoid having to ask for help.

Most interactive learning environments (ILEs) offer different types of help functionalities to learners. Few studies, however, focused on the gender issue in this environment (Aleven, et al., 2003), with a few exceptions (Arroyo, et al., 2001; Arroyo, et al., 2000). Arroyo with his colleagues (2000) investigated how elementary students' learning was affected by two types of interactive hints (brief versus detailed messages) in an intelligent tutoring system. Results from mean comparisons showed that girls performed better when provided more information by the

interactive hints, while boys performed better with less information ($F(1, 5270) = 17.57, p < .000$). The same tutoring system was examined to identify gender differences in learners' responses to different types of system assistance (Arroyo et al., 2001). Girls spent 25-30% more time than boys did on processing each hint. Meanwhile, boys tended to give up on help features earlier, when they felt frustrated.

In summary, gender has been shown to be a meaningful factor on help seeking in learning contexts, regardless of whether the learning takes place in a classroom or a computing environment, which implies the possibility of gender differences in help-seeking behaviors in the setting of accomplishing computer tasks.

Prior Experience

Prior experience is the knowledge, skills, or abilities that an individual brings to a particular situation in which s/he needs to utilize existing knowledge or skills to solve problems or accomplish tasks. Having more prior experience provides a better basis for an individual to deal with difficulties effectively. In either a learning or task-completion context, prior experience has been identified as an important factor that directly influences learning or task performance (e.g. Karsten & Roth, 1998; Newman & Schwager, 1995). Researchers have examined the effect of prior experience on help-seeking behaviors in all three contexts (traditional classroom learning settings, ILEs, and IR).

In a traditional classroom learning environment, "prior experience" refers to learners' prior knowledge about one particular subject domain. Higher levels of prior knowledge can assist learners to search, integrate, and structure new information more effectively, based on their existing knowledge structures, which creates better learning outcomes (Kintsch, 1988). In addition, prior knowledge can also benefit learners in monitoring and controlling their help-

seeking behaviors when they encounter problems in learning. Many studies have examined the relationship between students' prior knowledge and help-seeking behaviors. Miyake and Norman (1979) proposed that an individual's knowledge level could both help him or her to become aware of a potential problem and also to know how to get information to solve the problem. Therefore, prior knowledge may influence individuals' decisions to seek help. Newman and Schwager (1995) investigated the types of help that middle school students requested when solving math problems in an experimental study. Students' prior math knowledge was represented by prior math achievement and measured by a standard math test score. Low achievers showed a greater need for help and made more process-related help requests than did high achievers ($p < .05$). Prior knowledge can also regulate learners' help-seeking behaviors, by restricting help requests to what is necessary and encouraging the re-use of prior help information received for a similar task (Puustinen, 1998). A total of 80 pupils were asked to finish six logical mathematical reasoning tasks and were allowed to ask for help. The help content would be either an explanation to assist them to continue, or the answer itself. The results from the logistic regression analysis showed that age and prior math achievements had significant interaction effects on the types of questions the learners asked and on their reuse of the help contents.

In the computer-assisted learning context, the effect of prior subject knowledge on help-seeking behaviors was also examined. Wood and colleagues (1999, 2001) examined students' help seeking and their prior algebra knowledge when students used a computer-based tutoring system called QUADRATIC to perform tasks. Students with less prior knowledge were less accurate in their judgments of their need for help, and were also less proficient in seeking help, which in turn resulted in lower learning gains. Bartholome and colleagues (2006) examined help

seeking and five learner factors: prior knowledge, motivational orientation, interest, self-reported competence, and epistemological beliefs. Seventy-four students in a plant-identification class were required to identify plants in a computer-assisted learning system. Results suggested that dyads with low botanical knowledge used help more frequently and used more context-sensitive help than dyads with higher knowledge. Results from a more recent study (Babin, Tricot, & Marine, 2009) confirmed that experts asked for help less often than novices.

Only a few studies have considered the effect of users' prior experience with the IR system on their solicitation of help. Xie and Cool (2009) gave 90 novice users (identified by the prescreening questions on their familiarity with digital libraries) three search tasks in two digital libraries. The search session, including on-screen activity and think-aloud verbal data, was recorded using usability software in the lab. Prior experience was defined as participants' past experience in searching information in different types of IR systems. Qualitative data from recordings and verbal data were conceptualized and categorized into types of help-seeking situations. Results from think-aloud data showed that users' previous experience in using IR systems was related to two types of help-seeking situations: the inability to start the search process because of unfamiliarity with a digital library environment, and the inability to create search statements because different search operators are used by current digital libraries and other IR systems.

In summary, prior experience, (defined as either prior knowledge in a particular subject domain, or prior experience with the computer system), has certain effects on people's help-seeking behaviors, across different contexts, including the computer task accomplishment setting.

Self-Efficacy

One of the factors that shapes individuals' feelings and influences their behaviors is self-efficacy (SE). Bandura (1977) defined efficacy expectation as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193). Self-efficacy affects not only the choice of engaging in a certain activity, such as whether individuals try to cope with a given challenging situation, but also how much effort and how long individuals are willing to sustain that effort, in dealing with a stressful situation. Thus, the belief that one has the capability to perform a particular task, or to learn a subject, has been found to influence the person's effort to pursue the goal, the decision to undertake certain behaviors, and the emotions experienced while performing the behaviors (e.g., Debowski, Wood, & Bandura, 2001; Hill, Smith, & Mann, 1987; Jorde-Bloom, 1988). Efficacy-related help-seeking studies have been conducted in traditional classroom settings, but not in HCI contexts, including computer-assisted learning settings, or with IR systems.

Several empirical studies have reported that students' academic self-efficacy, which refers to students' judgments of their capabilities to complete schoolwork successfully, is related to their tendencies to seek help when encountering difficulties. A series of studies (Butler & Neuman, 1995; Newman, 1990; Ryan, et al., 1998, 2005) confirmed that students with high levels of academic efficacy were more likely to view help-seeking as a useful strategy for learning, whereas students with low academic efficacy tended to avoid help because they viewed help-seeking as a sign of incompetence. Ryan, et al. (1998) examined the correlates between students' reported avoidance of help-seeking, and certain student and classroom characteristics: academic efficacy, classroom goal structure, and classroom social climate. Students' academic efficacy was a significant predictor of the avoidance of help-seeking ($\gamma = -.283, p < .001$);

students with low academic efficacy were more likely to avoid seeking assistance. The supporting evidence was provided by a later study conducted by Ryan, et al. (2005), which found that students with mastery goals and high academic efficacy were less likely to avoid help-seeking.

The findings from traditional classroom learning settings mentioned above imply that self-assessment of abilities could affect help-seeking related behaviors. In a computer-based task context, efficacy should be redefined to reflect individuals' assessment of their computing abilities. Compeau and Higgins (1995) defined computer self-efficacy (CSE) as "an individual's perception of his/her ability to use computers in the accomplishment of a task" (p. 191).

Computer self-efficacy is not only the perception of ability, but also an orchestration for the motivation and effort that are required to complete a task in a computer-based system. However, previous studies did not examine the impact of CSE on help-seeking behaviors; they evaluated CSE's impact on computer task performance only. Empirical studies have reported that individuals with high computer self-efficacy produced better task performance than those with low CSE (Brosnan, 1998; Johnson, Hornik, & Salas, 2008). In particular, one study (Brosnan, 1998) found that users with feelings of high self-efficacy, performing in a task-accomplishment setting, tended to use certain types of tables, a choice which was directly related to spending more time to work through and complete the tasks, and achieving a more accurate performance.

Furthermore, the literature has also shown that prior experience has been an important factor influencing computer self-efficacy. Bandura (1977) stated that the strongest influence on self-efficacy formation was performance accomplishment or prior experience. Previous successful task accomplishment has been shown to increase an individual's mastery expectations. Cassidy and Eachus (2002) constructed a 30-item Computer User Self-Efficacy

(CUSE) Scale to measure university students' computer self-efficacy; they examined the relative contribution of other personal factors to explain CSE formation. Results showed that experience was the most important predictor, accounting for 63.51% of the variability in CSE ($R^2 = .635$, $F(1, 196) = 341.121$, $p < .0005$).

In summary, an individual's feeling of efficacy affects his or her help-seeking behaviors, task-performing behaviors, and learning behaviors, which in turn results in different learning outcomes or task performance. Hence, in the computer task accomplishment context, it is important to understand how users' varied levels of computer self-efficacy influence their help-seeking behaviors. In addition, an individual's efficacy in using a particular computer system is influenced by his or her prior experience with this system.

Anxiety

User behaviors can be influenced not only by a person's efficacy expectations, but also emotions and affective state. One of the extensively studied emotional responses is an individuals' anxiety status. Anxiety has been described as a "specific emotional state which consists of unpleasant, consciously-perceived feelings of nervousness, tension, and apprehension, with associated activation or arousal of the autonomic nervous system" (Spielberger, 1972, p. 45). People experience anxiety in all aspects of life. With the introduction of computers into daily life, the demands of learning how to operate and utilize computer technologies have produced a specific type of anxiety, namely computer anxiety. Anxiety concerning the use of computers is defined as "a negative emotional state and/or negative cognition experienced by a person when he/she is using a computer or imagining future computer use" (Wilfong, 2006, p.1002).

Anxiety or computer anxiety has not received enough attention regarding its relationship with help-seeking in any HCI contexts. Few studies focusing on anxiety and help-seeking behaviors have been conducted in learning environments or with IR systems, but there are a variety of studies that have examined the effect of anxiety on individuals' computer-related behaviors in the computing environment. These studies have identified a negative relationship between computer anxiety and computer-related behaviors. One of the problems associated with computer anxiety is the person's avoidance of or resistance to computer/technology use. Harrington, McElroy, and Morrow (1990) found that the fear of using computers is one of the main causes of the avoidance of computer use by undergraduate students ($F = 4.777, p < .05$). Another negative outcome of high computer anxiety has been shown to be poor computer task performance. Anxious individuals tend to periodically divert their attention from the task at hand to self-assessing or self-relevant thoughts (Mandler & Sarason, 1952), which results in ineffective task accomplishment. In a study by Glass and Knight (1988), 59 undergraduates interacted with computers to complete three learning tasks that had increasing levels of difficulty. A self-reporting checklist was developed to assess students' thoughts associated with anxiety and computer use. Significant relationships were found between behavioral outcomes and different levels of computer anxiety. High computer anxiety students held lower expectations of successful performance, reported more debilitating thoughts during task completion, and demonstrated poorer performance by taking a longer time to complete the tasks. Hence, computer anxiety has been perceived as a barrier to acquiring computing skills and improving task performance. Furthermore, prior experience is shown to be inversely related to anxiety level. Chua, Chen, and Wong (1999) conducted a meta-analysis of computer anxiety and

its correlates, which supported the inverse relationship between prior experience and computer anxiety.

In summary, there is scant literature studying associations between help-seeking behaviors and anxiety in HCI environments. Studies have, however, examined the correlates between anxiety and computer users' behaviors in performing tasks. Anxieties lead to more off-task thoughts during task accomplishment, such as worries about success, one's self-image, and the avoidance of related computer use. Therefore, users with high levels of computer anxiety may not effectively utilize help sources to complete a task, because of their anxious and distracted mental state about their current task.

Summary

Table 1 summarizes help-seeking studies with the personal factors of interest in this study, in the three identified contexts. Since there were no studies that considered the four personal factors, and help-seeking, and task performance together, the aim of this study was to explore the effects of individual differences on help-seeking and performance outcomes in a single computer task completion setting.

Table 1 Summary of Literature of Help-Seeking Studies

		Studied Contexts		
		Information Retrieval Systems	Traditional Classroom Settings	Computer-Assisted Learning Settings
Personal Factors	Gender	×	√	√
	Prior Experience	√	√	√
	Self-Efficacy	×	√	×
	Computer Anxiety	×	N/A	×
Research Method		Lab observations	Survey Experiment	Lab observations Field observations

√: the factor has been studied in the indicated context

×: the factor has not been studied in the indicated context

In addition, the main research methods used to examine help-seeking in the three contexts were listed in Table 1. Help-seeking studies in traditional classroom settings mainly adopted survey and experimental methods to test the relationship between personal factors and observed or self-reported help-seeking behaviors. In IR or computer-assisted learning environments, because of the need to capture learners' or searchers' interactions with the learning or IR system, observation methods were adopted for these two settings. Both lab observations and field observations were employed to collect the interaction data.

Chapter 3

Conceptual Model and Research Questions

This chapter first introduces the conceptual models and discusses the research questions which frame the study. Then the chapter presents the definitions and measurements for the constructs included in the research questions.

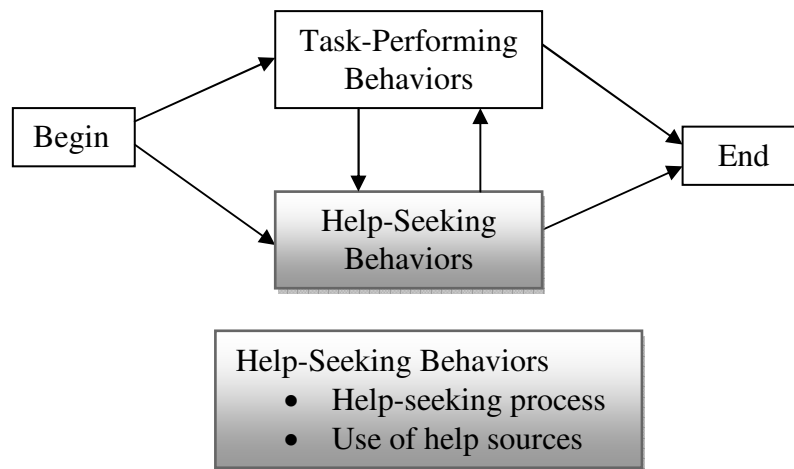
Conceptual Models

Adopting Nelson- LeGall's HSP model and Marchionini's ISP model, this study develops three models to guide data collection and data analysis. The first model, the *Task-evoked Help-seeking Process* (Figure 3), focuses on help-seeking behaviors occurring in the process of performing a task. The second model, the *Help-seeking Factors Model* (Figure 4), investigates relationships between personal factors and help-seeking behaviors, and between help-seeking behaviors and task outcomes. The third model, the *Task-evoked Help-seeking Structural Model* (Figure 5), depicts how individual differences contribute to task performance through the mediating effect of help-seeking effectiveness.

The Task-Evoked Help-Seeking Process Model

When a user interacts with the computer to perform an unfamiliar task, the user may encounter a difficulty that prevents him or her from continuing with the task at hand. Facing the difficulty, the user may take a trial-and-error approach to explore the system, in order to continue with the task. Alternatively, the user may seek help to solve the problem. To move forward toward task completion, the user employs information obtained from help-seeking efforts to assist with task performance. In addition, making no or slow progress in completing the task can drive users to seek help again. Therefore, users usually move between seeking help and performing the task, as illustrated in Figure 3. The two arrows between the "help-seeking

behaviors” and “task-performing behaviors” boxes represent the interactive and iterative relationship between these two types of behaviors. Users can end the process after performing the task or right after seeking help. There are three possible task completion states that can exist at the point that a user decides to end the task process: successful completion of the task, partial completion of the task, or no progress made on the task.



Note: arrows represent the order from one activity to another

Figure 3. Task-evoked Help-seeking Process Model

The shaded box of “Help-seeking behaviors” (itemized in the expanded box below it) includes two elements of help seeking: how computer users seek help, which is the “Help-seeking process;” and how users utilize different help sources, which is the “Use of help sources.” The help-seeking process focuses on a user’s starting point to seek help, the effort spent on seeking help, and help-seeking patterns. The use of help sources examines any distinctive use of help sources, sequential patterns of source use, and the effect of help source features on help-seeking behaviors. The first two research questions for this study are derived from this model:

RQ1: How do computer users seek help during the process of accomplishing a computer task?

- RQ1a: What is the latency period in seeking help during the task?
- RQ1b: How frequently do users seek help during the task?
- RQ1c: How much time do users spend on seeking help during the task?
- RQ1d: Are there any help-seeking patterns during the task?

RQ2: How do computer users use different help sources?

- RQ2a: What help sources do users use?
- RQ2b: What requests do users submit to the selected help sources?
- RQ2c: How frequently do users seek help from the selected help sources?
- RQ2d: How much time do users spend on seeking help from the selected help sources?
- RQ2e: Are there sequential patterns in using help sources?
- RQ2f: How do features of help sources affect help-seeking behaviors?

The Help-Seeking Factors Model

Help-seeking behaviors are carried out by users and can be influenced by personal characteristics; the purpose of seeking help is to support users' task completion. The help-seeking factors model assumes that help-seeking behaviors are related to personal factors and in turn affect task outcomes. Therefore, this study is interested in both how users' help-seeking behaviors, as a problem-solving strategy, are affected by individual differences and how help-seeking behaviors affect task outcomes. Help-seeking behaviors act as a mediating factor between personal factors and task outcomes. The research questions derived from this model are as follows:

- RQ3a: How are personal factors related to users' help-seeking behaviors?
- RQ3b: How are users' help-seeking behaviors related to task outcomes?

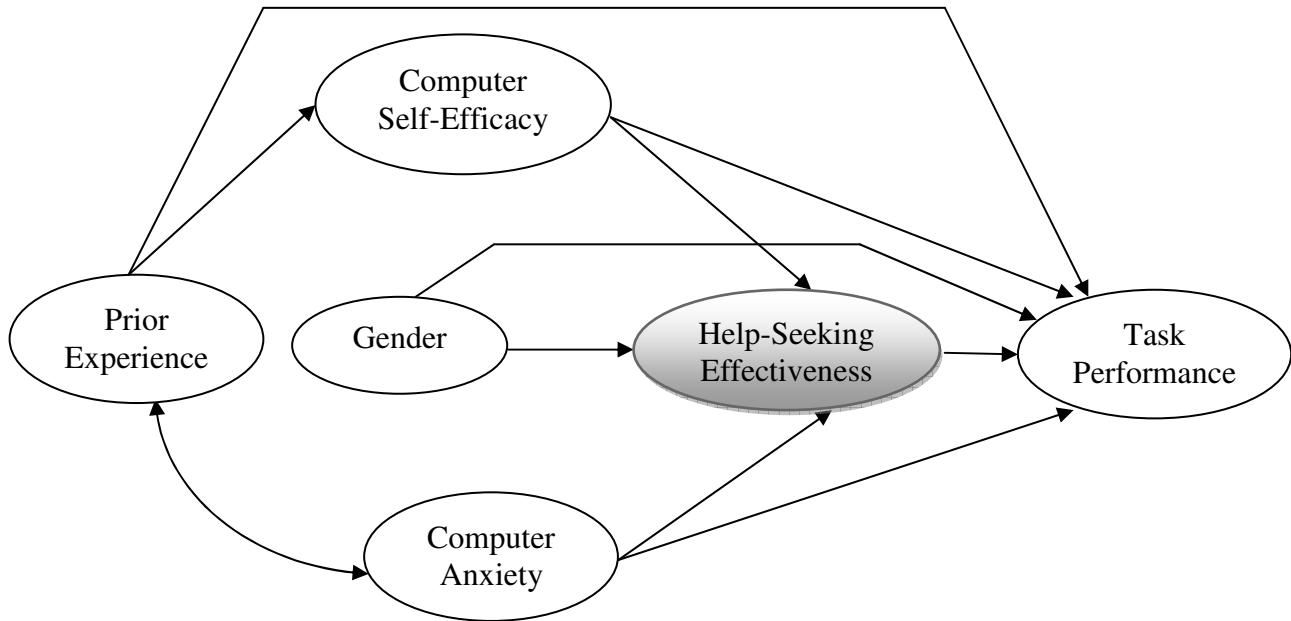


Note: arrows represent the impact of one construct on the next one

Figure 4. Help-seeking Factors Model

Task-Evoked Help-Seeking Structural Model

The task-evoked help-seeking structural model (Figure 5) expands upon the help-seeking factors model (Figure 4) to examine the relationships between the four personal factors and the help-seeking behaviors as measured by help-seeking effectiveness, the relationship between help-seeking effectiveness and task performance, as well as the effect of personal factors on task performance. The model assumes that the partial effect of personal factors on task performance is a result of effective help seeking.



Note: the lines with single arrowhead represent the influence of one construct on the other; the curved line with two arrowheads represents the correlation between two constructs

Figure 5. Task-evoked Help-Seeking Structural Model

Four personal factors are assumed to have a direct effect on task performance. Four direct arrows from these personal factors to help-seeking effectiveness represent the direct influence. In addition, gender, computer self-efficacy, and computer anxiety are three personal factors that may directly affect help-seeking effectiveness. The observed gender differences in help-seeking strategies in traditional classroom settings suggest that there is a possible gender difference in help-seeking effectiveness within the HCI context. The positive effect of efficacy on effective help-seeking in the traditional classroom learning context suggests that computer self-efficacy may have a direct positive effect on help-seeking effectiveness in this study. Anxious computer users who worry about their performance tend to have more off-task thoughts, which result in poor task performance. This connection indicates that computer anxiety may hinder computer users' effective help-seeking. This assumption may provide another explanation of why anxious

computer users have poor task performances. Thus, these three personal factors are shown to be directly linked to help-seeking effectiveness in Figure 5.

The fourth personal factor, prior experience, refers to the baseline knowledge and skills that individuals possess coming into a problem-solving situation. Prior experience or knowledge is assumed to have an effect on people's judgment about when and how to seek help, but not on help-seeking effectiveness. Therefore, this study investigates how prior experience influences computer self-efficacy and computer anxiety, which in turn impact help-seeking effectiveness. The direct arrow from help-seeking effectiveness to task performance represents the direct positive influence suggested by the literature.

In summary, the task-evoked help-seeking structural model examines how the personal characteristics of a user impact task accomplishment, through the effectiveness of help-seeking behaviors. The model situates help-seeking effectiveness as a factor mediating between personal factors and task performance. This structural model is built from the findings of previous empirical studies. The lack of strong theories to support hypotheses about the relationships among these factors challenges the use of statistical methods to test the model. Therefore, the model is proposed as tentative to a large extent, and intended for exploratory purposes. The research questions derived from this model are as follows:

RQ4a: What personal factors affect help-seeking effectiveness?

RQ4b: Does help-seeking effectiveness, in turn, impact the task performance?

RQ4c: What personal factors influence the task performance?

Measurements

This study closely examines help-seeking phenomena in a computer task accomplishment setting. Four research questions created for the purpose of exploring the phenomena suggest the

investigation of help-seeking behaviors at an in-depth level, as well as the examination of relevant factors. This section defines and provides measurements for these behavioral variables, personal factors, and outcome measures, in order to answer the research questions.

The entire task accomplishing process, conducted as one session, can have one or more than one help-seeking episodes. One help-seeking episode refers to the period during which the user is involved in seeking external assistance. Accordingly, help-seeking behavioral variables are conceptualized and measured at both the session level and the help-seeking episode level. Help-seeking behaviors refer to the actions users take to find relevant information to assist with task completion.

Behavior Variables:

1. *Latency in seeking help* is defined as the time elapsed from the beginning of the session to the time at which users begin to seek the help for the first time.
2. *Frequency of help seeking* is the number of help-seeking episodes users engage in during the entire task accomplishment process.
3. *Time on help seeking* is the total time a user spends in seeking help from external sources during the entire task completion process. This variable is measured by summing the amount of time spent on seeking help for each help-seeking episode in one session.
4. *Use of help sources* refers to users' selection of help sources. It is measured as the number of users selecting a particular help source.
5. *Help request* is the presentation of users' requests submitted to a particular help source in each help-seeking episode.

6. *Repetitive use of a selected help source* is the number of help-seeking episodes involving the use of a specific source.
7. *Mean time spent on a selected help source* is the average amount of time spent using a specific source during each episode.
8. *Help source transition* refers to users' selection of different help sources in two consecutive help-seeking episodes.
9. *Help-seeking effectiveness* refers to how effective users' help-seeking efforts are in producing the intended or expected results. If the user completes the task after seeking help, this help-seeking episode is considered an "effective" episode (score: 1). Otherwise, this help episode is not effective (score: 0). Help-seeking effectiveness is manifested as two measures. One measure is the successful rate, the ratio of the number of effective help-seeking episodes to the total number of help-seeking episodes in one session. The other measure is help-seeking efficiency, which is the ratio of the number of effective help-seeking episodes to the total time spent on help-seeking in one session.

Personal Factors:

1. *Gender* takes the value "male" or "female."
2. *Prior experience* is based on the skills and knowledge that users possess prior to initiating the completion of a specific computer task. In this study, it is conceptualized and measured as users' self-reported experience with a specific software package.

3. *Computer self-efficacy* refers to individuals' assessments of their abilities to perform a specific task using a particular software package. It is measured by users' self-assessment of several skills in one software package.
4. *Computer anxiety* refers to individuals' general anxiety levels regarding using computers. It is measured by users' self-reported levels of anxious feelings.

Task Outcome Variables:

1. *Task completion status* refers to the different states of task accomplishment. The task accomplishment state is assigned a numerical number: a score of 2 is assigned if the task is fully completed, a score of 1 is assigned if the task is partially completed, and if there is no progress made on the task, a score of 0 is assigned.
2. *Time spent on the task* measures the total time a user spends on the whole process, including help-seeking time and task-performing time.
3. *Usefulness of help sources* is also considered to be one perspective to assess the outcome of the whole task completion process. It is based on the users' judgments or favorable opinions about a particular help source which they have used throughout the entire process.
4. *Task performance* is conceptualized as task efficiency and is measured by the ratio of the completion status of the computer task to the total time spent on the entire task completion process.

Chapter 4

Research Method

The observation of task processes in the lab or in a natural setting (such as a user's office workstation) is an appropriate method for studying human-computer interactions, because researchers can then observe individual problem-solving and help-seeking behaviors as they occur. To answer the four research questions, the researcher needs to document a detailed description of users' behavioral activities. Field observations can record the help-seeking process as it happens naturally in real life. However, obtaining access to participants while they use computers in their home or work environment is challenging, and is likely to limit the scope of the observations to only a small convenience sample of users. Thus, the research method adopted for this study was to conduct observations of computer users in a lab setting.

This study is designed to observe how individuals interact with application software, and how they move forward to complete a challenging task in a problem-solving situation. For this purpose, the researcher created a task-accomplishment scenario for the lab setting to simulate a real-life, problem-solving situation. Participants were required to perform a computer task in a usability lab, which was equipped with a one-way mirror to separate the participant and the researcher, to minimize issues with observer's effect. The task was performed using an application software program with which participants were familiar. All participants were asked to perform the same task, which was to use an advanced feature of the application software. The task was designed to be challenging, so that participants were expected to encounter difficulty in completing the task, and therefore be motivated to seek help from a variety of available help sources.

Study Design

Task Description

For this study, the selected application software for the assigned computer task needed to meet a specific criterion: it had to require no additional training for participants to be able to use it on a general level, yet still include a feature that was complex enough to create a problem-solving situation that would evoke help-seeking. The completion of a task using professional software requires not only that users have prior experience with the particular software, but also that users have relevant domain knowledge in this professional field (e.g., accomplishing a task using statistical software requires users to have experience with the software, as well as a knowledge of statistics). For this study, a simple, generally-used software program with few requirements pertaining to users' domain knowledge was needed for this study. Microsoft Word, a common text-editing software application widely used by many people in daily life, was chosen for this purpose. Individuals without Microsoft Word experience were not invited to participate. The study provided both Word 2003 and Word 2007, to allow participants to choose their preferred version. The purpose of providing two versions was to create a comfortable and familiar software-use environment so that the participants would not encounter problems resulting from an unfamiliar interface.

Help-seeking behavior is problem driven and is evoked when the user encounters a challenging issue that hinders the user's progress toward completing the task. For this study, the researcher chose "creating a table of contents" as the challenging task. "Creating a table of contents" is an advanced feature in Microsoft Word that was shown to be an unfamiliar and difficult task for the participants in the pilot study. All participants were required to accomplish this same task.

Participants were instructed to create a “table of contents” for a sample Word file prepared by the researcher. According to the Microsoft Office website (<http://technet.microsoft.com/en-us/library/cc179199.aspx>, accessed on December 10, 2009), there is no difference in the technique required to create a “table of contents” in Word 2007, as compared to Word 2003. Thus, using either version would not bias the task performance in this study. Participants were given 30 minutes to work on the task. If a participant had prior experience with creating a Word “table of content” before, she or he was still allowed to participate in the study.

Help Sources

Five help sources were made available to the participants, based on the discussion of two fundamental traits of help sources: help source media types (electronic vs. non-electronic) and interactivity levels (high vs. low). The five help sources were: (1) Microsoft Word’s built-in system help, referred to here as “F1 help”; (2) Microsoft Word printed reference books (both the 2003 and 2007 versions); (3) the Internet/World Wide Web, in that participants were told that they could freely use the Internet to search for information; (4) video help: two video clips about how to create a “table of contents” for both Word 2003 and Word 2007 were placed on the desktop of the lab computer; and (5) a human lab assistant, in that participants could press a bell in order to ask questions of the assistant. Table 2 lists the categorization of each of these five help sources in terms of the two key features: source media type and interactivity level.

Table 2 Features of Five Help Sources

		Interactivity Level	
		Low	High
Media Type	Electronic source	Video clip	F1 help Web
	Non-electronic source	Reference book	Lab assistant

First, there are two help source media types: electronic sources and non-electronic sources. Electronic help sources store information content in a computer-based (digital) system, whereas non-electronic help sources do not use a computer to store the information. Therefore, “F1 help,” “web,” and “video clip” are electronic help sources, whereas “reference book” and “lab assistant” are non-electronic sources. Second, these five help sources differ in terms of interactivity levels. Both “reference book” and “video” contain static contents. Users do not have the flexibility to obtain different information from these two sources by changing their help requests. Conversely, users can modify the help requests to obtain different information from the “F1 help,” “web,” and “lab assistant” sources. These three help sources are considered to have a high level of interactivity, whereas “book” and “video” are sources that provide a low interactivity level.

Facilities and Equipment

The study was conducted in a usability lab located in the University of Tennessee College of Communication and Information building. The lab includes three individual rooms with one-way mirrors between the three rooms, as well as a waiting lounge in the middle. Two of the three rooms are participants’ rooms equipped with computers, Web cameras, speakerphones, and the usability software MORAE that records participants’ interactions with the computer system (Figure 6). The study was carried out in either one of the participant rooms. The third room is the observer’s room (Figure 7) that is used to monitor participants’ interactions with the system in real time.

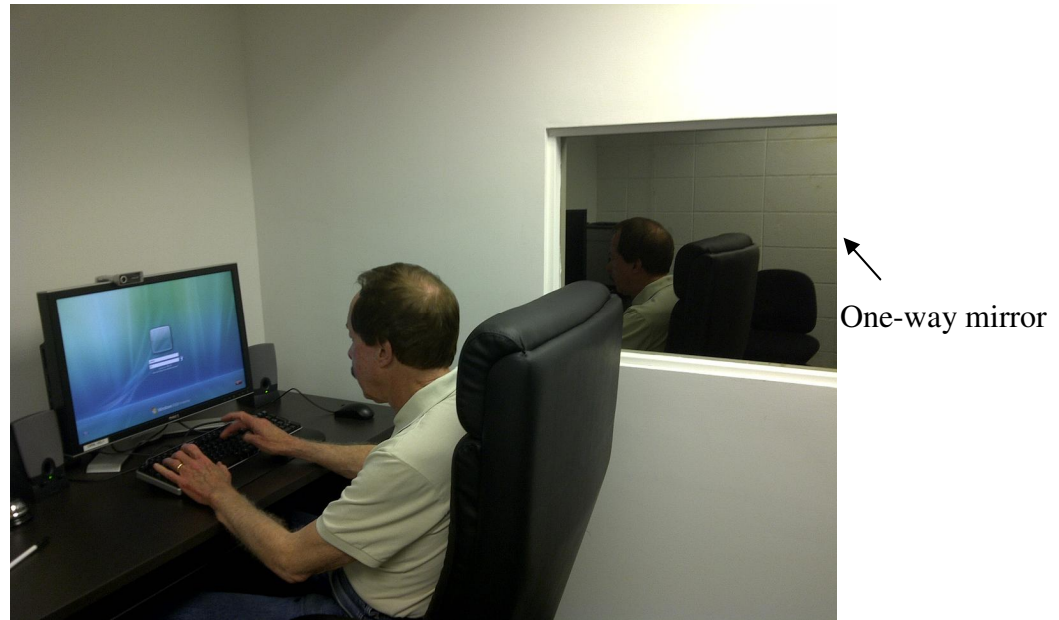


Figure 6. Participant room in the usability lab

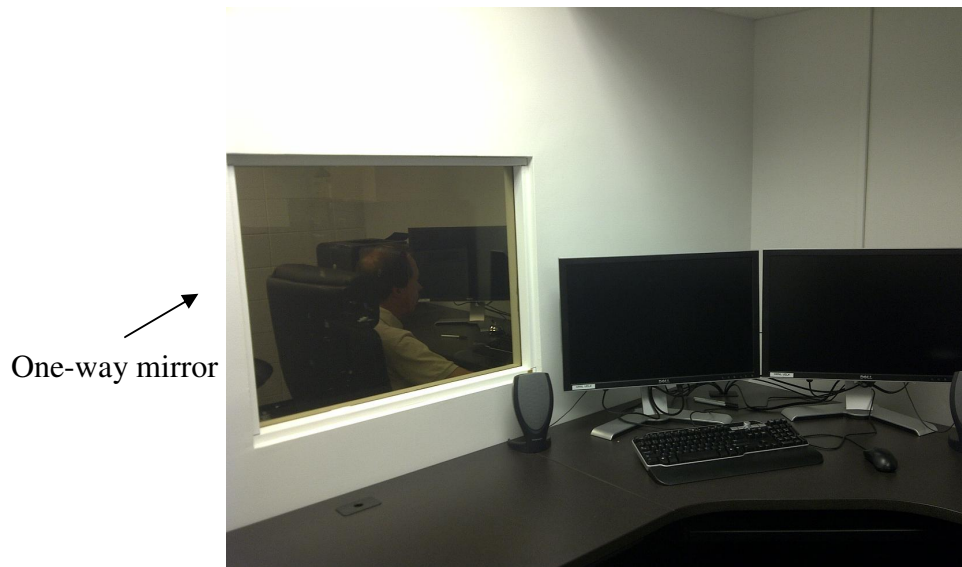


Figure 7. Observer's room in the usability lab

To capture participants' interactions with the computer systems, the MORAE recorder program is installed on the computers that are located in the participants' rooms. The MORAE recorder captures "every nuance of live customer interactions" (Recording user tests with

MORAE, user testing and market research software by TechSmith, 2009), including the screen video, screen text, mouse clicks, keyboard activity, audio, and camera video. The recorder program provides the least intrusive method to record screen activities, so users can perform any tasks without noticing or being affected by an obtrusive recording program. Another program in the MORAE family is the observer program, which enables the researcher to observe the participants remotely and simultaneously by connecting to a live MORAE recorder session. Researchers can see and hear anything being recorded synchronously. The MORAE observer is installed on the computers in the observer's room. In addition, the recording file generated by the MORAE recorder can be imported and analyzed using the MORAE manager program. The MORAE manager program helps researchers to analyze the visual recordings more efficiently, and to generate graphs easily, and also supports exporting data to other application programs, such as a spreadsheet, for further data analysis. The MORAE manager program is installed on the computer in the observer's room.

Participants

Participants were recruited from undergraduate students enrolled in Public Speaking courses at the University of Tennessee, Knoxville in the Spring, Summer, and Fall 2010 semesters. The Public Speaking class is a required course for all undergraduates, so there is a total enrollment of 38 sections, with 22 students per section for each semester. Students received extra research course credits for their participation in this study. The researcher obtained the permission from the director of the Communication Studies program to recruit participants from this pool of students (Appendix A).

The director wrote an email to a graduate assistant who helped to set up the study, using an online participation tracking system that allowed the researcher to have contact access to

potential participants. The system kept track of qualifications based on age (18 and older) and gender, set up the schedule of times and places for the lab sessions, and allowed students to sign up to participate in a particular time slot. The study description in the online participation system introduced potential participants to the intent of the study and invited students' voluntary participation.

Because the first three research questions aim at describing the nature of the help-seeking process, there was no particular requirement for sample size. For the structural model derived research question (RQ4), the sample size is based on the suggestion by Mitchell (1993): with 10-20 cases per indicator/variable, to meet the requirement of the statistical method structural equation modeling (SEM). The proposed structural model includes 11 variables (4 indicators for efficacy, 4 indicators for computer anxiety, one indicator for prior experience, one for help-seeking effectiveness, and one for task performance), so this study originally targeted 200 participants, with an equal number of males and females. Because of the time-consuming data collection process, and the need for participants to be physically present in the lab, only 67 students participated (35 males and 32 females). Although the smaller sample size provided adequate data to answer the first three research questions (RQ1 – RQ3), it did impact the analysis of the fourth research question (RQ4) to validate the structural model. Thus, the results for RQ4 need to be interpreted cautiously.

Study Procedure

Prior to the lab session, the researcher prepared an orientation video to standardize the participants' introduction to the study. The video was stored on the lab's computers. In each lab session, the researcher collected data from one participant at a time. The total time for one lab

session varied from approximately 30 minutes to one hour. The following procedure was used for data collection:

1. The researcher greeted and welcomed the participant into the participants' room.
2. The researcher played the video to introduce the participant to the purpose and procedures of the study.
3. After the video played, the researcher asked if the participant had any questions.
4. The researcher gave the participant the consent form. The participant read it. Both the participant and the researcher signed the consent form (Appendix B).
5. The researcher opened the web browser and loaded the online questionnaire covering demographics, computer self-efficacy, computer anxiety, and prior experience with Microsoft Word (Appendix C). Participants filled out the questionnaire on the lab's computer.
6. Upon the participant's completion of the questionnaire, the researcher provided the participant with the task description sheet (Appendix D), and then showed the participant the Microsoft Word file on which she or he needed to work (Appendix E). The researcher also showed the participant a Microsoft Word file with a finished "table of contents" in an electronic version. The researcher informed the participant of the five help sources available to him or her.
7. After confirming for the researcher that he or she understood the procedure and had no questions, the participant began the lab session by starting the MORAE recording. The researcher then went to the observer room to perform the synchronous observation and took notes when necessary. There was no penalty if the participant

- could not accomplish the task in 30 minutes. The participant could also withdraw from the study at any time during the session.
8. Upon the completion of the task, or at the point the 30 minute time limit was reached, the researcher stopped the recording and went to the participant's room to stop the session.
 9. The researcher gave the participant one final question page, asking for his or her perceived usefulness of the help sources they had used in the lab. Participants rated the usefulness of each help source (Appendix F).
 10. The researcher thanked the participant and stored the recorded session file on the lab computer.

Variables and Data Collection Instruments

Chapter 3 discussed the conceptual definitions and measurements of constructs that were included in the four research questions. Table 3 lists the constructs, specific variables representing each construct, and the ways of collecting data in this study.

Table 3 Research Questions and Corresponding Variables

RQs	Construct	Variables	Collection Method
RQ1: examination of help-seeking process	Help-Seeking Process	1. Latency in seeking help 2. Frequency of help- seeking episodes 3. Time spent on seeking help	MORAE recordings
RQ2: examination of help source use	Use of Help Source	1. Use of a particular help source 2. Help request 3. Repeated use of one source 4. Time on using one source 5. Help source transitions	MORAE recordings
RQ3: Examination of relationships	Help-Seeking Process & Use of Help Source	Same as RQ1, RQ2	MORAE recordings
	Personal Factors	1. Gender 2. Prior experience using Microsoft Word 3. Microsoft Word efficacy 4. Computer anxiety	Questionnaire before the lab session
	Outcomes	1. Task score 2. Session length 3. Perceived usefulness of help sources	MORAE recordings Questionnaire at the end of lab session
RQ4: Examination of SEM	Help-Seeking Effectiveness	Help-seeking successful rate Help-seeking efficiency	MORAE recordings
	Personal Factors	Same as RQ2	Questionnaire before the lab session
	Task Performance	Task efficiency	MORAE recordings

RQ1 and RQ2 focused on the participants' help-seeking behaviors. The MORAE software generated recordings of the whole interaction process between the user and the software system. Thus, the researcher replayed the recordings and identified the help-seeking behavioral

variables. RQ3 and RQ4 investigated the relationships among personal factors, help-seeking behaviors, and outcomes. Help-seeking variables were the same variables used in RQ1 and RQ2. Two outcome variables, time and task completion status, were also obtained through the MORAE recordings. Personal factors and participants' perceptions of help sources used in the session were obtained through questionnaire responses using Likert scales.

The personal data questionnaire administered prior to the lab session consisted of questions pertaining to the participant's age, gender, major, and year in school (see Appendix B). Participants' prior experience using Microsoft Word was quantified based on the total number of self-reported familiar functions in Word, with participants' checking off the functions with which they considered themselves to be familiar, from a list (see Appendix B). Examples of these functions included basic editing, printing documents, and working with styles. The list of functions was created by choosing the overlapping functions listed in both the Microsoft Office 2003 and Microsoft Office 2007 Reference Books.

Computer self-efficacy (CSE) was measured using an application-specific self-efficacy scale. The researcher adopted an extant scale entitled "The Word Processing CSE" scale (Marakas, Johnson, & Clay, 2007; Hardin, Chang, & Fuller, 2008). The scale includes four items, each of which measures a person's self-assessment of her or his Word-related skills. Participants first answered "yes" or "no" based on his or her self-assessment of his or her ability to perform the described skill. If they answered "yes", participants then assessed their confidence level in performing this skill as ranging from "not at all confident (1)" to "totally confident (10)" on a 10-point interval scale (see Appendix B). The "no" answer was later coded to 0 and was added to the interval scale. Therefore, averaging the summed scores from each question

represented participants' computer self-efficacy level in using Microsoft Word at a particular score level, potentially ranging from low (0) to high (10).

The Computer Anxiety Scale used Thatcher & Perrewé's scale (2002), which was based on the Computer Anxiety Rating scale (CARS-H) developed by Heinssen, Glass and Knight (1987). The scale required the participant to respond using a 5-point Likert scale, with values ranging from "strongly disagree (1)" to "strongly agree (5)" for four items (see Appendix B). The computer anxiety score was calculated by averaging the summed ratings for all of the items. Scores from low (1) to high (5) represented the corresponding level of anxiety about computer use. Thatcher & Perrewé (2002) reported a high composite reliability of 0.94 for their Computer Anxiety Scale.

Three outcome measures were included: (1) the task score, (2) session length, and (3) the perceived usefulness of each help source. For session length, the MORAE software recorded the starting and stopping time for each participant to determine the amount of time spent in the lab session. Session length was expressed as a value of up to 30 minutes. The perceived usefulness of each help source was obtained by asking participants to rate the help sources they had used in the lab from "least helpful" (1) to "most helpful" (5) at the end of lab session. The average rank value for each help source was calculated by averaging the rank values across all participants who had used this particular help source. The task score was determined by each participant's task completion status at the end of the session. The researcher determined the score in following ways. The task "table of contents" was divided into five subtasks (Table 4), which were assumed to be milestones toward accomplishing the task. There was no specific order for the completion of these sub-tasks; the sub-tasks were also not presented to the participants. The researcher assigned a score to each subtask based on its accomplishment status (Table 4): full completion,

partial completion, and no completion. Summing the score from each sub-task yielded the total score the participant earned in the session. Thus, the total task score for each participant ranged from 0 to 10.

Table 4 Subtasks and Subtask Scores

Subtasks	Subtask Score		
	No Completion	Partial Completion	Full Completion
Locate “heading styles” function (T1)	0	1	2
Apply heading styles to headings (T2)	0	1	2
Locate “table of contents” function (T3)	0	1	2
Insert “table of contents” (T4)	0	1	2
Change “show of levels” into “4” (T5)	0	1	2
Total task score range: 0 to 10 (for completion of all sub-tasks)			

Data Analysis

Data Preparation

The researcher assigned a pseudo-name to each recording for each participant’s lab session to maintain anonymity of the data. MORAE recordings were stored on the lab’s password-protected computer in the observer’s room. The recordings on the lab computer in the participants’ room were deleted permanently from that computer after being transferred to the observer’s room computer. Consent forms were locked in a file cabinet at researcher’s office. The electronic questionnaire was hosted on the University of Tennessee’s secure web survey server. Data collected using the electronic questionnaires was downloaded and imported into SPSS software. The recordings from the MORAE software were imported into the MORAE manager software on the observer’s room computer for replay and data extraction. A project space was created in the MORAE manager, so that the recordings from all participants were imported into the same project space. The recordings were replayed to identify help-seeking

behavioral variables and outcome measures. The quantified data were entered into the same SPSS file that had the responses from the electronic questionnaire, in order to match the data to each participant's personal data.

Data Analysis

To answer the four research questions, the researcher employed different analysis methods based on the nature of each of the questions: descriptive analysis, descriptive statistics, independent t-tests, one-way ANOVA, correlation analysis, sequential analysis, and structural equation modeling. In addition, the researcher identified two types of analytical units in this study, depending on the nature of the particular research question. The first unit of analysis was a help-seeking episode. The duration of one help-seeking episode starts at the point when the user begins to seek help from a particular help source and ends at the point when the user either switches to another help source or switches back to performing the task. Each help-seeking episode was considered a distinct instance, and the study yielded a total of 348 help-seeking episodes. The second unit of analysis was a session. The entire task completion process is a session. There were a total of 67 sessions from the 67 participants. Table 5 summarizes data analysis methods and the units of analysis for each research question.

Table 5 Data Analysis Units and Analysis Methods for Research Questions

Research Question	Analytical Unit	Analysis Method
RQ1		
• RQ1a: latency in seeking help	Session	Descriptive statistics
• RQ1b: frequency in seeking help	Session	Descriptive statistics
• RQ1c: time spent on seeking help	Session	Descriptive statistics
• RQ1d: help-seeking pattern	Session	Description
RQ2		
• RQ2a: use of help source	Session	Descriptive statistics
• RQ2b: help request	Episode	Description
• RQ2c: repeated use of one source	Episode	Descriptive statistics
• RQ2d: mean time on one source	Episode	Descriptive statistics
• RQ2e: sequential pattern of help source use	Episode	Sequential analysis
• RQ2f: effect of help source features on help-seeking behaviors	Episode	Description
RQ3		
• RQ3a: relations between personal factors and help-seeking behaviors	Session	Independent t-test; Correlation analysis; ANOVA
• RQ3b: relations between help-seeking behaviors and outcomes	Session	Correlation analysis; ANOVA
RQ4: structural model	Session	Structural Equation Modeling (SEM)

The first analysis approach used in RQ1, RQ2a – RQ2d, and RQ2f examined key aspects of the data in a discrete, descriptive manner. Data were extracted from recordings and reported as frequencies or percentages. Another approach was to investigate the participants' choice of help sources in a sequential manner, in order to answer RQ2e. Each participant's task completion process was transformed into a sequence of moves including help-seeking moves and task-performing moves (Appendix G). The sequential analysis focused on help source moves by extracting the sequence of help source usage in each sequence. The analysis was based on the Markov model (Gottman & Roy, 1990). The Markov model addresses a sequence of states observed in a defined setting, and emphasizes that each subsequent state is influenced by the prior state in the sequence. In this study, the state was defined as a particular help source used in

one help-seeking episode. The help-seeking model (Nelson-Le Gall, 1981) described that the last stage of the help-seeking process is to evaluate and reflect on the current help-seeking experience in ways that could influence the individuals' choice of help source for the next time help is needed. Therefore, the researcher assumed that the participant's selection of a help source in the current help-seeking episode was dependent upon the participant's experience with using a particular source in previous episode. The assumption that the current help source use is dependent only on the immediately preceding help source use illustrates the concept of sequential data in "a first-order Markov model" (Gottman & Roy, 1990).

Literature in the library and information science field has already described the use of the Markov model for examining users' information-seeking patterns in information retrieval systems. Chapman (1981) investigated users' commands to an online database system through Markovian analyses of the sequential command list from zero- to fourth-order (a Markov chain of m -th order refers to the current state depends on the past m states). Borgman (1986) examined users' mental models of an online library catalog by comparing the search-state transition matrices between groups that received different training methods, and for gender-based groups. Marchionini (1989) also used a first-order transition matrix to analyze novices' information-seeking patterns when searching in a full-text electronic encyclopedia. Thus, this study formed and analyzed first-order transition matrices for the sequences of help source moves, in order to identify the pattern of help source transitions within the context of completing a challenging computer task. Because a total of five help sources were provided to participants, to form the first-order transition matrix, a five-by-five grid defining all possible two-step help source moves was built (e.g., "F1 help" to "video help"). The value in each cell was calculated by counting the occurrences of each two-step help source move in all sequences. The building of transition

matrices was done by hand. Examination of the transition matrix helps to identify any possible sequential pattern regarding help source moves.

The researcher employed appropriate statistical tests to examine any possible associations between help-seeking data, personal factors, and outcome measures, to answer RQ3. Correlation analysis, independent t-tests, and one-way ANOVA were used to investigate the associations. Because this study did not state any hypotheses a priori, the statistical results were reported in a suggestive rather than a demonstrative nature. One should note, however, that the associations were examined on the session level only, because personal factors and outcomes were measured only at the session level. In addition, the instances at the help-seeking episode level were not independent, because several help-seeking episodes were performed by the same participant.

To answer RQ4, regarding the role of help-seeking effectiveness, the researcher used SPSS Amos software for structural equation modeling (SEM) analysis. The Structural equation modeling was performed in two steps: (1) performing confirmatory factor analysis to evaluate the construct validity of computer self-efficacy and computer anxiety, to ensure a valid measurement model for following structural model analysis; and (2) performing path analysis to make an exploratory examination of the role of help-seeking effectiveness as a mediator between personal factors and task performance.

Pilot Test

The researcher conducted a pilot test with four participants (two males and two females) in the summer of 2009 to test the instruments and the lab procedure. The pilot participants were recruited from the same pool of the formal data collection participants. The purpose of the pilot test was to identify potential problems and to refine the design if necessary. To test the instruments, the focus was on participants' feedback about any ambiguities in the introduction

video, or the task sheet, as well as any problematic questions on the survey. In addition, the pilot test provided an opportunity to make sure the chosen task – creating a table of contents – would be a challenging activity for potential participants in the formal data collection phase.

The pilot participants mentioned that creating a “table of contents” was a difficult task for them and that they had never performed this task before. Additionally, the four participants understood the questions on the questionnaire, and the content of the introduction video, and the consent form. The task sheet was clear enough to tell them what to do in the lab. However, several improvements to the study design were identified through the pilot test. First, an electronic version of the Word file with a generated “table of contents,” instead of a paper version of the file, was provided to participants to inform them more effectively about what they were expected to accomplish for the task. Second, the researcher added a brief description of a “table of contents” to the task sheet to help participants understand the function of a “table of contents.” Third, for the “video” help source, the researcher used local video files for the formal data collection phase, instead of links to online video files, to avoid the Internet connection problems that were observed in the pilot test.

Chapter 5

Results and Discussion

This chapter reports the results of this research, and discusses help-seeking behaviors and the interactions between help seeking and relevant factors. This chapter organizes this study's findings to address the research questions and sub-questions in this order: RQ1, RQ2, RQ3, and RQ4.

RQ1: Help-Seeking Behaviors while Performing a Task

Of the 67 participants, 62 sought help at least once during the task session, whereas five participants performed the task without seeking any assistance. Table 6 summarizes the two groups of participants: help-seeking participants and non-help-seeking participants.

Table 6 Personal Factors of Two Groups of Participants (N=67)

		Help-Seeking Participants (n=62)	Non-Help-Seeking Participants (n=5)
Gender	Male	33	2
	Female	29	3
Prior Experience	Mean	10.7	9.4
	SD	3.6	3.1
	(Min, Max)	(2, 17)	(6, 13)
Computer Self-Efficacy	Mean	6.6	6.5
	SD	2.3	2.9
	(Min, Max)	(0.8, 10.0)	(2.0, 9.8)
Computer Anxiety	Mean	2.0	1.9
	SD	0.6	1.0
	(Min, Max)	(1.0, 3.3)	(1.0, 3.3)

The majority of the participants sought help during the task sessions; more than 12 times as many participants were help-seekers, versus the few participants who were non-help-seekers. The standard deviations for self-efficacy and computer anxiety for the non-help-seeking participants were slightly more diverse than those for the help-seeking participants. The help-seeking participants have slightly higher means for prior experience, self-efficacy levels, and

computer anxiety levels than non-help-seeking participants. T-tests were not run because the small number of non-help-seeking participants (n=5) could introduce Type II error.

Table 7 Task Outcomes of Two Groups of Participants (N=67)

		Help-Seeking Participants (n=62)	Non-Help-Seeking Participants (n=5)
Session Length (minutes)	Mean	20.47	16.03
	SD	7.65	8.85
	(Min, Max)	(7.07, 30)	(7, 30)
Task completion Score	Mean	7.8	6.6
	SD	1.8	1.8
	(Min, Max)	(4, 10)	(5,7)

Table 7 shows the task outcomes of these two groups. The participants in the help-seeking group spent more time on the task than those in the non-help-seeking group did. In addition, the help-seeking group had a higher task completion score than the non-help-seeking group. It should be pointed out that no one in the non-help-seeking group completed the task with the maximum task score of 10; that is, the group of non-help-seeking participants did not fully accomplish the task. As a comparison, 16 of the help-seeking participants achieved full marks. Because of the small number of non-help-seeking participants, a t-test was not conducted to evaluate if the difference in two groups' task outcomes was statistically significant. The following sections focus on the behaviors of the 62 help-seeking participants.

RQ1a: Latency in Seeking Help

In this study, the assigned novel task created a problem-solving situation for the participants. The participants had to recognize their insufficient skills or insufficient knowledge to solve the problem first. However, merely acknowledging the problem did not necessarily trigger help-seeking behaviors. The participants could instead take a trial and error approach to solve the problem. The decision to seek help is dependent upon an individuals' evaluation of the costs and benefits associated with taking help-seeking actions (DePaulo & Fisher, 1980; Lee,

2002). Thus, the time point of participants' initial help-seeking actions reflects their decision points about seeking assistance from external sources. Each participant's decision point to seek help was the point in time when each participant began to seek the first help, which is the latency. The latency period is the time that has elapsed from the beginning of the session until the point in time at which the participant seeks help for the first time. Figure 8 shows the distribution of the latency values in minutes.

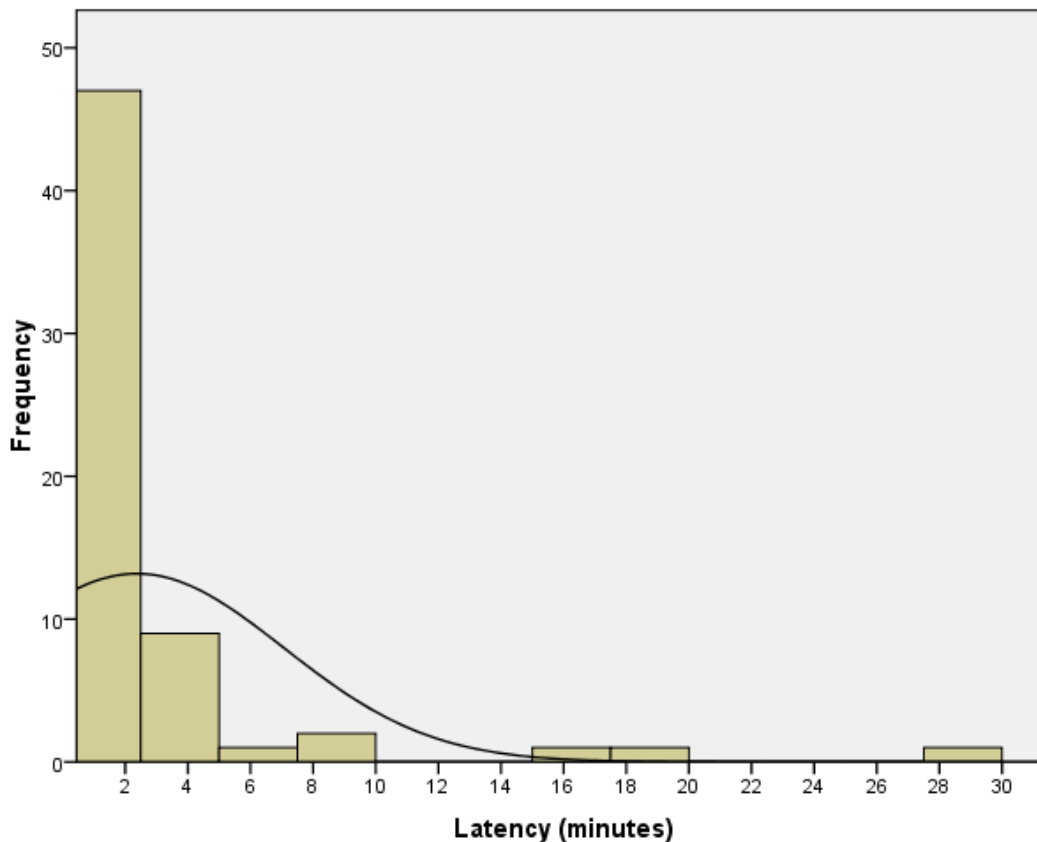


Figure 8. Distribution of latency (N = 62)

The mean latency was 2.36 minutes ($SD = 4.69$). The median and mode values were 51 seconds and 10 seconds, respectively. A majority of the participants began seeking help almost instantly when the lab session began (within less than 5 seconds), although one

participant first sought help only after self-exploring in Microsoft Word for approximately 28 minutes. Figure 8 shows a positively skewed distribution of latency values, suggesting that most participants' decision points for seeking first help were smaller than the mean value (less than 2 minutes). The long tail shows that a few participants decided to begin seeking help very late in the session.

The analysis of latency shows that users have varied time points at which they decide to begin seeking help. Both the help-seeking process and the information-seeking process require that individuals be aware of the problem and make a decision to act. Although latency is measurable based on the observable help-seeking behavior, this study did not identify when the participants began to be aware of the problem, or when they began to make decisions to seek assistance. Nevertheless, the concept of latency in seeking help can serve as an indicator for users' tendencies toward help-seeking. The smaller the latency value is, the sooner the user is likely to use external help in a problem-solving situation. A majority of the participants showed a tendency toward earlier help-seeking.

RQ1b: Frequency of Engaging in Help Seeking

Another perspective on users' help-seeking behaviors is to examine how frequently a user seeks help during the whole process. The frequency of seeking help in this study is measured by the number of help-seeking episodes a participant engaged in during the task session. Figure 9 illustrates the distribution of the number of help-seeking episodes engaged in by the participants.

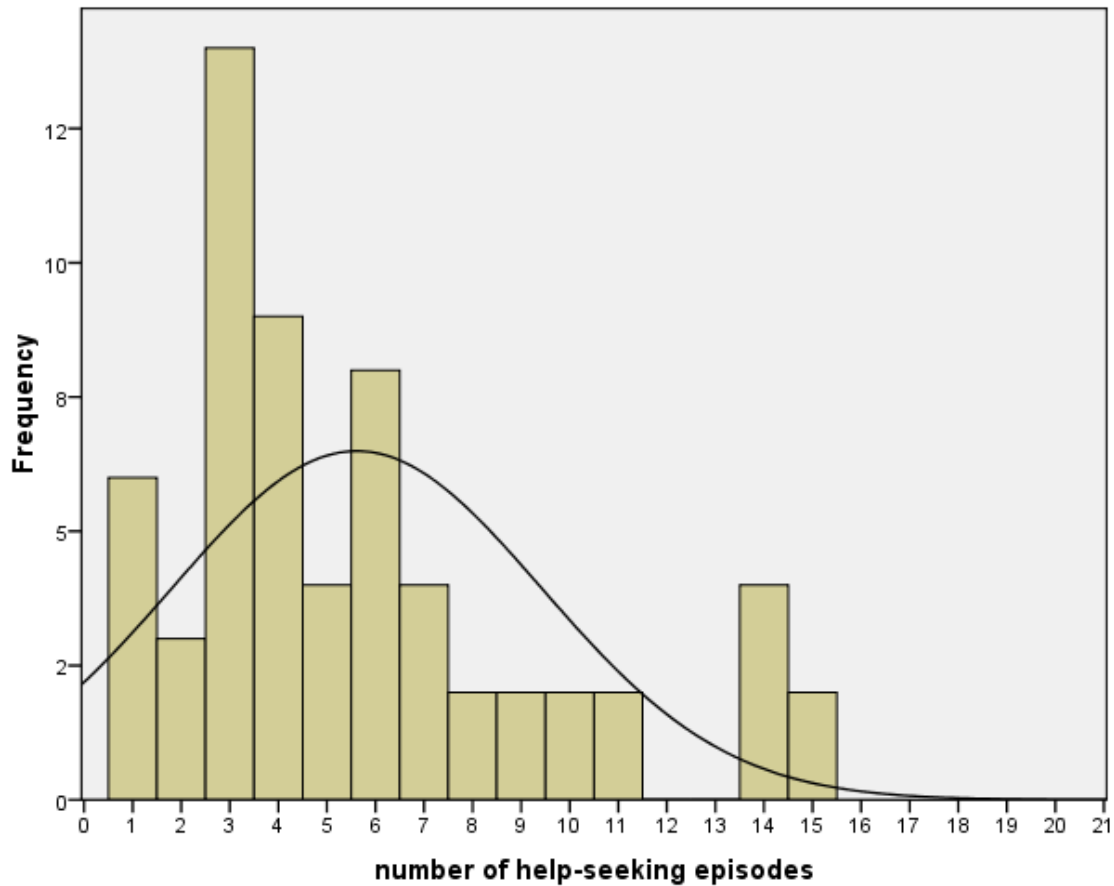


Figure 9. Distribution of Help-Seeking Episodes (N = 62)

The participants engaged in a total of 348 help-seeking episodes. The average number of help-seeking episodes for each participant was 5.61 with a standard deviation of 3.81. The median and mode values were 4 and 3. The minimum number of help-seeking episodes was one and the maximum was 15. The results suggest that few participants sought help only once in the lab and that most participants engaged in about three help-seeking episodes during the entire process. Several participants even engaged in more than ten help-seeking episodes in the whole session. The distribution figure suggests that the frequency of seeking help varies from one participant to another. The frequency of seeking help implies a substantial degree of interaction

by the user toward seeking help from external sources. The higher the number of help-seeking episodes the participant engaged in, the more active the participant was in seeking help, which is indicative of a higher degree of interaction of the participant with external help sources.

RQ1c: Time Spent on Seeking Help

The frequency of the user's help-seeking during the session characterizes the degree of interaction with the help sources, while the total time spent on seeking help characterizes the amount of effort expended on seeking help. The average total time spent on seeking help for each participant was 5.48 minutes over the course of the whole session ($SD = 3.25$, $Min = 0.5$, $Max = 15.3$). The median and mode values were 5.13 minutes and 2.92 minutes (multiple modes exist, so the smallest value was reported). The average expenditure of 5.48 minutes on seeking help during the whole session seems to be a short period of time, but this number might be misleading because individual participants spent varied amounts of total time in the lab. Using the absolute amount of time spent on help-seeking can also be misleading for drawing conclusions. Thus, to get an accurate account of how much time the participants spent seeking help, the percentage of time used for seeking help for the whole session was calculated. Figure 10 shows the distribution of the percentage of help-seeking time for in the whole session, among the participants who sought help.

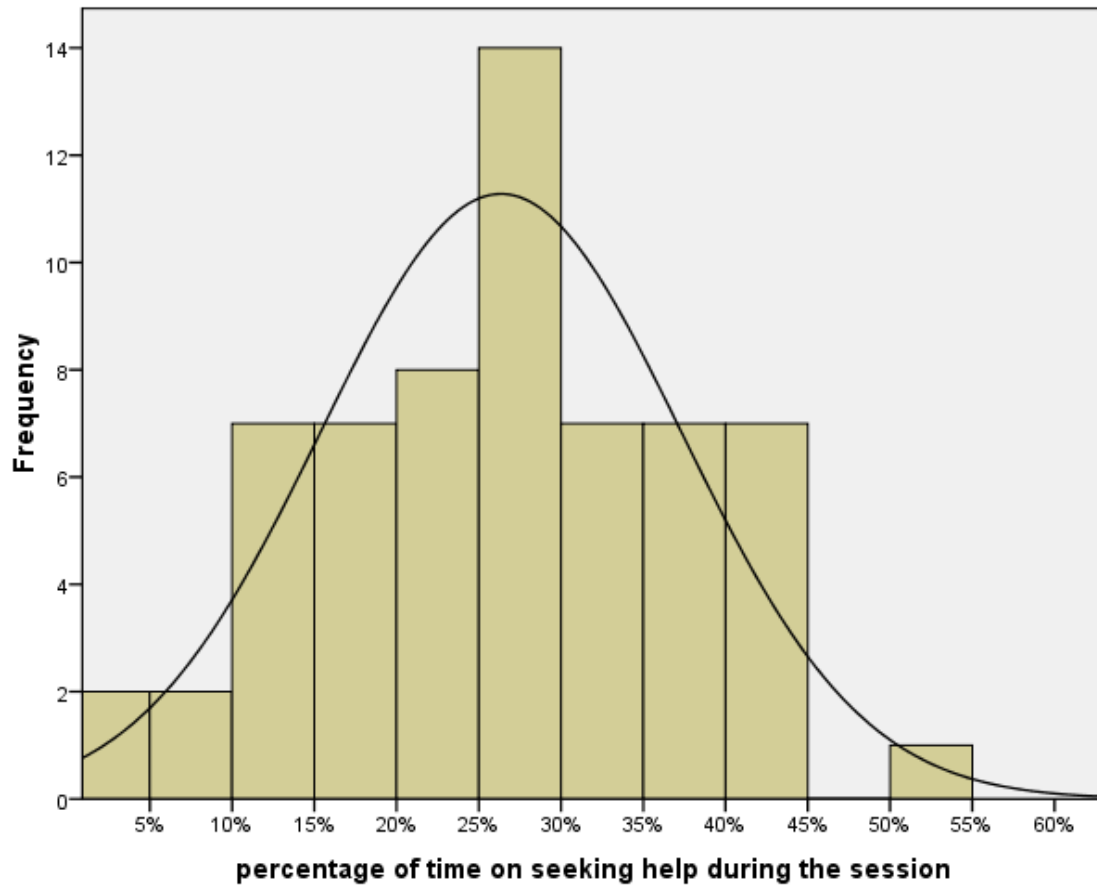


Figure 10. Distribution of the percentage of time on seeking help (N = 62)

The average percentage of time spent on seeking help was 26%, with a standard deviation of 11%. The minimum percentage was 4% and the maximum was 51%. The participants generally spent approximately one fourth of the total session time on seeking help, with the rest of the session time devoted to accomplishing the task. This result indicates that most participants allocated a greater proportion of the time to task completion than to help-seeking during the task process.

RQ1d: Help-Seeking Patterns

The latency period for initially seeking help, the frequency of help seeking, and the time allocated to help seeking, together describe how a user seeks help as part of the task completion process. The latency measure indicates a user's propensity to seek external assistance, while the frequency of and time spent on help-seeking respectively indicate a user's degree of interaction with, and proportion of effort given to, seeking assistance. The researcher performed a Spearman's rho correlation analysis to examine the potential associations among these three help-seeking behavioral variables (Table 8).

Table 8 Correlation among Latency, Frequency, and Time on Help Seeking (N = 62)

Pairs	Spearman's rho	<i>p value</i>
Latency & Frequency	-.40	.001
Latency & Percentage of time	-.36	.004
Frequency & Percentage of time	.55	.000

First, participants' latency was inversely correlated with the frequency of help-seeking episodes. Although the effect size ($r = -.40$) was moderate, the findings suggest that the participants who began seeking help earlier in the session, tended to be very active in seeking help over the whole session. Second, the moderate effect size ($r = -.36$) of the inverse relationship between latency and the percentage of time allocated to seeking help, implies that the participants who began seeking help earlier in the session were also more likely to spend more time overall on seeking help. Third, it was not surprising that the frequency of participants' help-seeking episodes was positively correlated with percentage of time devoted to seeking help. The three significant correlations pointed to a significant pattern in users' help-seeking behaviors. An active help-seeking user is characterized by three help-seeking constructs: the tendency to seek help, the degree of interaction with help sources, and the level of effort given to

seeking help. Specifically: the active help-seeking users, on average, seek help earlier, engage in more help-seeking episodes, and spend more time on seeking help during the entire session, than those who are less active about help seeking.

In addition, the task-evoked help-seeking process model (Figure 3) illustrates two behavioral options users can adopt to begin the task completion process: seeking help immediately before taking any actions to perform the task, or employing a trial-and-error approach to solve the problem before seeking help from external sources. Five participants who did not seek any help were considered as interacting with the system first. Therefore, among 67 participants, twenty-six participants (39%) sought the help before performing the task; the rest (61%, $n = 41$) interacted with the system first before seeking help for the first time. The participants were classified as belonging to either the “Help-Seeking First” group (HSF) or the “Task-Performing First” group (TPF), according to how they started the task. Regarding whether the three help-seeking behavioral variables examined here were significantly different in these two groups, Table 9 presents the descriptive statistics of the latency, frequency, and percentage of time spent on seeking help, for each of these two groups of 62 participants who did seek help during the process. Appendix G lists the HSF or TPF group assignment for 62 participants. For example, P3, P4, and P6 – P12 were categorized in the HSF group, while P1, P2, P5, and P13 – P16 belonged in the TPF group.

Table 9 Help-Seeking Variables in Two Groups (N = 67)

	n	Mean	SD	Median	Mode	Min	Max	<i>t</i> (<i>df</i>)
<i>Latency to seek help</i>								
Help-seeking first	26	0.28	0.26	0.17	0.17	0.02	1.0	<i>t</i> (60) = -3.20 ^{**}
Task-performing first	36	3.88	5.72	1.86	0.50 ^a	0.50	28.57	
<i>Frequency of seeking help</i>								
Help-seeking first	26	6.54	3.49	5.5	4	2	15	<i>t</i> (60) = 1.65
Task-performing first	36	4.94	3.94	3.0	3	1	15	
<i>Percentage of time on seeking help</i>								
Help-seeking first	26	28%	9%	29%	10% ^a	10%	44%	<i>t</i> (60) = 1.17
Task-performing first	36	25%	12%	26%	4% ^a	4%	51%	

^a Multiple modes exist. The smallest value is shown.

** $p < .01$.

The “Help-Seeking First” participants sought help within an average of one minute, but the relatively large standard deviation value (compared to the group’s mean value) implies variation within the latency values for this group. Observations from the session recordings showed that some participants sought help immediately, while others took some time before seeking help. On the other hand, the average latency of the “Task-Performing First” participants was about 4 minutes, with a large standard deviation and large range between the minimum and maximum latency values. In addition, the median value and the existence of multiple modes in this group suggest that the decision point to seek help varied greatly from one user to another. The recordings showed that some TPF participants explored the system quickly by checking the menu bar in Microsoft Word and then turned to seek help relatively soon after beginning the session, whereas some participants would not seek help until they had exhaustively explored the system and tried different functions in Word. It is not surprising that the difference between the latency measures for these two groups was statistically significant.

The participants' degree of interaction with the help sources and their efforts to seek help, as measured by frequency of and time spent on seeking help, also showed differences between the two groups. Participants who sought help first, engaged in more help-seeking episodes and spent more time on seeking help than those who performed the task first, on average. However, the differences between the two groups for these two variables were not statistically significant. The insignificant mean differences between the groups of the users' initial option of how they began the task process, indicates that users' initial behavior in the process is not a good predictor of what users' subsequent effort spent on help-seeking will be. A user who explores the system first, then decides to seek help, does not necessarily put more or less effort into seeking help later.

When starting an unfamiliar task, some users go directly for assistance, whereas others prefer to rely on self-exploration of the software system. Based on users' help-seeking behaviors, there are active help seekers who are likely to seek help earlier, engage more frequently in seeking help, and spend more time on seeking help. A user's choice of approach to starting the task does not necessarily indicate what his or her overall effort given to help seeking during the whole process will be.

RQ2: Help Sources

This set of questions focuses on users' utilization of help sources. Five different help sources, "F1 help," "lab assistant," "reference book," "video tutorial," and "web," were made available to users in this study. It was assumed that the features or characteristics of help sources influence users' help-seeking behaviors (specifically the selection, repetitive use, and perceived help-seeking effectiveness of a source). Source features include the media type (electronic vs. non-electronic) and the level of interactivity (high or low). In this study, the participants were

allowed to use any of the five help sources. The results reveal several distinct help-seeking patterns regarding the use of different help sources.

RQ2a: Use of Help Sources

Figure 11 shows the level of use of each of the five help sources, in the order of the number of participants using each one. A total of 23 participants chose to use the “F1 help” during the entire session. An equal number of participants ($n=21$) chose the “reference book,” the “web” or the “video” at least once during the session. The “lab assistant” received the least number of uses ($n=13$). Therefore, “F1 help” was shown to be the most-often selected help source and the “lab assistant” was the least chosen source, with the other three sources in the middle as equally likely to be selected by participants. This finding was consistent with the results from the study by Karabenick and Knapp (1988), which found that users tended to seek more help when the source of help was a computer rather than a person.

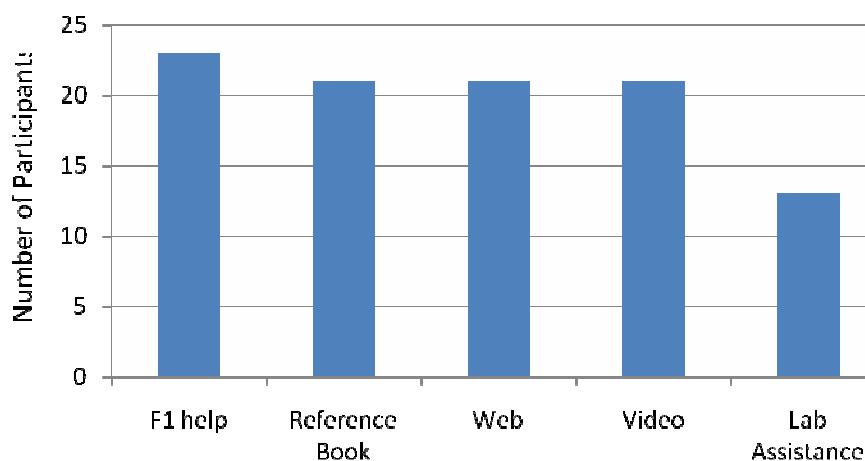


Figure 11. Number of participants using each help source (N = 62)

The use of five help sources was further examined in terms of the number of participants who used the same or different sources, or who used different source media types, or who used

sources with varied interactivity levels. Table 10 shows the number of participants using help sources, as examined from these three perspectives.

Table 10 Use of Help Sources (N = 62)

	n (percentage)
Number of Help Sources	
Single help source	29 (47%)
Two help sources	29 (47%)
Three help sources	4 (6%)
Help Source Type (Media)	
Electronic help source	30 (48%)
Non-electronic help source	9 (15%)
Both	23 (37%)
Help Source Interactivity	
High interactive only	23 (37%)
Low interactive only	14 (23%)
Both	25 (40%)

An equal number of participants used either a single help source (47%) or used two help sources (47%), during the session, with only 6% of participants using three help sources. No participant used either four or five help sources in the lab. This finding indicated that it was not necessary for the participants to use all of the help sources that were made available to them. Similarly, in real-life problem-solving situations, users may not try all of the sources available to them.

Regarding the use of help source types, most participants chose electronic sources only (48%) or used both types (37%), while only nine participants (15%) used only non-electronic sources. Regarding the level of interactivity of help sources, 23% of the participants used highly interactive help sources exclusively, while 14% of the participants chose help sources with low interactivity only. Twenty-five percent of the participants used both high and low interactive help sources. The selection of help sources based on the media types and interactivity levels reflects users' preferences or strategies. Most participants preferred to use only electronic sources or to

switch between an electronic help source and a non-electronic source. Fewer participants used only non-electronic help sources. In addition, although highly interactive help sources were used by more participants than low interactivity sources were (37% vs. 23%), many participants (40%) used help sources with both levels. It seems that the variance in users' selections of source media types is bigger than the variance of their selection of sources with different interactivity levels.

RQ2b: Help Requests

The interfaces of the five help sources determine how users must make a help request. For example, both “F1 help” and “Web” allow users to search for their choice of specific topics or content, but video can only be viewed sequentially, and without tools to search for specific content. It was observed that the participants did not submit any help requests to either of these two sources: “reference book” and “video.” The participants simply opened the book to read or loaded the video clip to view the help content. Although the help requests toward the two sources could not be identified in this study, there was an observed difference in the way participants accessed the content of each of the two help sources. For the participants who chose to use the “reference book,” they usually checked the table of contents of the book or turned to the index to locate the page number to find the relevant part of the book. For those using the “video” source, the participants either watched the video sequentially or used the slider on the time scale to fast forward or move backward to locate the relevant part.

On the other hand, the participants submitted explicit help requests to the three sources: “F1 help,” the “Web,” and the “lab assistant”. Table 11 summarizes the types of help requests submitted to these three sources, the requests that targeted the possible subtasks, and the point at which the requests were submitted during the session (earlier vs. later).

Table 11 Help Requests to F1, Web, and Lab Assistant Sources

Help Source	Help Request Type	Example Requests	Subtask(s)	Session Time
F1 Help	General request	“table of contents” “create table of contents”	T1, T2, T3, T4, T5	Mostly in earlier session, some in later session
	Specific request	“outline level” “built in heading style”	T1, T2	Later session
		“change level toc”	T5	
Web	General request	“how to make a table of contents in word 2007” “create a table of contents word 2007”	T1, T2, T3, T4, T5	Mostly in earlier session, some in later session
	Specific request	“mark the headings for a table of contents”	T1, T2	Later session
		“adding level 4 to table of contents”	T5	
Lab Assistant	Unclear request	“I am lost” “I don’t know what I’m doing wrong”	T1, T2, T3, T4, T5	One early in session, others in later session
	Clear request	“I just got one question. You [your file] have 4 levels. On this [my file], I only get 3 levels. because the menu only gives 3 levels”	T5	Later session

Of the participants who chose “F1 help” (n = 23), about 70% (n = 16) employed a keyword search of the “F1 help” database. The help requests made to the “F1 help” source were primarily focused on obtaining general information about the “table of contents.” The most frequent queries made to “F1 help” were “table of contents” and “create table of contents.” Other help requests were specific in obtaining information about one particular function in Word, such as “outline level,” “built in heading style,” “formats,” etc. One should note that the terms used in all of these help requests made to the “F1help” source seem to be mostly limited by the technical terms that are possibly used in the F1 system manual. Besides keyword queries submitted to the “F1 help” source, participants could also browse the list of the index topics in “F1 help,” as

another way to access the contents. Five participants (22%) browsed the topics first and then chose one topic to read. Two participants (8%) initiated the context-sensitive F1 help by pressing the F1 button within a particular task window. Keyword searching for general information about “table of contents,” the browsing action, and the context-sensitive F1 help were used primarily in the earlier portion of the session, whereas keyword searching for specific information was used later in the session. It seems that users tend to need more general information when beginning an unfamiliar task, but then require more specific information as they get to know what is needed to accomplish the task.

Of the 21 participants who used the “web,” 90% (n=19) went to Google to search for information. One chose to search in “Yahoo Answers!” and the other searched the Wikipedia site. Using a popular search engine was shown to be the primary starting point for most participants who chose to search the Web for help. In addition, these participants mainly used natural language statements in formulating their requests. Similar to the requests posed to the “F1 help” source, the content of the help requests made to the “Web” source varied in the same way, in that general information requests were made earlier in the session, with more specific ones falling later in the lab session. For example, in the early portion of the lab session, the participants usually used broader search statements in the form of “create/make/insert a table of contents in Word 2007,” “how to make a table of contents in Microsoft Word,” or “using Microsoft Word 2007 to make table of contents.” Later in the lab sessions, the participants submitted more specific requests, when they were aware of the necessity of performing specific subtasks in order to finish the whole task. In particular, the participants dealing with the subtask about displaying level four headings in the “table of contents” used statements such as “adding

level 4 to table of contents,” “get table of contents to level 4,” or “Word 2007 table of contents heading 4” as search requests.

When a participant decided to ask questions of the lab assistant, the help requests were formulated in a more flexible way than those submitted to the “Web” or “F1 help” source. The participants seeking human help usually engaged in conversation with the assistant. During the conversation, some participants showed the assistant how they did certain steps on the computer and stated that they did not get the expected results. Thus, most participants formulated requests as asking for a solution, rather than for a confirmation, in a problematic situation they could not work out. Some requests were clear statements, rather than questions, such as “the only thing I don’t know how to do is how to get the fourth level,” or “well, I tried, but I couldn’t get this heading. I put [this heading] on level 4, but it wouldn’t show up for some reason.” However, some less clearly stated requests required the lab assistant to communicate further with the participant. For example, a female participant (P34) said, “I’m struggling. I don’t know what I’m doing,” then showed the assistant on the computer what she had done. The assistant replied that the participant erred by putting the “table of contents” in a separate file. The participant added, “I was looking at this [the file provided by the researcher], which is totally different from what I’m doing. I am trying to figure out, but I’m not doing it correctly, I don’t know what I’m doing.” The assistant then showed the participant the correct place to insert a “table of contents.”

In addition to making a request for help, some participants also expressed their feelings. For example, a female participant (P18) was working on applying heading levels to the headings in the document but could not figure out how to do it. After trying with Microsoft Word for a while, she said to the assistant, “I am totally confused what I did wrong here.” Another female participant (P26) revealed a frustrated tone in her statement “I cannot figure it out. I look [for] it

everywhere; I cannot find it anywhere,” regarding locating the “table of contents” function in Microsoft Word. Besides asking for a solution request, one participant asked a confirmation request, regarding whether the indentations in different heading levels shown in the table of contents were required for the task. In all, when the help requests to the assistant are not clear enough initially, the lab assistant can ask clarifying questions of the user to get a better understanding of the problem. The interactions between the user and the assistant help define the problem clearly, which in turn helps the assistant to provide accurate information to assist the user.

In summary, the degree of flexibility users are permitted when expressing help requests depends on the help source they use. The specificity of the help requests submitted to “F1 help” or “Web” increases as the session continues, and the user has a better understanding of what needs to be accomplished in the process.

RQ2c: Repetitive Use of a Particular Help Source

One observation that emerged from the help-seeking behaviors was that some participants repeatedly used a particular help source in several help-seeking episodes. Thus, the total of 348 help-seeking episodes was further broken down by the five help sources. The number of help-seeking episodes per each help source indicates how frequently a particular help source was used repetitively. Figure 12 illustrates the order of the five help sources from highest to lowest, regarding the frequency of repeated use.

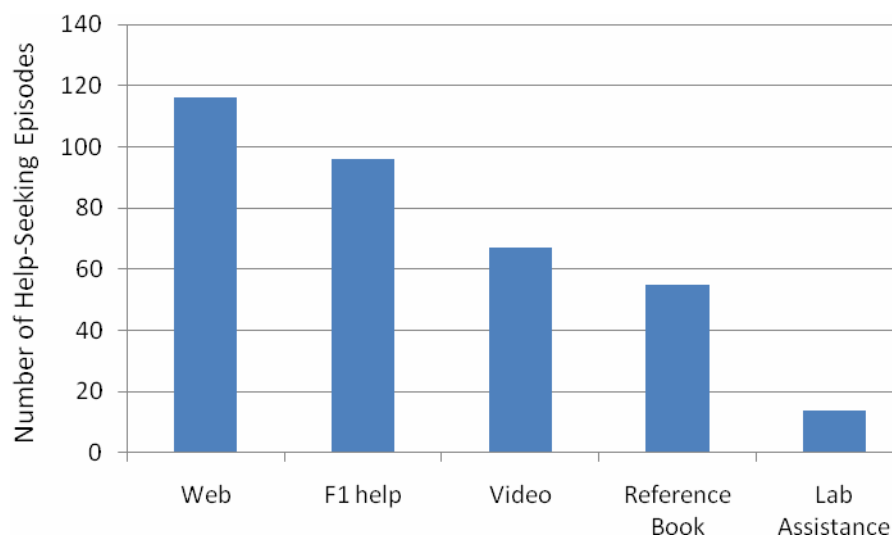


Figure 12. Use of five help sources by episodes (N = 348)

The “Web” was the most repeatedly used help source, as it was put into play in 116 of the total help-seeking episodes. “F1 help” was used in 96 help-seeking episodes, substantially more than the “video” (67 episodes) or the “reference book” (55 episodes). The “lab assistant” was the help source least likely to be used repeatedly in this study (14 episodes). The general use of help sources in Figure 11 and the repeated use of help sources in Figure 12 reveal a specific help-seeking pattern regarding the use of the five help sources. Except for the “lab assistant,” participants were almost equally likely to choose the sources “F1 help,” the “reference book,” the “Web,” or the “video,” but they were more likely to repeatedly use one of the three electronic help sources (“F1 help,” “web,” or “video”) than non-electronic sources (reference book).

RQ2d: Time Spent Using a Particular Help Source

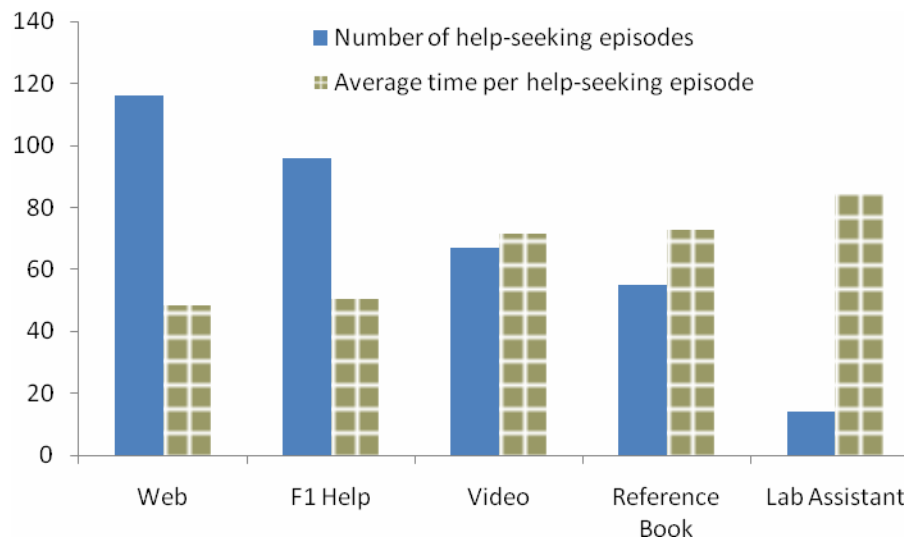
Users’ help-seeking effort is measured by the amount of time spent on using different sources. A comparison of the average time spent per help-seeking episode can provide another aspect to understanding how users spend time differently when seeking help from different help

sources. Table 12 lists the descriptive statistics for the time spent per help-seeking episode for five sources (from high to low).

Table 12 Time Spent in One Help-Seeking Episode by Source (N = 348)

Help Source	Mean	SD	Min	Max
Lab Assistant	1.41	1.29	0.5	5.62
Reference Book	1.21	0.78	0.13	3.08
Video	1.19	1.0	0.08	3.82
F1 Help	0.84	0.67	0.05	3.12
Web	0.81	0.73	0.05	4.33

On average the participants spent more than one minute in a help-seeking episode when using the “lab assistant,” “reference book,” or “video.” On the other hand, the participants spent less than one minute per help-seeking episode when using either “F1 help” or “web” source. In the order of highest to lowest, the amount of time spent using different help sources was as follows: “lab assistant” > “reference book” > “video” > “F1 help” > “web”. Further, Figure 13 combines the findings about the repetitive use of help sources and the time spent on help sources to further examine users’ help-seeking behavioral patterns.



Note: the unit for average time is second.

Figure 13. Comparison of repeated use and time spent on five help sources (N = 348)

The participants sought out “F1 help” and “web” most frequently, but spent less than one minute on average on either of the two sources, indicating that the use of these two sources occurs frequently but briefly. In contrast, the participants did not seek help frequently from the “reference book,” “video,” or “lab assistant” sources, but they did spend more time on each help-seeking episode using these sources. Observing participants’ help-seeking behaviors in recordings revealed that, when using “F1 help” or “web” source, the participants usually searched the source, selected a search result, read the help content screen swiftly, and then went back to the task window. Alternatively, they just went back to the previous search window, selected another search result or reformulated the query to do a new search, after which they read the result quickly to go back to the task window. The observations indicated that the participants tended to be very interactive with the “F1 help” and “web” sources, but tended to spend less effort on these two sources.

RQ2e: Sequential Use of Help Source

The questions RQ2a to RQ2d measure help source use patterns in individual help-seeking episodes. The sequential order of selecting help sources is dependent on the experience and outcome of the previous help-seeking episode. Users apply the content obtained from a particular help source in the previous episode to move forward with completing the task. Based on the task accomplishment status, a participant forms some perception of the help source. This perception influences the participant’s subsequent selection of a help source. Therefore, the use of help sources over the entire session shows a sequence of help source selections over the session.

Help source selection in the entire session. The objective of the sequential analysis was to observe how the participants made choices of help sources during the entire lab session. The

researcher examined the trend of using five help sources in the earlier part of the session versus the later part of the session. Because the length of the participants' help source uses in the session were varied, to make the analysis of help source selection manageable, the researcher examined the first six help-seeking episodes by each participant, based on the fact that on average there were 5.66 help-seeking episodes per participant. This observation of the first six help source uses provides an account of how users move from one help source to another, and a comparison of how particular help sources are selected differently in earlier portions of the session versus later session time (Figure 14).

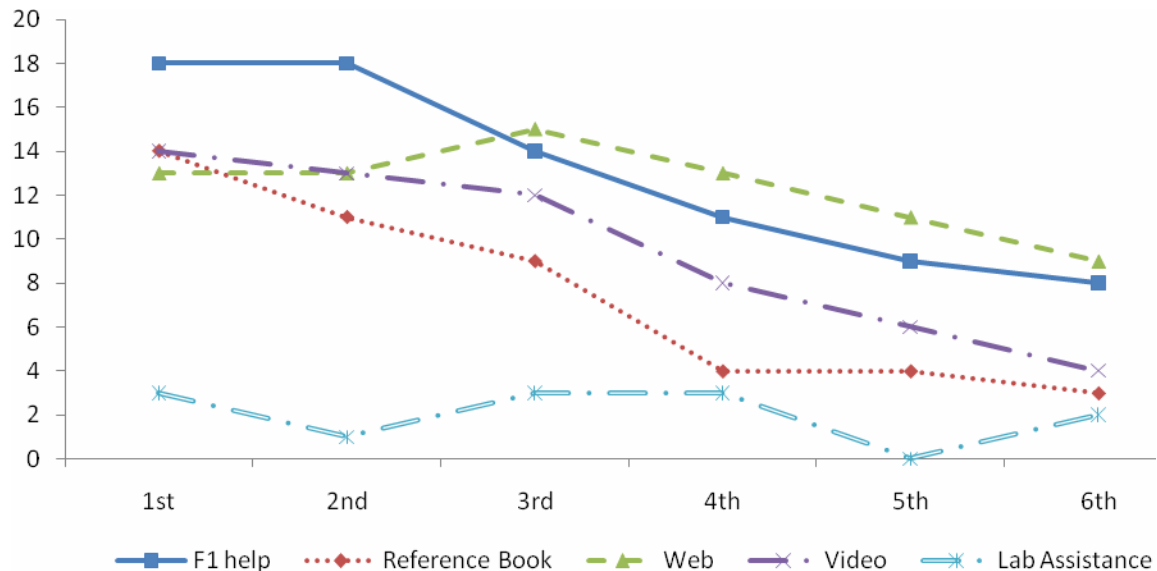


Figure 14. First six help source choices in the session

“F1 help” received the highest count as the first help choice, whereas “lab assistant” had the lowest count as a first choice of help source. The other three help sources had almost equal counts as the first help source selection. The first choice of a particular help source, which is independent from any earlier help-seeking experience, may be considered as the participant’s

initial judgment about the most useful help source at that point in time. Thus, the count of participants who used a particular source in the first help-seeking episode might indicate participants' preference for a help source at the beginning of the session. The finding that "F1 help" was the most selected first-choice source and the "lab assistant" was the least selected first-choice source early in the session is consistent with the findings about the use of the five help sources, per RQ2a.

As the lab session progressed, the count of using "F1 help" in subsequent help-seeking episodes decreased. The "reference book" and "video" also presented the same pattern. On the other hand, the count of the participants who used the "web" or "lab assistant" sources either increased or stayed the same as the task process went along. These results suggest that the participants used the "F1 help," "reference book," and "video" primarily in a session's earlier help-seeking episodes, but then replaced that source with other help sources in later help-seeking episodes. The participants were more likely to choose one of the other two help sources (the "web" or "lab assistant") during the later portions of the session period. In all, the sources "F1 help," "reference book," and "video" displayed a trend of decreasing counts in help-seeking episodes occurring later in the sessions, as compared to the counts for the earlier portion of the sessions. In contrast, the "web" and "lab assistant" sources experienced increasing or consistent counts in the later portion of the sessions.

Further, the first order transition matrix was constructed to examine the pattern of how the particular help source used in the previous help-seeking episode relates to the different help source selected for the current help-seeking episode. The matrix of all of these changes to a different help source is comprised of all of the two-step help source moves that took place at any time during the entire session. Among the help-seeking participants, six participants (9.7%)

sought help only once from one source during the entire session; because these participants' use of help sources did not involve a second source, they are excluded from the analysis of the two-step help source moves. The transition matrix was built on the rest of the help-seeking participants' (n=56) sequences of help source moves, following the method to create the first order transition matrix described in Chapter 4.

Table 13 Transition Matrix for First Six Help-Seeking Episodes

		Subsequent help source				
		F1	Book	Web	Video	Lab assistant
Preceding help source	F1	<i>0.82(53)^a</i>	0.08(5)	0.02(1)	0.04(3)	0.04(3)
	Book	0.13(5)	<i>0.67(24)</i>	0.11(4)	0.06(2)	0.03(1)
	Web	0.02(1)	0.02(1)	<i>0.94(55)</i>	0.02(1)	0(0)
	Video	0(0)	0.02 (1)	0.02 (1)	<i>0.86(36)</i>	0.10 (4)
	Lab assistant	0.33(1)	0(0)	0(0)	0.33(1)	<i>0.33(1)</i>

^aEach cell shows as “probability (number of occurrences)”

The italicized diagonal values in Table 13 represent the probability of transitions from a particular help source to the same source. With the exception of the transition “lab assistant → lab assistant,” the other four diagonal values (F1 → F1; book → book; web → web; video → video) were the highest values in each row, suggesting that most two-step help source moves involved the use of the same help source again. The participants tended to be persistent in using the same source in both the previous and current help-seeking episodes during the entire session.

The non-diagonal values in each cell represent the probability of transition from a preceding help source to a subsequent different help source. Participants who had used “F1 help” as the previous source, and then switched to a different source for the current help-seeking event, were more likely to use the “reference book” than other three sources. After the initial use of the “reference book,” as a help source, the participants who then changed sources tended to switch to

one of the two electronic sources, “F1 help” or “web.” Users switching away from the “video” source were more likely to turn to the “lab assistant” for help.

Another finding revealed by the transition matrix is that the probability of transitioning from the “web” to any of the other sources is very low, meaning that the participants tended to stick to the “web” source most of time. There were only three transitions made from the “lab assistant” to either the same or a different source, which is likely a function of the prior finding that the use of the “lab assistant” tended to occur near the end of the session, without the occurrence of any subsequent help-seeking behaviors. The matrix also includes four zero values that represent the absence of four sequential moves. This result indicates that: 1) no participants switched help sources from the “web” to the “lab assistant” or vice versa; 2) none chose to use the “reference book” after watching the video clip; and 3) no one chose to consult the “reference book” after asking for help from the lab assistant.

To explore how the participants made help source moves between electronic and non-electronic sources or between highly interactive and low interactivity sources, two coarser first-order transition matrices were generated. The first coarser transition matrix focused on the sequential moves between electronic and non-electronic help sources (Table 14). Figure 15 illustrates the first order transition between the two types of help sources.

Table 14 Transition Matrix for First 6 Help-Seeking Episodes by Source Types

		Subsequent help source	
		Electronic help source	Non-electronic help source
Preceding help source	Electronic help source	0.92(151) ^a	0.08(14)
	Non-electronic help source	0.33(13)	0.67(26)

^aEach cell shows as “probability (number of occurrences)”



Figure 15. Transition probabilities in first 6 help-seeking episodes by source types

Figure 15 suggests that the predominant transitions were from an electronic help source to another electronic help source. There were very few situations in which the participants would switch from an electronic source to a non-electronic source. In addition, there is a two-thirds probability that the participants would stay with a non-electronic source, and a one-third probability that the participants would change from a non-electronic to an electronic source. The findings suggest that the participants who used an electronic source in a previous help-seeking episode are very likely to continue using an electronic source, whereas those who used non-electronic sources earlier are somewhat more likely to stick with one of the non-electronic sources. The second coarser transition matrix focused on the sequential moves between high-interactive and low-interactive help sources (Table 15). Figure 16 illustrates the first order transition between the help sources with varied interactive levels.

Table 15 Transition Matrix for First 6 Help-Seeking Episodes by Interactivity Levels

		Subsequent help source	
		High interactive help source	Low interactive help source
Preceding help source	High interactive help source	0.91(115) ^a	0.09(11)
	Low interactive help source	0.19(15)	0.81(63)

^aEach cell value shows as “probability (number of occurrences)”

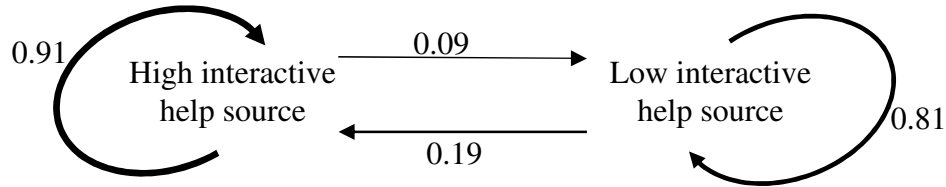


Figure 16. Transition probabilities in first 6 help-seeking episodes by interactive levels

The probability of transitioning from a highly interactive source to a highly interactive source is much higher than the probability of transitioning from a highly interactive source to a source with low interactivity. In addition, the participants were more likely to transit from a low-interactive source to another low-interactive source, than to a high- interactive source. These results suggest that the participants tend to be consistent in selecting sources having similar interactivity levels.

Findings regarding the two-step help source moves taking place over the entire session reveal that, in two consecutive help-seeking episodes, there was a high probability that the participants would repeatedly use the same help source. Considering the types and interactivity levels of the various help sources, the participants tended to choose the same type of help source or a source with a similar interactivity level for the current help-seeking episode, as the source they had used in the previous episode.

Help source moves before the completion of subtasks. The purpose of seeking help is to assist users in accomplishing the assigned task, so the examination of help source moves should be associated with task accomplishment. The successful accomplishment of one or more subtasks was considered to be an important event, because it represented not only the completion of one or more subtasks, but also the beginning of the effort on one or more new subtasks.

Therefore, participants' help source moves were further analyzed within the context of subtask completion. Participants' interactions with the help sources in Appendix G were broken down into sub-sequences of interactions. Each sub-sequence starts with the help source that is either in use at the beginning of the session or that is being used at the beginning of one or more new subtasks. Each sub-sequence ends at the point that one or more subtasks are successfully completed (see Appendix H). The sequential analysis of the sub-sequences of interaction with the help sources provides a description of the help source transitions within the context of successful subtask performance. Appendix H displays a total of 132 sequences of help source moves before the completion of subtasks. Among these sequences, 72 sequences (54.5%) included the use of only one help source, meaning that over half of the sequences leading to the subtask completions only required one help-seeking episode. The analysis of these 72 events, in which only a single help source was used before the completion of the subtasks, is discussed in the next section. These 72 single help source sequences are of course excluded from sub-sequence analysis of the two-step help source move. Thus, only the 60 sub-sequences involved in two-step help source moves were used to form the first order transition matrix (Table 16).

Table 16 Transition Matrix for Help Source Moves before the Completion of Subtasks

		Subsequent help source				
		F1	Book	Web	Video	Lab assistant
Preceding help source	F1	<i>0.75(30)^a</i>	0.1(4)	0.02(1)	0.05(2)	0.08(3)
	Book	0.15(5)	<i>0.64(21)</i>	0.09(3)	0.06(2)	0.06(2)
	Web	0.02(1)	0.02(1)	<i>0.94(43)</i>	0.02(1)	0(0)
	Video	0(0)	0.07(1)	0(0)	<i>0.8(12)</i>	0.13(2)
	Lab assistant	<i>0(0)</i>	<i>0(0)</i>	<i>0(0)</i>	<i>0(0)</i>	<i>0(0)</i>

^aEach cell shows as "probability (number of occurrences)"

Table 16 suggests that there is a high probability of using the same help source in two consecutive help-seeking episodes to achieve the successful completion of subtasks (displayed as the italicized diagonal values). This finding about help source moves involved in the completion of subtasks is similar to the findings about help source moves in the whole session. The participants showed the sequential pattern of interacting with the same help source in the session to complete the task. All of the row values for the “lab assistant” source were zeroes (bold italicized values), which suggest that any sequences of help source moves involving the use of the “lab assistant” had this as the last help source in the sequence to complete the subtasks. In other words, the participants who sought help from the “lab assistant” usually achieved success, so no other help sources were consulted following the use of the “lab assistant.” The help from the “lab assistant” was effective in assisting the participants to accomplish the subtasks.

Additional analyses of two coarser transition matrices, regarding the help source media types and source interactivity levels for sub-sequences, revealed similar results to those obtained in the examination of transitions in the whole session. That is, if the preceding help source was an electronic source, the participants are more likely to select an electronic source again. The probability of transitioning between electronic help sources (probability = 0.89) is substantially higher than the probability of transitioning from an electronic to a non-electronic source (probability = 0.11), in completing subtasks. Similarly, the probability of transitioning between non-electronic help sources (probability = 0.69) is higher than that of transitioning from a non-electronic source to an electronic source (probability = 0.31), in accomplishing subtasks. Further, the probability of transitioning from a high-interactive source to another high interactive source (probability = 0.91) is substantially greater than the probability of transitioning from a high-interactive source to a low-interactive source (probability = 0.09) in completing a series of

subtasks. If a participant used a low interactive source in the prior help-seeking episode, the participant is likely to choose a low-interactive source again in the subsequent help-seeking episode (probability = 0.75). That is, he or she is less likely to switch to a high-interactive source (probability = 0.25). The transitions between sources with similar interactivity levels occupied a large proportion of the source moves in the sequences of help source moves used to complete one or more subtasks.

Effective help source and transition from effective source to another source. The previous analyses have focused on the sequence of help source transitions during the completion of one or more subtasks. The analysis assumes that each help-seeking episode in the sequences provided some useful experiences that accumulated, leading to the completion of one or more subtasks. The help source that was used in the help-seeking episode that resulted in the successful subtask accomplishment is considered to be an effective help source for task performance. Therefore, the effective help source used in the preceding help-seeking episode of a successful subtask performance is an important element in understanding the task process, as is the transition from the effective help source to the selection of next help source. The examination of the effectiveness of the help sources in the completion of the subtasks provides information for the comparison of the effectiveness of the five help sources for the completion of the task. The transitions from an effective help source to a subsequent help source show participants' help-seeking strategies regarding the influence of their previous successful help-seeking on the choice of a subsequent help source. Figure 17 illustrates the frequency with which each of the five help sources was the "effective" source for a help-seeking episode.

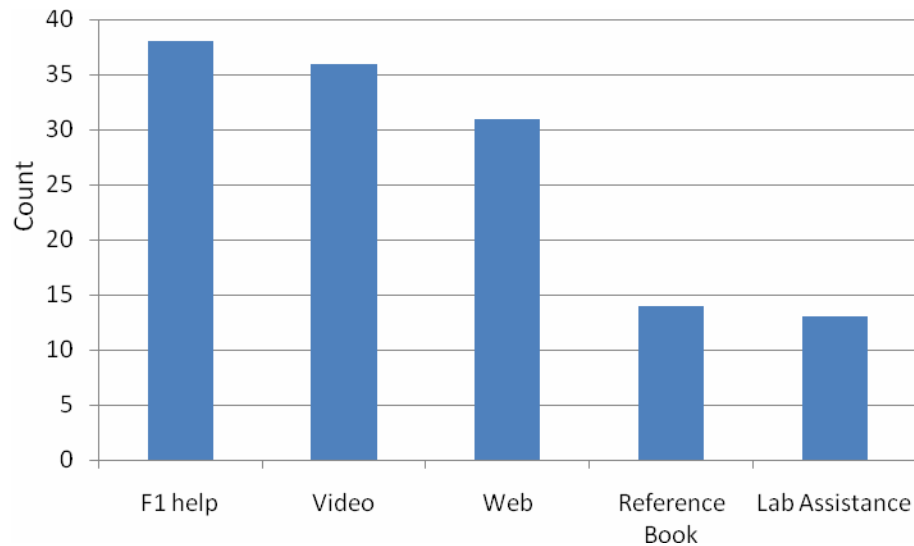


Figure 17. Effectiveness of five help sources

“F1 help” was shown to have the highest frequency of being the chosen source for a help-seeking episode that led to the accomplishment of a subtask. In general, the three electronic help sources had higher counts on this measure than the two non-electronic help sources did.

However, the higher counts do not necessarily mean that the “F1 help” and the “web” were more effective help sources than the “reference book” and the “lab assistant.” The findings about the repetitive use of help sources revealed that the “F1 help” and the “web” were repeatedly used in the most help-seeking episodes. Therefore, the effective rate of a help source is a preferable measurement of the source’s effectiveness. The effective rate is calculated by dividing the number of help-seeking episodes involving each of the five help sources in the completion of subtasks, by the number of total help-seeking episodes involving the five sources (Table 17).

Table 17 Effective Rate of Five Help Sources

Help Source	# of help-seeking episodes involving each help source in the completion of subtasks	# of help-seeking episodes in total	Effective Rate
Lab assistant	13	14	.93
Video	36	67	.54
F1 help	38	96	.40
Web	31	116	.27
Reference Book	14	55	.25

The “lab assistant” has the highest effective rate, with the lowest number of total uses in help-seeking episodes. The result suggests that seeking help from a person leads directly to a successful completion of one or more subtasks, despite the fact that participants in this study tend to seek help from other sources rather than from the “lab assistant.” The “video” also has a high effective rate of 0.54, but received a higher number of requests in help-seeking episodes than the “lab assistant” did. It is likely that the participants preferred the video’s multimedia format, with visual instructions on task completion. The participants who used this help source had a good performance outcome on the task. The “F1 help” was used in more help-seeking episodes, but had only a mediocre effective rate. The “Web” had the highest total number of help-seeking episodes, but achieved only a low effective rate. The frequent use combined with low effectiveness for “F1 help” and “web” sources indicate that the participants tended to use these two sources frequently in several help-seeking episodes, but that most of the help-seeking episodes which involved the use of either of these two help sources did not directly result in the completion of subtasks. Finally, the “reference book” had both the lowest success rate, as well as only a small number of help-seeking episodes, meaning that the participants generally did not use the reference book to seek help, and for those who did use it, the book did not help the participants effectively.

When a user needs help again for a different problem, the user can choose the same source that they used in the prior episode, or transition to a different source. When the successful completion of the subtask results from consulting a particular help source, this positive experience with that source can influence the user's choice of a help source for the next episode when a new need arise. Table 18 presents a first order transition matrix to illustrate all moves from the "effective" help source to using a subsequent help source for a different subtask.

Table 18 Transition Matrix from Effective Help Source to Next One

		Subsequent help source				
		F1	Book	Web	Video	Lab assistant
Effective help source	F1	0.85(26) ^a	0.06(2)	0(0)	0.06(2)	0.03(1)
	Book	0.11(1)	0.78(7)	0.11(1)	0(0)	0(0)
	Web	0.05(1)	0(0)	0.95(20)	0(0)	0(0)
	Video	0(0)	0(0)	0.04(1)	0.88(23)	0.08(2)
	Lab assistant	0.5(1)	0(0)	0(0)	0(0)	0.5(1)

^aEach cell value shows as "probability (number of occurrences)"

According to the matrix, if the effective help source is one of the four non-human sources ("F1 help," "reference book," "web," and "video"), there is a high probability that the participants will stay with the same source for the subsequent help-seeking episode. In other words, the participants tend to stay with the effective help source for the subsequent subtasks. The transition from using the "lab assistant" to a subsequent help source in this study has different patterns. Only two such moves were observed: "lab assistant → F1 help" and "lab assistant → lab assistant." In most of these cases, the participants turned to the "lab assistant" as a last resource in the entire process, and ended with no further help-seeking requests after the use of the "lab assistant."

It is not surprising that users do not change the help source that provided effective assistance and helped them to complete the previous task successfully. The analyses of transitions between help source types, and of help sources with different interactivity levels using coarser transition matrices, showed users' persistent patterns in using sources of the same type or similar interactivity levels. The effective use of a help source affects the choice of a help source in subsequent help-seeking episodes. The participants showed "loyalty" or a preference for the help source that effectively helped them in the task completion.

RQ2f: Help Source Features Influence Behavior

Two help source features were examined in this study: help source media types and interactivity levels. RQ2a to RQ2e investigated the different usage of five help sources in terms of help requests, frequency, time, and sequential pattern. RQ2f expanded the examination of help source use to include the possible effects of the two source features on participants' help source use behaviors.

First, the interactivity level of help sources has an effect on users' help requests. A highly interactive source encourages communication between the user and the source, so that users can formulate explicit requests and have the flexibility to make vague requests of the source. In this study, "reference book" and "video" are considered to be low-interactive level sources; with low interaction between users and the source, users do not submit explicit help requests to these two sources. On the other hand, the participants who used the three highly interactive help sources ("F1 help," "web," and "lab assistant") submitted explicit help requests. Participants using the "web" source or the "lab assistant," showed more flexibility in formulating their help requests. The higher the interactivity level of the source, the less clear the help request can be.

Second, both the help source media type and the interactivity level influence how users interact with the source in terms of both use frequency and time used. Electronic help sources, compared to non-electronic sources, can process and respond to users' requests faster. Among the five help sources available in this study, the "F1 help," "web," and "video" are electronic help sources. In particular, the "F1 help" and "web" source are two electronic information search systems where users can search, browse, and retrieve results quickly. The "video" content is static, but this source allows users to drag a slider on the time scale to a particular point to watch the desired portion of the content in a timely way. Therefore, the fast response mechanism in electronic help sources tends to lead users to interact more with them. The order of the repetitive use of the five sources from high to low confirms this claim: the "web," "F1 help," and "video" were used more frequently than the "reference book" and "lab assistant" were. In addition, this fast-response characteristic of electronic sources influences the amount of users' time spent on seeking help. Participants spent less time on average using electronic sources than they spent using non-electronic ones. As a non-electronic help source with highest level of interactivity, the "lab assistant" or human help has another feature that may also influence users' help-seeking behaviors. Although the "lab assistant" can offer the most interactive form of assistance, seeking help from a person usually entails a unique cost to users. Karabenick and Knapp (1988) found that asking for help from a person posed a threat to users' self-esteem. This finding provided another possible explanation for why the "lab assistant" was the least likely source to be repetitively used by participants. Participants' posing questions to the lab assistant, who was a stranger to them, can be a way of admitting their lack of personal knowledge or skills to the assistant, which may hinder their willingness both to choose the "lab assistant" as a source, and to engage in repeated use of this source. In summary, users' help-seeking strategy regarding the

repetitive use of, and effort spent on, a particular help source entails considerations of the electronic and interactivity features of help sources, as well as any associated psychological costs.

Third, source interactivity also has an effect on the user's choice of help sources, depending on whether the choice is made earlier or later in the task completion process. At the beginning of the session, most participants, regardless of which source they chose, formulated a straightforward and broad request about how to create a table of contents. As the task completion process went on, the help-seeking participants turned to highly interactive sources, the "web" or "lab assistant," with a specific help request expressed in natural language. Highly interactive sources provide flexibility for users to express specific requests in statements, rather than being limited by specific system terminology. In addition, some problems are not easy to express as a keyword search request, nor are they easy to locate in a "book" or "video." The "Web" and "lab assistant" sources, then, encourage dynamic interaction between users and sources, in the formulation and clarification of initially vague help requests. Therefore, the participants were likely to choose the "web" or "lab assistant" help sources during the later portions of the session for help with a specific subtask, or for a vague problem. In all, the trend of help source selection during the session seems to correspond to the interactivity level of each help source.

RQ1 & RQ2: Summary and Discussion

RQ1 and RQ2 aim at observing how users go through the process of seeking help and how they use different help sources during the process. Help-seeking processes are characterized by the latency in seeking help (RQ1a), the level of effort expended on seeking help (as indicated by the frequency (RQ1b), and the time spent on help-seeking (RQ1c)). The concept of help-

seeking patterns (RQ1d) focuses on illustrating the behavior of the active help-seeking users, and users' starting approach when faced with an unfamiliar computer task.

The users' help-seeking pattern in using external help sources varies as a function of three help-seeking variables: latency, frequency, and time. Latency measures users' propensities toward engaging in the first help-seeking action during the session. The tendency to seek help may be a good indicator for predicting the intensity of subsequent efforts spent on seeking help, which are expressed by users' engagement in help-seeking and their effort put into help seeking. Users with a tendency to seek help initially early in the session are more likely to (1) engage in more help-seeking episodes, and (2) spend a greater proportion of time on help-seeking than those who seek help for the first time later in the session. Therefore, a user's tendency and efforts to seek help comprise a distinct computer user's help-seeking behavior, within the context of accomplishing a computer task. A high tendency toward, a high frequency of, and more time spent, in seeking help, indicate an active, help-seeking computer user. Another characteristic of help-seeking behavior pertains to how users start the process, by either directly seeking helps first or by relying on a trial-and-error approach first. This behavioral characteristic indicates the user's personal dependence on internal or external assistance at the beginning of a problem-solving situation. However, a users' initial approach at the beginning of the process does not seem to determine users' subsequent efforts to seek help.

The use of the five different help sources (RQ2) is indicative of an individual user's choice of help source, and of various interactions with the different sources. The participants' use of help sources in the task process are characterized by the frequencies of choice of particular sources (RQ2a), the type of help requests that are submitted to the sources (RQ2b), the repetitive use of a given source (RQ2c), the time spent using specific sources (RQ2d), and the sequential

use of help sources (RQ2e). Four of the available help sources were used by a nearly equal number of participants, with the exception of the “lab assistant,” an option initially chosen by few participants. Different types of help requests were submitted to particular help sources, and the specificity of the help requests increases as task process progresses. Users’ interactions with “F1 help,” “web,” and “video” sources, compared to their interactions with “book” and “lab assistant,” show a more repetitive but quicker, skimming use pattern. The sequential use of help sources reflects users’ primary help-seeking strategy during the task completion process: staying with the same help source, with same help source type (electronic or non-electronic), and with sources with similar interactivity levels. This persistent use of the same help source was consistent throughout the entire session, in the sequential use of a help source for task completion, and in transitions from a previously effective help source to a subsequent help source selection. Therefore, users showed a predominant pattern of using the same help source, or one with similar features, in two consecutive help-seeking efforts.

The features of help sources, which are the level of interactivity, and the general source type (non-electronic versus electronic media), can affect users’ help-seeking behaviors (RQ2f). Electronic help sources respond to users’ help requests and provide feedback to users faster than non-electronic sources. Therefore, users select electronic help sources more frequently, particularly the “F1 help” and “web” sources; users also spend less than one minute on average when using these electronic help sources. On the other hand, users make use of non-electronic help sources less frequently, yet when they are selected, users spend more time on these sources (“reference book” and “lab assistant”). In addition, the interactivity level of a help source influences the type of help requests. More highly interactive sources, the “web” and “lab assistant,” were used in later stages of the session. Natural language statements, instead of

keywords, were used to query these two highly interactive sources for assistance with a specific subtask. In addition, the more interactive the source, the more flexible the user can be in clarify his or her needs. As a result, the participants tended to use highly-interactive sources to communicate less clear help requests to the chosen source.

RQ3: Help-Seeking Factors

The third research question focuses on the relationships between personal factors and help-seeking behaviors, and between help-seeking behaviors and outcomes. The results are reported here in two parts. A summary and discussion are provided at the end of this section.

RQ3a: Personal Factors and Help-Seeking Behaviors

Help-seeking process. Based on the results of RQ1a – RQ1c, the active help-seeking user is characterized by three help-seeking variables: the latency period before initially seeking help, the frequency of seeking help, and the proportion of time spent on seeking help. When examining the relationship between the four personal factors and the three help-seeking variables, the researcher used the absolute value of time spent on seeking help instead of the percentage of time spent on seeking help. The use of the percentage measure in RQ1 was to allow the comparison of participants' time spent on seeking help, given that the participants spent varied amounts of time on help-seeking during in the session. However, the effect of personal factors on users' efforts spent on seeking help is better shown by the actual time spent on seeking help, rather than the percentage of time.

There were no significant gender differences for these three help-seeking variables, meaning that males and females did not show differences in the degree of interaction with help sources. Similarly, prior experience and computer anxiety were not significantly related to any of the three help-seeking variables. Users' prior experience with, and anxious feelings toward,

computer use do not indicate their tendencies to seek help, or their efforts to seek help. Values from a Spearman's rho analysis showed one significant correlation, an inverse relationship between efficacy and time spent on help seeking, expressed as $r(\text{efficacy, time}) = -.27 (p < .05)$. The higher the CSE level of the participant, the less time the participant spent on help-seeking. However, CSE was not significantly associated with the tendency to seek help or the frequency of seeking help. The findings suggest that, when facing a challenging and unfamiliar computer task, users, regardless of having high or low confidence in using the software, become aware of the need and decide to seek external help (tendency and frequency). However, computer users who have high confidence in their self-assessed abilities in using Microsoft Word tend to rely primarily on themselves, so that during the help-seeking process, they tend to switch back to performing the task quickly, by reducing the time spent on seeking external help.

The results reported in RQ1d show that each participant either sought help first or performed the task first at the beginning of the session. This initial behavior is not significantly associated with any personal factors. Users' characteristics, including being a male or a female, or having more prior experience with the software, or being more confident in using the software, or being anxious about computer use, are not predictive of which starting approach users will employ (relying on self or external assistance) when facing a problem-solving situation. This distinct help-seeking related behavior can be examined in a future study to explore its relationship with other possible personal factors.

Use of help sources. Among the sub-questions for RQ2, only RQ2a examined the use of help sources at a session/participant level. The following results report only the associations between personal factors and the help source use variables from RQ2a.

Statistical results show that none of the four personal factors is associated with the use of four of the help sources: the “F1 help,” “lab assistant,” “web,” and “video.” However, there is a significant positive correlation between the participants’ computer anxiety level and their use of the “reference book” (Table 19). The participants who chose to use the “reference book” had a higher anxiety level than those chose to use the other four help sources. It is not a surprising finding that the users with high computer anxiety tend to use the help sources that do not require using a computer. This result is consistent with the definition of computer anxiety and the findings from earlier empirical studies. The finding, however, calls for special attention to the help needs of high-anxiety computer users, with solutions from non-computerized help sources.

Table 19 Computer Anxiety in the Use of “Reference Book” (N = 62)

	Using “book”			Not using “book”			<i>t</i>
	n	Mean	SD	n	Mean	SD	
Computer Anxiety	21	2.31	0.55	41	1.82	0.59	3.14**

**
 $p < .01$.

Regarding the use of help sources by media type, the participants were grouped into (1) those using electronic sources only ($n = 30$), (2) those using non-electronic sources only ($n = 9$), and (3) those using both ($n = 23$). Gender was not significantly associated with the use of different types of help sources. Table 20 lists the results of the differences in the means of the other three personal factors, in these three groups.

Table 20 ANOVA Results of Personal Factors in the Use of Source Types

	Electronic source only (n=30)		Non-electronic source only (n=9)		Both (n=23)		<i>F</i> (2,59)
	Mean	SD	Mean	SD	Mean	SD	
Prior Experience	11.3	3.4	10.11	4.21	10.17	4.21	0.80
Microsoft Word Efficacy	7.85	1.54	7.26	1.42	7.80	1.57	1.19
Computer Anxiety	1.78	.56	2.33	.60	2.12	.63	3.91*

* $p < .05$

The CA level was the only personal factor shown to be significantly different across the three groups ($p < .05$). Further analysis aimed to identify the differences between the groups. A Post Hoc Tukey test showed that the participants who used only electronic sources had significantly lower CA levels (mean = 1.78) than those using non-electronic sources only (mean = 2.33). There was no significant CA difference between the group using both types of sources and the group using either one of two source types. The finding of significant differences in CA levels between participants using electronic sources and using non-electronic sources is consistent with the results of the empirical studies of CA in HCI contexts. On the other hand, participants' prior experience and efficacy did not show any significant differences in the groups based on the use of different help source types, because users' prior experience or self-assessment of abilities measures their experience and perceptions about particular software. It is not related to users' perception and choice of help source media types.

Regarding the use of help sources with different interactivity levels, the participants were grouped into three categories: (1) those using low-interactive sources only, (2) those using high-interactive sources only, and (3) those using both. Statistical analysis revealed that the use of different-level interactive help sources was not associated with any of the four personal factors.

In other words, the four personal factors did not influence users' choice of help sources with low or high interactivity.

The analysis of associations between personal factors and the use of help sources suggests that only users' computer anxiety level is associated with users' choice of help source, particularly the non-electronic sources. A users' choice of other help sources during the session is not associated with individual differences in gender, prior experience, and software efficacy.

RQ3b: Task Outcomes and Help-Seeking Behaviors

Task outcomes are measured by session length, task completion score, and the perceived usefulness of the help sources. Although the participants were instructed to perform the computer task in 30 minutes, the majority of participants (80%; $n = 50$) ended the lab session in less than 30 minutes. The average session length was 20.49 minutes ($SD = 7.7$), with the range of lengths between 7.07 to 30 minutes. The average task score was 7.81 with a standard deviation of 1.77, with scores ranging from 4 to 10. Correlation analysis showed that task score was not associated with task time ($p > .05$), meaning that spending more time in the task completion process is not necessarily indicative of better task accomplishment. The average values of the perceived usefulness of the five help sources from highest to lowest were: "lab assistant" (mean = 4.62), "video" (mean = 4.38), "web" (mean = 3.57), "F1 help" (mean = 3.13), and "reference book" (mean = 2.67).

The overall task of generating a table of contents was comprised of five subtasks, but the total task score does not show the differences in each subtask's completion status. Table 21 lists the frequency levels for each completion status for the five subtasks.

Table 21 Completion Status for Five Subtasks (N = 62)

Subtasks	No Completion	Partial Completion	Full Completion
Locate “heading styles” function (T1)	5 (8%) ^a	6 (9%)	51 (83%)
Apply heading styles to headings (T2)	8 (13%)	31 (50%)	23 (37%)
Locate “table of contents” function (T3)	0 (0%)	0 (0%)	62 (100%)
Insert “table of contents” (T4)	0 (0%)	3 (5%)	59 (95%)
Change “show of levels” into “4” (T5)	36 (58%)	1 (2%)	25 (40%)

^aEach cell represents “number of participants (percentage)”

All participants fully completed the subtask “locating TOC function (T3)” and almost all participants (over 90%) fully completed the subtask “inserting TOC (T4).” In addition, more than 80% of participants fully accomplished the subtask “locating heading styles (T1),” but a few participants did not even partially complete this subtask. Less than half of the participants achieved full completion for the subtasks “apply heading styles to headings (T2)” and “changing TOC display levels (T5).” More than half of the participants (58%) did not complete any part of the subtask “changing TOC display level.” The varied subtask performance underlines the five subtasks’ different difficulty levels: locating a certain function in Microsoft Word (T1 and T3) and inserting the TOC (T4) were relatively easier to complete, as compared to applying heading styles or changing the TOC display levels (T2 and T5).

Help-seeking process. Task outcomes are related directly to the users’ help-seeking process (reported in RQ1a – RQ1c). Statistical analyses reveal that there is a significant positive correlation between the frequency of help-seeking episodes and the session length (Spearman’s ρ (frequency, session length) = 0.42, $p < .01$); and there is a significant positive correlation between the actual time spent on seeking help and the session length (Spearman’s ρ (time, session length) = 0.68, $p < .01$). These results mean that the participants who sought help more frequently, and spent more time on seeking help, also spent more time in the whole task session. However, no significant correlation exists between the time spent on seeking help and the task

score. There is also no significant correlation between the frequency of help-seeking episodes and the task score. These findings indicate that seeking help more frequently and spending more time on help seeking do not necessarily lead to better task performance, but rather the person ends up spending more time on the whole interaction process. In addition, there is no significant association between the latency period and the task outcome, which indicates that a user's tendency to seek help is not a predictor for task performance or the session length. There is also no significant association between the participants' starting approaches (seeking help first or performing the task first in RQ1d) and task outcomes, which means the users' session-starting behavior is not indicative of time spent or task accomplishment.

Use of help sources. The researcher also examined the relationships between the use of help sources (RQ2a) and task outcomes. Regarding the use of the five help sources, only task score was found to be significantly different between the participants who used the “reference book” and those who did not (Table 22).

Table 22 Task Score in the Use of “Reference Book” (N = 62)

	Using “book”			Not using “book”			<i>t</i>
	n	Mean	SD	n	Mean	SD	
Task Score	21	7.10	1.73	41	8.17	1.70	-2.34**

***p* < .01.

The participants who used the “reference book” during the session have lower task scores than those who did not use the “reference book.” In other words, the use of the “reference book” did not result in effective assistance for task completion. This finding is consistent with the results reported for RQ2, about the low effective rate of the “reference book” in aiding task completion. Regarding the source types and interactivity levels, neither the session length nor the task score was significantly different in participant groups based on using different help source

types or using sources with different interactivity levels. The use of electronic or non-electronic sources, or the use of a help source with a low or high level of interactivity, did not matter to the final task outcomes. The non-significant associations between help source use and task outcomes suggest that the users' choice of using a particular help source, except for the use of the "reference book", do not indicate users' total effort in the session or their final task accomplishment.

Help-seeking variables in RQ2b – RQ2e were examined at the help-seeking episode level, so the researcher did not perform a statistical analysis to investigate relationships between any help source use in RQ2b – RQ2e and task outcomes. Instead, the researcher examined the help source use and subtask completion in a descriptive manner, through the observations made in the session recordings.

The examination of help source use and subtask performance during the sessions reveals that the use of different help sources is associated with the effective completion of different subtasks. Specifically, the "F1 help" was shown to be the most helpful source for the completion of the "locating a function" subtasks. The "Video" was effective in accomplishing both the "locating a function" subtask and the procedural task. The subtask T2, "apply heading styles to headings," requires several consecutive actions (e.g., highlighting the heading in the text, choosing and applying a heading style to the highlighted one, and repeating the two steps for all headings within the document). The "video" help source shows the sequential steps for this subtask visually. The "video" was the most effective source in helping users to complete the subtask T2. The "lab assistant" and the "web" were the most useful help sources in completing the subtask T5 "change TOC display levels to 4." Subtask T5 was indicated earlier to be the most difficult subtask, as more than 50% of participants did not achieve even partial completion of this

subtask. One feature that these two help sources (“Web” and “lab assistant”) share in common is a high interactivity level, which facilitates handling vague help requests from the users. The “reference book,” however, did not provide a superior performance in any single subtask completion. One possible explanation of the variations in subtask completion with different help sources is the user’s ability to define the encountered problem. Van der Meij (1996), in describing the stages of problem solving, explained the impact of the level of ease users face in defining an encountered problem on users’ decisions to select a source from which to seek help. With a clearly defined problem, such as “locating the TOC function in Microsoft Word,” users can define their help request easily, and proceed in a straightforward way to locate the information. However, with an ill-defined, more ambiguous problem, users may experience difficulties in defining what to look for, which in turn results in a difficulty in clearly expressing the help request. As a result, users need to turn to a help source that supports their attempts to express the need for help in their situations in a vague but more interactive way. Therefore, it is not surprising that, with the flexibility of interaction using natural language afforded by the “web” and “lab assistant” sources, T5 was more likely to be accomplished successfully by users’ seeking help from these two sources.

The feedback on the immediate task-performing behaviors after seeking assistance from a particular help source had some impact on participants’ evaluations of the help-seeking effort. The analysis of the effectiveness of the help sources for assisting with subtask completion was compared with users’ self-reported usefulness of each help source. Findings in RQ2e investigated the effective rate for each help source, which was ascertained by the observed success of each help source in leading to the accomplishment of the subtasks. Participants’ self-reported evaluations of the usefulness of each help source were obtained at the end of the lab

session, based on the participants' subjective judgment. Table 23 lists the effective rate and the perceived usefulness values for the five help sources based on the order from high to low in effective rate.

Table 23 Effective Rate and Self-Reported Usefulness of Five Help Sources

Help Source	Effective Rate (0 – 1)	Usefulness (1 – 5)
Lab Assistant	.93	4.62
Video	.54	4.38
F1 help	.40	3.13
Web	.27	3.57
Reference Book	.25	2.67

Table 23 suggests that the effective rate and the user's evaluation of the usefulness of help sources corroborate with each other. Both the "lab assistant" and "video" received a high rating of usefulness from the participants, as well as the observed highest effective rate, whereas the "reference book" got the lowest reported value and observed effective rate. Participants' rankings and observed rates of both the "F1 help" and "Web" were better than those for the "reference book," but not as good as those for "lab assistant" and "video." Although the "F1 help" had a lower rank than the "Web," "F1 help" had a higher effective rate than the "Web" did. Therefore, the finding that the two measures were consistent suggests that the users' evaluation of a particular help source is indeed based on and influenced by the actual contribution users receive from the source toward the completion of the task.

RQ3: Summary and Discussion

RQ3, derived from the help-seeking factors model, examined how different help-seeking variables related to both personal factors (RQ3a) and outcome measures (RQ3b). The researcher found several important findings. Regarding the individual differences in the help-seeking process and the use of help sources, participants' software efficacy level was inversely related to

the time spent on help seeking; participants who were anxious about computer use tended to turn to a non-computer based help source to seek assistance. Regarding the effect of help-seeking behaviors on task outcomes, participants' engagement in help-seeking, in terms of the frequency and time spent, showed a connection with the total time spent on the entire process. More engagement in seeking assistance prolongs users' whole time spent on the task completion process. In addition, participants who used the "reference book" had lower task scores, compared to those who did not use the "book" source. Finally, the effective rate by observation for each help source was consistent with participants' self-reported usefulness of each help source, which demonstrates that the preference for a particular help source at the end of session is dependent upon the effectiveness of the help source in furthering task accomplishment in the process.

In contrast with the identified significant associations, many associations were found to be not statistically significant. First, gender and prior experience using Microsoft Word were not found to be associated with any help-seeking variables and outcome measures, although earlier research had identified these two factors as having an impact on certain help-seeking strategies and task performance. Two possible reasons may explain the non-significant relationships in this study. First, the contexts in which the earlier studies have identified significant associations are different from this study's. Gender differences and the impact of prior knowledge on help seeking were primarily identified in traditional classroom settings, which focused on human-human interaction only (Butler, 1998; Newman & Goldin, 1990; Newman & Schwager, 1995; Ryan et al., 1998). Thus, the observed impact of gender and prior experience on help-seeking behaviors in previous studies cannot be simply transited to this new context. Second, as an exploratory study, this study operationalized complex help-seeking behaviors into several variables. The unidentified gender difference or the influence of prior experience may not be

reflected in the examined help-seeking variables in this study, but exists in other perspectives of users' help-seeking behaviors. For example, the gender of the "lab assistant" in this study may influence users' decision to ask for help or not. A previous study (Harris & Michell, 1986) found that the gender of a human helper might be a potential factor affecting individuals' help-seeking behavior, in that the gender of the librarian impacted library patrons' choice of seeking help or not.

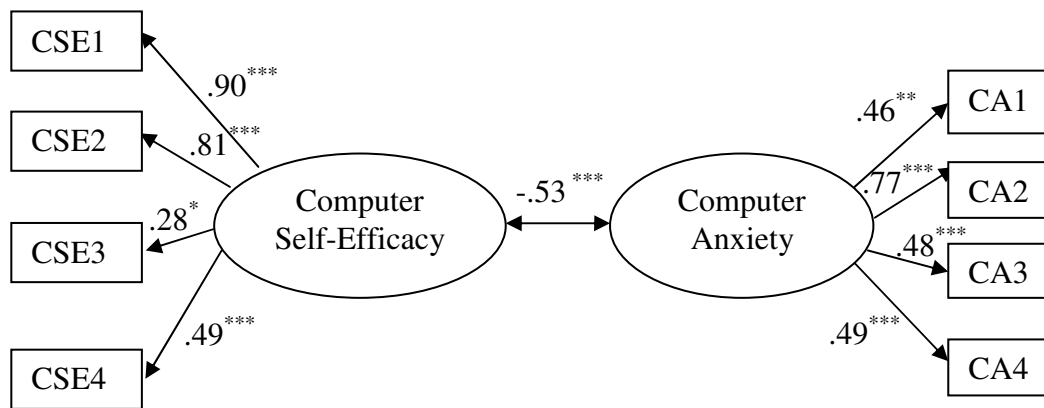
In addition, task score was not related to help-seeking frequency or time spent on help seeking. This is an unexpected finding, because the purpose of seeking help is to accomplish the task. This discrepancy between help-seeking effort and task completion suggests that the action of seeking help may not necessarily guarantee a good task accomplishment. What matters in effective help-seeking behaviors may be the users' cognitive efforts devoted to understanding the help content and employing the information in task-performing behaviors. The observations in help-seeking behaviors certainly raise more questions and open new research avenues for investigating help-seeking behaviors and users' mental activities.

RQ4: the Help-Seeking Structural Model

RQ4, derived from the task-evoked, help-seeking structural model, investigates all the relationships among the variables in the entire model simultaneously. The structural model focuses on help-seeking effectiveness: how personal factors affected task performance, mediated by help-seeking effectiveness.

To examine the construct validity, the measurement for the model was first analyzed by performing the confirmatory factor analysis (CFA). The CFA examined the construct validity of the two latent variables, "Microsoft Word efficacy" and "computer anxiety." Gender is a self-explanatory variable; help-seeking effectiveness and task performance were calculated from

observational data; prior experience with Microsoft Word was represented by a single number of self-reported familiar functions in Microsoft Word. Thus, these constructs were not tested using CFA. Figure 18 illustrates the results of CFA from Amos software with the loadings coefficients of indicators for the two constructs.



Note: all the coefficients are completely standardized.

* $p < .05$. ** $p < .01$. *** $p < .001$.

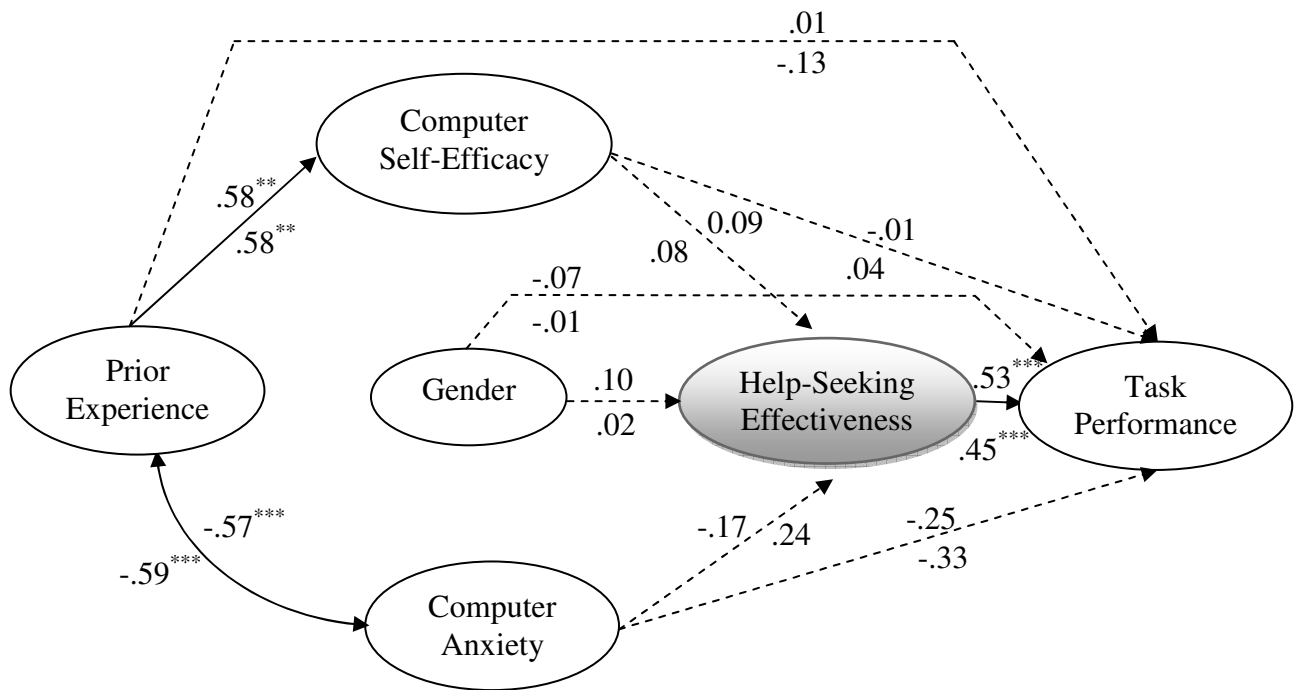
Figure 18. Measurement model (N = 62)

Several goodness-of-fit indices, including a Chi-square test, Normed Fit Index (NFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square of Approximation (RMSEA), were computed to examine the measurement model fit. The CFA model was well-fitted in the data set: $\chi^2 (19) = 23.56$, $p > .05$, NFI = .81, CFI = .95, TLI = .93, RMSEA = .06. The items in the scales were all loaded significantly in the construct, so all items were retained in subsequent analysis, although the loading value of item CSE3 is small (0.28). In addition, computer self-efficacy was inversely associated with computer anxiety ($r = -.53$). This finding is consistent with the literature about the inverse relationships between the two variables. In all, the results of the CFA suggested that the scales used in this study measured the two constructs well.

After fitting the measurement model, structural equation modeling was performed to examine the path coefficients. As illustrated in the task-evoked help-seeking structural model (Figure 5), the construct of “help-seeking effectiveness” was measured by two variables: help-seeking success rate and help-seeking efficiency. The two variables are in a perfect correlation ($r = 1, p < .01$). Therefore, either variable is a good measure of help-seeking effectiveness. Two structural models, using the two variables respectively were examined. Table 24 shows the goodness-of-fit indices for the two models. The two proposed models fit well with the data set, based on these goodness-of-fit statistics. Figure 19 illustrates the two models with the standardized path coefficients in the models. The coefficient values in the model of “help-seeking success rate” are shown above each arrow; the coefficient values in the model with “help-seeking efficiency” are shown below each arrow.

Table 24 Goodness-of-fit Indices for Two Structural Models

Model	$\chi^2 (48)$	p	NFI	CFI	TLI	RMSEA
Help-seeking success rate model	58.34	0.146	0.73	0.93	0.91	0.06
Help-seeking efficiency model	59.70	0.120	0.72	0.92	0.89	0.06



Note: all the coefficients are completely standardized. Dotted lines represent insignificant path coefficients. Solid lines indicate significant coefficient results.

** $p < .05$. ** $p < .01$. *** $p < .001$.*

Figure 19. Structural model (N = 62)

It must be noted that the sample size (N = 62) is small for SEM analysis. The small sample size may lead to the overestimation of model fit indices and the results for the test of the model may not be reliable. For the explorative purpose of this study, the results can still provide some valuable information and provide potential suggestions for further studies.

RQ4a: Impact of Personal Factors on Help-Seeking Effectiveness

The three personal factors – gender, computer self-efficacy, and computer anxiety – did not yield the expected significant effects for help-seeking effectiveness in both models. In other words, whether a user's help-seeking behavior is effective or not is not influenced by these four

personal characteristics. However, the results in RQ3a (relationships between personal factors and help-seeking behaviors) showed that CSE and CA were associated with certain help-seeking behavioral variables, such as time spent on seeking help or the use of the “reference book.” The impacted help-seeking variables in RQ3a are the indications of the help-seeking process. Help-seeking effectiveness in RQ4a is the result of the help-seeking process. Therefore, the findings for RQ3a and the findings for the structural models in RQ4a indicate that CSE and CA may not have direct impact on the result of help-seeking process, but may have influence on how the final outcome of help-seeking effectiveness is achieved. In addition, gender does not seem to be an impacting factor on either the process to achieve effective help-seeking or the final help-seeking effectiveness.

Both models showed that prior experience had a significant positive effect on computer self-efficacy, and prior experience was also inversely related to computer anxiety. However, the insignificant paths from CSE and CA to help-seeking effectiveness indicate that prior experience may not have influence on help-seeking effectiveness through the effect of two mediating factors. As with the findings about gender effect, prior experience does not influence the help-seeking process or the help-seeking effectiveness. The two significant paths (prior experience → computer self-efficacy and prior experience ↔ computer anxiety) were consistent with Bandura’s discussion (1977) about the formation of self-efficacy, and with the computer self-efficacy framework by Marakas, Yi, and Johnson (1998). Bandura (1977) stated that the strongest source influencing self-efficacy formation was performance accomplishment. Previous successful task accomplishment, representing personal experience with a particular task or environment, has been shown to increase individuals’ expectations for accomplishment for similar tasks or in similar environments. The computer self-efficacy framework also supports the

same claim. In addition, the anxieties experienced by computer users may be relieved through gaining more experience working with the software. Being consistent with results in earlier studies, the inverse relationship between these two factors was observed in two models.

RQ4b: Impact of Help-Seeking Effectiveness on Task Performance

Importantly, help-seeking effectiveness in terms of the success rate or efficiency had directly positive effects on task efficiency, meaning that effective help-seeking indeed improves task performance. The results demonstrate that the positive impact of help-seeking effectiveness on task performance is supported in this computer task accomplishment setting, and confirm that effective help-seeking is a useful problem-solving strategy for coping with current difficulty. Thus, this finding provides support for continuing the line of research in studying help-seeking behaviors and how to develop effective help-seeking in order to improve task performance in this particular HCI context.

RQ4c: Impact of Personal Factors on Task Performance

The insignificant path coefficients from four personal factors in relation to task performance suggest that the four personal factors are not predictive factors for users' task performance. Although literature suggests the direct influence of the four personal factors on task performance, the expected influence was not identified in this study's context. The possible explanation for the discrepancy is the task difficulty and task familiarity for the users. The task employed in previous studies was either a simple task or a task that required using participants' familiar features in a system. For example, Imhof, Vollmeyer, and Beierlein (2007) required the participants to redesign slides using PowerPoint software. The task included simple operations, such as changing font size or reformatting text styles. However, the task assigned in this study is a novel task for participants, which requires participants to explore and use features in the

software system they have never used before. Users lack the knowledge and skills to accomplish the task, because of the novelty of the task. Thus, prior experience with the software or self-perceived confidence in using the software does not have a direct impact on how users finish the new task and the resulting task performance. The expected gender differences are also diminished in the novel task accomplishment setting. Users' general computer anxiety did not show a significant influence on performance, meaning that users' anxious feelings toward computer use that are assumed to impact their deliberate off-task thoughts did not influence task accomplishment. Even users with a low level of computer anxiety may also have lower task performance in a challenging task accomplishment setting. The results suggest that there is no direct impact of gender, prior experience, efficacy, or anxiety on the task performance as measured by task efficiency in a novel task setting.

RQ4: Summary

Help-seeking effectiveness does not act as a mediating factor between personal factors and task performance in this study. Personal factors are not predictive factors for task performance either. Effective help seeking, however, is shown to have a direct impact on task efficiency. The insignificant influence of personal factors on effective help seeking shows that the individual differences do not impact the outcomes of help-seeking behaviors as measured by help-seeking effectiveness, but may influence the process to achieve the effectiveness.

Chapter 6

Conclusions and Recommendations

Chapter 5 presents the detailed findings and discussions for the four research questions proposed in Chapter 3: (1) the process of how users seek help; (2) how users use different help sources; (3) how help-seeking behaviors relate to personal factors and task outcomes, and (4) the role of help-seeking effectiveness between personal factors and task efficiency. This chapter reports the conclusions and discusses the implications of the study.

The first section of this chapter summarizes the findings of this study. The second section examines the limitations of this study. The third section discusses the overall research value of this study, regarding its contributions to our knowledge of help-seeking studies in the HCI context, followed by a section discussing the practical implications for system design. The last section proposes several directions for future research.

Summary

Help-seeking in various HCI contexts has attracted considerable attention. Help-seeking behavior is difficult to examine, because it involves a variety of factors (e.g., individual characteristics, the task features, the computer system, and the features of help sources) and the ongoing interactions among all these factors. Thus, the design of effective help systems is important, in order to support users in carrying out the task efficiently. However, the results from earlier studies about help-seeking behaviors were limited to a level of analysis which examined the behaviors from a general and broad sense, such as simplifying the help-seeking as seeking help or avoiding help. In the absence of comprehensive knowledge of help-seeking behaviors at an in-depth level, this limited understanding of help-seeking behaviors yields insufficient insights on help-seeking phenomena, as well as limited indications of how to improve the design

of help features, in order to assist users effectively. In addition, if the design of any software needs to be attuned to users' help-seeking patterns and strategies, the first step is to understand users' help-seeking behaviors and their potential relationships with personal factors and task performance. To fill the gap, this study examined users' help-seeking behaviors within the context of computer task accomplishment, based on Nelson-Le Gall's Help-Seeking Process Model (1981) and Marchionini's Information-Seeking Process Model (1997). This was an exploratory study to investigate users' help-seeking behaviors as well as relevant personal factors and outcome factors. The researcher identified distinct help-seeking strategies, patterns, and significant relationships between varied help-seeking practices and relevant factors.

Users show different degrees of interaction with external help sources during the task completion process. Some users are more active in seeking help from external sources than others, in the problem-solving situation. These active help-seeking users tend to seek help earlier, interact with external help sources more frequently, and spend more time on seeking help. Users, who are less active in seeking help, rely more on their own efforts to explore the system and work out the problem. Users also adopt different approaches when starting a challenging task in a problem-solving situation. Some tend to rely on their own efforts in working on the task first, whereas others tend to seek external assistance immediately. A user's starting approach in the problem-solving situation is indicative of his or her tendency to begin seeking help, but it does not indicate users' subsequent efforts in help-seeking, in terms of frequency and time spent on help seeking.

In addition, the features of help sources affect users' behaviors when using help sources. Users apply different help request strategies to different sources and show different patterns in using these sources during the process. Two help source features were investigated in this study:

(1) electronic help sources respond to users' help requests faster than non-electronic sources and provide quick feedback, and (2) highly interactive help sources provide more flexibility for users to formulate their help requests than sources with low interactivity levels. The help-seeking pattern in using electronic sources shows that users who choose electronic help sources, tend to repeatedly use electronic sources during the task session, but spend only a short period of time on using these sources. On the other hand, users who select non-electronic help sources tend not to repeatedly use the same source during the task session, but instead spend more time in seeking help from these sources. In addition, vague help requests are usually submitted to the most interactive source – the human helper – in the very late stages of the session. Furthermore, users' help-seeking strategies change across subtasks. The adjustments include the selection of a high or low interactivity-level source, and the preparation of a general or specific help request, depending on the task encountered. Users usually prepare general help requests at earlier stages of the task session. As users acquire a better understanding of the task requirement, they use more specific requests later in the session. Considering the sequential pattern of help source use, users' primary help-seeking strategy is to stay with the same source they used in a previous help-seeking period, or to stick to the same help source media types or the source with a similar interactivity level.

To some extent, users' help-seeking behaviors are related to their personal characteristics. Users' computer self-efficacy in using particular software does not inhibit their actions to seek help while performing a task. But, high efficacy users tend to spend less time on seeking help. Users with high computer anxiety prefer non-electronic help sources. Neither gender nor prior experience with the particular software has a significant impact on how users seek help or users' behaviors in using help sources.

In addition, task outcomes are related to users' help-seeking behaviors. In general, a user's effort expended on help seeking is indicative of his/her effort applied to the whole task completion process. The more frequently a user seeks help, and the more time given to seeking help, then the more the time is spent on the task process. Specifically, users' success in completing a specific subtask is related to the type of help sources that are selected. The electronic sources "F1 help" and "Web" are effective for assisting users to locate a certain function in the software. The "video" source, that shows step-by-step content, is helpful for a procedural task. Human help is particularly useful in situations where users have only vague thoughts about defining and describing the problem.

Finally, the four personal factors do not directly influence help-seeking effectiveness, nor do they directly influence task performance. Importantly, effective help-seeking does lead to better task performance. Therefore, help-seeking effectiveness does not emerge as a mediating factor between individual differences and task performance.

Limitations of the Study

As with any empirical research, this study has limitations that should be addressed. First, there are some methodological limitations. This study was conducted in a lab setting, to simulate a real-life task-accomplishment setting. However, the lab setting is likely to impact participants' choice of using a particular help source. For example, the role of "lab assistant" in this study was filled by the researcher, who was a stranger to the participants in this study. In real life, users may be more willing to ask for a friend's help. In addition, the software used in this study was Microsoft Word, a general software package that does not require knowledge of a particular domain in order to use it. Thus, the findings from this study may be applicable to similar software environments for the purposes of task accomplishment, but the results are not meant to

be generalized to specific professional software environments, or to real-life situations.

Participants in this study were recruited from undergraduate students, so data and results may be skewed regarding the characteristics of this young adult group, such as having similar levels of prior experience with Microsoft Word, and familiarity with Internet search engines.

Second, this study primarily observed users' behaviors during the task process without soliciting their thoughts and emotional responses. Thus, it is difficult to interpret certain behaviors. The findings need to be enhanced and validated by understanding the thoughts and feelings underlying users' help-seeking behavior. The pilot test of the research design showed that soliciting verbalization while performing a challenging task, would cause cognitive overload. The participants in the pilot test mentioned in the exit interview that they felt too distracted to talk about their thoughts when they were paying close attention to the task. The alternative to concurrent verbalization is to conduct a retrospective interview with the participant, by showing him/her the replay of the session. This study did not perform post session interviews with replay due to the time constrain.

Third, this study examined help-seeking behaviors within the context of task accomplishment to a limited extent. Particularly in the sequential analysis of help source moves, the analysis took out task-performing behaviors from the interaction process and instead focused on help source selection only. The cross-influence between help-seeking and task-performing was not examined in this study, but certainly these two behavioral activities influence each other.

Fourth, as an exploratory study, this research included four personal factors related to computer task accomplishment situations. Decisions about selecting factors are a trade-off between being comprehensive and being more focused. With the purpose of exploring an under-examined context, this study focused on a narrow area in which the researcher chose factors that

were assumed to have more potential effects on help seeking. Certainly, the findings need corroboration from future research.

Finally, the measurement of participants' prior experience with Microsoft Word and computer self-efficacy (CSE) could limit the identifications of significant impacts of personal factors on help-seeking behaviors and task performance. The small loading value of item CSE3 in RQ4 indicates low convergent validity on the construct of efficacy. In addition, the items in the measurements of prior experience and efficacy were lists of general Microsoft Word functions, not related to the functions required by the particular task in this study. For better examination of the relationship between personal factors and help-seeking behaviors/task outcomes, future study is needed to develop and validate the measurements for personal factors that are task-relevant.

Research Value of the Study

This study makes contributions to the knowledge base of help-seeking literature, and provides a basis for researchers to expand the findings, illuminating possible directions to extend the study.

First, help seeking in HCI has been mostly studied in computer-assisted learning settings and information retrieval settings. This exploratory study examined computer users' help-seeking behaviors within an under-explored HCI context – solving an unfamiliar computer task. Results of this study add to the existing knowledge of individuals' help-seeking behaviors in this less-studied but commonly encountered scenario in HCI. In addition, the study provided five help sources to simulate possible help source choices that are usually available in real-life situations. The availability of different help sources, which differ from each other in terms of the source type and interactivity level, makes it possible to observe computer users' varied help-

seeking behaviors when using each source, formulating help requests, spending effort on different help sources, and making selections among different help sources. More importantly, the findings explore the interactions among the features of the help sources, the characteristics of the completed subtask (e.g., difficulty level), and corresponding help-seeking activities. In all, findings in this study enhance previous research about help-seeking behaviors by examining a new HCI context, comparing help-seeking behaviors using different help sources, and exploring how help-seeking behaviors are possibly influenced by help source features and tasks.

Second, this study examined different help-seeking behavioral activities. Few studies in the literature have analyzed help-seeking behaviors at this in-depth level. Results of this study provide a starting point or a base for further studies. The measures of help-seeking behavior variables can be refined and supplemented in future studies to be adapted to other research questions of interest. The detailed analysis of the help-seeking process and help source use can stimulate future studies for the examination of the impact of the various features of help systems on the different help-seeking activities. Further, findings in this study can inspire future quantitative studies in a more controlled setting with hypothesis testing, to move forward from the descriptive study to an explanatory study.

Third, this study examined help-seeking behaviors together with relevant personal factors and task outcomes, and moved further to explore the possible relationship among these three factors in a structural model. Previous studies treated help-seeking behaviors either as independent variables to influence learning or task outcomes, or as dependent variables to be influenced by certain personal factors. This study included all three in one study and particularly situated help-seeking behaviors as a middle factor between individual differences and outcome measures. The exploration of help-seeking behaviors as a mediating factor expands the body of

knowledge about how individual differences lead to varied task outcomes, through the effect of help-seeking behaviors in the HCI context. Results from the structural model can inspire quantitative studies with additional theoretical support, to examine the mediating role of particular help-seeking aspects, between personal factors and final performance outcomes.

Fourth, this study demonstrates the possibility of analyzing the behavioral data in a sequential manner for the purpose of examining the iterative nature of the help-seeking process. The sequential analysis mainly focused on the transitions that occur in the sequential selection of help sources. This analysis technique makes methodological contributions for future research to adopt sequential analysis in help-seeking related studies within the context of HCI.

Practical Implications

Mathews and his colleagues (2000) propose that the help system should facilitate users' accomplishment of a particular task that he or she currently does not know how to do. This study provides valuable and relevant findings within the context of users' completion of an unfamiliar task. The detailed description of users' help-seeking behaviors, and the examination of related personal and outcome factors, can be used to guide the system design, particularly for providing effective assistance supporting users' ongoing task completion processes.

Delisle and Moulin (2002) mentioned that a help system should be an active system, which constantly monitors users' actions and provides assistance in a proactive mode, rather than a passive mode. Findings about users' varied tendencies to seek assistance in a problem-solving situation can provide suggestions in designing an active help system. Some users tend to seek help earlier, whereas others will be stuck in self-exploration of the system for a long time before seeking help. An active help system should have the capability to detect users' activities and provide timely assistance. Thus, system-initiated signals or messages as external triggers in a

help system can be designed in a way to help users quickly become aware of a potentially difficult situation and motivate them to seek assistance. As a result, providing system-initiated signals can reduce users' self-monitoring activity by prompting them to seek assistance.

However, some issues, such as when to offer the alert, and what alert content to provide that will not be too intimidating to users or overly intrusive on the current task, require more research. But the alert usually needs to be provided in a context-sensitive format, and in task-based settings. Thus, the active help system should also have the capability for task modeling (Shneiderman, 1998; Sullivan & Tyler, 1991). The help system needs to continuously observe user' actions to make inferences about the goals the user is pursuing. As a result, the system is able to issue contextually relevant and beneficial signals to motivate users to seek help.

Second, users' varied behaviors in using different help sources, such as the repeated use of certain help sources, types of help requests, and time spent on using the source, provide several design suggestions for different help sources. "F1 help" and "Web" sources were shown to be used most frequently and repetitively by users, but the time spent on these two help sources was the shortest among the five sources. The help source moves before the completion of the subtasks also showed that participants were repeatedly using "F1 help" or "Web" many times until they achieved a successful completion of the subtasks. The repeated use of these two sources, until the successful completion of the task, resulted in a low effectiveness rate for these two sources. Combining all the findings, it seems that users seek help from electronic help sources in a quick manner, but possibly do not pay enough attention, read carefully, or adequately comprehend the help information obtained from the sources. Software documentation, regardless of whether it is provided by the software company or third party, often includes lengthy texts and technical terminologies, which makes the contents difficult to find and

difficult to understand for the users. This study shows that (1) users' requests to "F1 help" are usually constrained to using technical vocabularies and (2) most information content from "F1 help" and "Web" help sources are long texts in paragraphs. To help users effectively locate and understand the information, the help system can be improved by (1) providing a natural language interface to allow users to create queries in natural language, and (2) providing short textual contents, organizing texts into more easily absorbed chunks or in bullet points, highlighting important words, or providing captured screenshots, to catch users' short attention spans.

Third, users' help-seeking behaviors related to the "reference book," in terms of frequency of use, the amount of time spent on the source, and having the lowest effectiveness rate, imply that users are less likely to use this source, and that the use of this non-electronic help source with static help content is unproductive. Help system designers may need to avoid using low-interactivity sources with static contents. The frequent use of the "video" help source and its high effectiveness rate in assisting users to accomplish the procedural subtasks, support the provision of multi-media formats of help content in a help system. Maybury (1993) has investigated the use of multimedia or multimodal interfaces to support users-system interactions. Particular projects utilized different media formats (e.g., voices, animation, natural language) to provide explanations or procedural instructions (André & Rist, 1993; Feiner & McKeown, 1993; Goodman, 1993; Maybury & Wahlster, 1998). Similarly, findings in this study also indicate that the visual demonstration of the steps involved in accomplishing a task, in the format of a video or flash, can assist users to effectively finish a procedural task. However, the "video" source is not a highly interactive source, so that users usually interact with the "video" source by using the sliding bar on the time scale to search for relevant information. To increase the interactivity level of the "video" source, the developer of "video" help can consider designing searchable "video"

help, or creating “video” sources with indexes to assist users in locating information more efficiently. In addition, the “lab assistant” was shown to be the least-used source, yet it also had a high effectiveness rate, and was perceived as the most useful source. Help requests to the “lab assistant” showed that users’ need to define their problem through highly interactive communication. Therefore, providing a virtual expert support or dialog support is necessary to encourage users to seek help from a virtual human agent. The virtual agent entails a lower psychological cost than getting assistance from an actual human being, while retaining the flexibility to express the help request in natural language.

Fourth, the examination of the effective help sources used to complete one or more subtasks provides an account regarding what type of task is better accomplished by a help source with particular features. Simple tasks such as locating an existing function in the software were found to be effectively assisted by electronic and interactive help sources. Users can simply formulate the request into keywords or terms to search in the help system to find the answers. Procedural tasks such as requiring a sequence of actions are better assisted by a visual format of demonstration by showing the step-by-step instructions. The reason that participants made no progress on certain subtasks is either that these participants were not aware of the necessity to perform the task or they gave up on performing the task. The help system can actively make suggestions to match with the working task, which can be inferred through the detection of users’ ongoing interactions with the system. The help mechanism can prompt a message to raise users’ awareness and assist users in formulating their help requests. The message should be offered in an unobtrusive way to inform users about the possible problems, and list options for users to choose one to proceed or ignore. In this way, the help system reduces users’ self-monitoring

process of being aware of possible problems, and motivates users to stay on the task completion rather than simply giving up.

The findings from the examination of relationships among personal factors, help-seeking behaviors, and outcome measures also provide implications for system design. System design to adapt to users – user modeling – has been a major research topic in the HCI field. Similar to task modeling in the help system, user modeling in the help system can initiate interactions with the users when the help system identifies the opportunity to do so (Delisle & Moulin, 2002). In this study, participants' time spent on help seeking during the whole process may be a possible mediating factor between efficacy assessment and session length. Computer users' efficacy judgment was inversely related to their time spent on interacting with external help sources, and the interaction with help sources positively relates to the individuals' total time spent on the task. A practical implication from this finding is to design adaptive help systems to detect users' ongoing interactions with the current task. For example, by identifying unsuccessful task completion after a user spends time seeking help from a help source, the dynamic help system can actively provide hints or tips to alert users for the possible options to move forward on the current task, so as to avoid spending too much time without successful progress on the task. Anxious users tend to turn to a non-computer based help source to seek assistance. This finding suggests that a help system with a friendly and less intimidating interface can invite and motivate users, even those with high computer anxiety, to interact with it to seek assistance. The system's responses can be tailored to offer friendly and relevant assistance at the appropriate level of explanation, using vocabularies adapted to users' attitudes, knowledge, and beliefs.

Finally, consistent results were found regarding the effectiveness of the five help sources from observational data and participants' self-reported data. This finding shows that users' final

evaluation of a particular help source is dependent upon the effectiveness of the help source in furthering task accomplishment. Although users repetitively used certain help sources during the session, users evaluated these sources as not very effective at the end. Thus, users choose a particular help source during the session but may not perceive it as useful. From the system designer's perspective, a particular help source needs to be designed in a way to encourage and motivate every user to try it, even those users who may not have had a preference toward the source before. Second, the order of effectiveness of the five help sources, from highest to lowest was: "lab assistant", "video", "F1 help" and "Web", followed by "reference book." This finding was also consistent with the findings from the study by Hills, et al. (2000), which found that users prefer specific, visual help with demonstrations, rather than general, textual help with descriptions. The practical implication from this finding is to inform the design of help systems to provide different formats of help access, with varied presentation styles, using a highly interactive mode.

Future Research

The researcher is aware of the limitations of this study and has kept an open mind for several directions for future studies. As has been pointed out, there are several methodological limitations. Further work with a more heterogeneous group, including high school students, graduate students, adults, elders, or professionals, will help to establish the generalizability of these findings. Additionally, findings from this study provide a starting point to call for further research to investigate help-seeking behaviors in various software environments and to explore the adoption of different methods (e.g., a field study) to illuminate users' real-life activities.

It has been mentioned that post-session interviews were not employed in this study. In future studies, it would be worthwhile to extract users' cognitive and affective thoughts to

complement the observed help-seeking behaviors. Particularly, future research should incorporate such interviews with participants on selected segments of the process. To add this to data collection will require identifying the segments to be interviewed during the session. A second lab administrator will be helpful.

Furthermore, additional analysis can be performed to identify the interplay between help-seeking behaviors and task-performing behaviors. Understanding the interactions between the two types of behaviors will help to investigate how specific help-seeking behavior assists in task completion. In addition, Xie and Cool (2009) recommended that “the specific relationship between task and help-seeking is a fruitful area for future research” (p.489). Therefore, future studies focusing on the impact of different types of tasks on help-seeking behaviors, as well as the interaction between these two behavioral activities, are needed.

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Appendix

Appendix A – Approval from Director of Communication Studies for Students Recruitment

Haas, John W

To: Wang, Peiling

Cc: Wu, Lei

Peiling:

Lei Wu has approached me about using CS 210 for her dissertation. We have met to discuss the matter and I approve of her use of CS 210 students for collecting dissertation data.

If you have any questions, please feel free to contact me at 4-2090.

Thanks

John

Appendix B – Consent Form

INFORMED CONSENT STATEMENT

Individuals' Problem-solving Behaviors in Computing Environment

You are invited to take part in a research study of how college students solve problems in computing environment. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to learn how individual factors influence personal problem-solving behaviors in computing environment.

What we will ask you to do: If you agree to be in this study, you will first fill out electronic surveys pertaining personal data, self-efficacy, and anxiety. Then you need to accomplish a task using Microsoft Word in 30 minutes. Your participation is voluntary. You can give up the task at any time during the experiment. With your permission, we would like to record your interactions with the computer system.

Risks and benefits:

There are not any anticipated risks to your participation in this study. All data generated from this study will be kept confidential. Only the researcher has access to the collected data. The data will be erased from lab computers after the data is saved on the researcher's office computer. You will be given a name that is different from your real name to protect your confidentiality.

Benefits include implications on software design and suggestions on training and educational settings to help individuals with different personal characteristics to seek help and accomplish computer tasks more effectively.

Compensation: You will receive extra credits in "Public Speaking" class for participating in this research project. The instructor will assign credits according to class policy.

Your answers will be confidential. The records of this study will be kept private. Only the researcher will have the access to the collected data. The researcher will assign a pseudo name to you so your real name will not be given to anyone. In any sort of report the researcher make public, it will not include any information that will make it possible to identify you. Research records will be kept in a locked file cabinet in researcher's office on campus; only the researchers will have access to the records. The interaction recordings will be permanently deleted from lab's computer after transferring to researcher's computer in office. If the interview is audio-recorded, the researcher will delete the recordings from digital recorder after they have been transferred to a password-protected computer in researcher's office.

Voluntary participation: Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide to take part, you are free to withdraw at any time.

If you have questions: If you have questions at any time about the study or you experience problems, you may contact Lei Wu at lwu9@utk.edu or at 865-974-8007 (office) or 865-964-0279 (cell). If you have any questions or concerns regarding your rights as a subject in this study, you may also contact Brenda Lawson at the University of Tennessee, Office of Research by email at blawson@tennessee.edu, or by phone at (865) 974-7697. You will be given a copy of this form to keep for your records.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____ Date _____

Your Name (printed) _____

In addition to agreeing to participate, I also consent to having my interaction with computer system and the interview recorded.

Your Signature _____ Date _____

Signature of person obtaining consent _____ Date _____

Printed name of person obtaining consent _____

This consent form will be kept by the researcher for at least three years beyond the end of the study and was approved by the IRB on August 18, 2009.

Appendix C – Questionnaire

Part I. Personal Data

1. Your age: _____
2. Your sex: M F
3. Major: _____
4. Years in college: _____

Part II. Prior Experience with Microsoft Word

1. How do you evaluate your skills using Microsoft Word software?

Novice Competent Proficient Expert Master

2. Please choose the Word functions that you are familiar with (choose all that apply):

- ☐ Basic editing
- ☐ Proofreading tools
- ☐ Using borders and colors
- ☐ Working with Tabs and Indents
- ☐ Examining documents in different views
- ☐ Working with margins, pages, and line spacing
- ☐ Adding headers, footers, and page numbers
- ☐ Printing documents
- ☐ Creating numbered and bulleted lists
- ☐ Creating tables in documents
- ☐ Using AutoFormatting to change text attributes
- ☐ Adding document text with AutoText and using special characters

☐ Working with Styles

☐ Adding graphics to a document

Part III. Application-Specific Computer Self-Efficacy for Microsoft Word

For each question, please answer “yes” or “no” first. If your answer is “yes”, please circle a number on a scale from 1 to 10, where 1 means “not at all confident” and 10 means “very confident”. If your answer is no, please go to next question.

1. I believe I have the ability to move a block of text in Microsoft Word.

Yes 1 2 3 4 5 6 7 8 9 10

No

2. I believe I have the ability to manipulate the way a paragraph looks in Microsoft Word.

Yes 1 2 3 4 5 6 7 8 9 10

No

3. I believe I have the ability to add a footnote to a document in Microsoft Word.

Yes 1 2 3 4 5 6 7 8 9 10

No

4. I believe I have the ability to merge information from two documents in Microsoft Word.

Yes 1 2 3 4 5 6 7 8 9 10

No

Part IV. Computer Anxiety

1. I feel apprehensive about using computers.

Strongly disagree Disagree Neutral Agree Strongly agree

2. It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key.

Strongly disagree Disagree Neutral Agree Strongly agree

3. I hesitate to use a computer for fear of making mistakes that I cannot correct.

Strongly disagree Disagree Neutral Agree Strongly agree

4. I have avoided computers because they are unfamiliar and somewhat intimidating to me.

Strongly disagree Disagree Neutral Agree Strongly agree

Part V. Prior Experience with “Table of Contents”

Have you ever used Microsoft Word built-in function “Table of Contents” before?

Yes No

When approximately was the last time you used the function “Table of Contents?”

Yesterday Sometime this week Sometime last week Before last week

Appendix D – Task Sheet

Individuals' Problem-solving Behaviors in Computing Environment

Instructions for Task

A “table of contents” is a list of the parts (i.e. chapters or headings) of a document organized in the order in which the parts appear. Clicking the chapter name or the heading in “table of contents” will directly lead readers to the certain chapter rather than scrolling down pages.

The task requires you to use a **system function** included in Microsoft Word to create a “table of contents” for the sample file named “2009 Oscar Awards Student”. Another file named “2009 Oscar Awards” with finished “table of contents” is stored on the desktop to provide you reference to finish the task. Please do not COPY & PASTE the “table of contents” to your sample file. You have 30 minutes to accomplish the task.

Feel free to go to restroom during the lab session and feel free to use five sources to seek information if you encounter problems:

1. Microsoft Word built-in help system;
2. Microsoft Word reference book;
3. Web: the computer is connected to the Internet;
4. Video clip: two video clips, “TOC_help2003.wmv” and “TOC_help2007.wmv”, show how to create “table of contents” in Word 2003 and Word 2007, respectively. Please choose the correct file version and double click it so the video will automatically open to show the demonstration;
5. If you want to ask questions or get information from the experimenter, please press the bell to issue a signal so the experimenter will come to the room.

If you find that you cannot accomplish the task, you may choose to stop. This will be perfectly acceptable, and you will still receive extra credit in the course. When you finish the task or withdraw from the lab session, please press the bell to signal the experimenter.

Thanks for your participation!

When you are ready to begin, click the red “start” button.

Appendix E – Sample File to create “Table of Contents”

2009 Academy Awards

Overview of Oscar

History of Academy Awards

The Academy Awards, popularly known as the Oscars, are presented annually by the American Academy of Motion Picture Arts and Sciences (AMPAS) to recognize excellence of professionals in the film industry, including directors, actors, and writers. The formal ceremony at which the awards are presented is one of the most prominent film award ceremonies in the world. The Academy of Motion Picture Arts and Sciences itself was conceived by Metro-Goldwyn-Mayer studio boss Louis B. Mayer.

The 1st Academy Awards ceremony was held on Thursday, May 16, 1929, at the Hotel Roosevelt in Hollywood to honor outstanding film achievements of 1927 and 1928. It was hosted by actor Douglas Fairbanks and director William C. deMille. The 81st Academy Awards, honoring the best in film for 2008, was held on Sunday, February 22, 2009, at the Kodak Theatre in Hollywood, with actor Hugh Jackman hosting the ceremony.

Oscar Statuette

Design

The official name of the Oscar statuette is the Academy Award of Merit. Made of gold-plated britannium on a black metal base, it is 13.5 in (34 cm) tall, weighs 8.5 lb (3.85 kg) and depicts a knight rendered in Art Deco style holding a crusader's sword standing on a reel of film with five spokes. The five spokes each represent the original branches of the Academy: Actors, Writers, Directors, Producers, and Technicians.

Naming

The root of the name Oscar is contested. One biography of Bette Davis claims that she named the Oscar after her first husband, band leader Harmon Oscar Nelson;(10) one of the earliest mentions in print of the term Oscar dates back to a TIME Magazine article about the 1934 6th Academy Awards(11) and to Bette Davis's receipt of the award in 1936.(12) Walt Disney is also quoted as thanking the Academy for his Oscar as early as 1932. Another claimed origin is that of the Academy's Executive Secretary, Margaret Herrick(13), who first saw the award in 1931 and made reference to the statuette reminding her of her "Uncle Oscar" (a nickname for her cousin Oscar Pierce)(14). Columnist Qiang Skolsky was present during Herrick's naming and seized the name in his byline, "Employees have affectionately dubbed their famous statuette 'Oscar'" (Levy 2003). The trophy was officially dubbed the "Oscar" in 1939 by the Academy of Motion Pictures Arts and Sciences.

Ownership

Since 1950, the statuettes have been legally encumbered by the requirement that neither winners nor their heirs may sell the statuettes without

first offering to sell them back to the Academy for US\$1. If a winner refuses to agree to this stipulation, then the Academy keeps the statuette. Academy Awards not protected by this agreement have been sold in public auctions and private deals for six-figure sums.

Nomination

Voters

The Academy of Motion Picture Arts and Sciences (AMPAS), a professional honorary organization, maintains a voting membership of 5,829 as of 2007.

Actors constitute the largest voting bloc, numbering 1,311 members (22 percent) of the Academy's composition. Votes have been certified by the auditing firm PricewaterhouseCoopers (and its predecessor Price Waterhouse) for the past 73 annual awards ceremonies.

All AMPAS members must be invited to join by the Board of Governors, on behalf of Academy Branch Executive Committees. Membership eligibility may be achieved by a competitive nomination or a member may submit a name based on other significant contribution to the field of motion pictures.

Rules

Today, according to Rules 2 and 3 of the official Academy Awards Rules, a film must open in the previous calendar year, from midnight at the start of January 1 to midnight at the end of December 31, in Los Angeles County, California, to qualify.(21) Rule 2 states that a film must be "feature-length", defined as a minimum of 40 minutes, except for short subject awards and it must exist either on a 35 mm or 70 mm film print or in 24 frame/s or 48 frame/s progressive scan digital cinema format with native resolution not less than 1280x720.

The members of the various branches nominate those in their respective fields while all members may submit nominees for Best Picture. The winners are then determined by a second round of voting in which all members are then allowed to vote in most categories, including Best Picture.

2009 Awards

The 81st Academy Awards ceremony was held by the Academy of Motion Picture Arts and Sciences (AMPAS) to honor its selection of the best films of 2008 on February 22, 2009, at the Kodak Theatre in Los Angeles, California. The nominees were announced on January 22, 2009, (6) by AMPAS president Sid Ganis and Oscar-winning actor Forest Whitaker at the Samuel Goldwyn Theater in the Academy's Beverly Hills headquarters.(7) The Curious Case of Benjamin Button led the nominations with a total of thirteen while Slumdog Millionaire received ten. The Dark Knight and Milk received eight nominations, and Doubt, The Reader, and Frost/Nixon each received five. WALL-E, the winner for Best Animated Feature, received six nominations, tying it with Beauty and the Beast for the most nominated animated film in Oscar history.

Winners of major awards

Feature Films

Best Picture



Slumdog Millionaire is a 2008 British film directed by Danny Boyle, written by Simon Beaufoy, and co-directed in India by Loveleen Tandan.⁽²⁾ It is an adaptation of the novel Q & A (2005) by Indian author and diplomat Vikas Swarup. Set and filmed in India, the film tells the story of a young man from the slums of Mumbai who appears on the Indian version of Who Wants to Be a Millionaire? (Kaun Banega Crorepati in the Hindi version) and exceeds people's expectations, thereby arousing the suspicions of the game show host and of law enforcement officials.

Slumdog Millionaire was nominated for ten Academy Awards in 2009 and won eight, the most for any film of 2008, including Best Picture, Best Director, Best Adapted Screenplay, Best Film Editing, Best Sound Mixing, Best Cinematography, Best Original Score and Best Original Song. It also won five Critics' Choice Awards, four Golden Globes, and seven BAFTA Awards, including Best Film. Slumdog Millionaire has stirred controversy concerning language use, its portrayals of Indians and Hinduism, and the welfare of its child actors.

Best Animated Feature



WALL-E (promoted with an interpunct as WALL•E) is a 2008 computer-animated science fiction film produced by Pixar Animation Studios and directed by Andrew Stanton. It follows the story of a robot named WALL-E who is designed to clean up a waste-covered Earth far in the future. He eventually falls in love with another robot named EVE, and follows her into outer space on an adventure that changes the destiny of both his kind and humanity.

Walt Disney Pictures released it in the United States and Canada on June 27, 2008. The film grossed \$23.1 million on its opening day, and \$63 million during its opening weekend in 3,992 theaters, ranking # 1 at the box office. This ranks the third highest-grossing opening weekend for a Pixar film as of July 2008. Following Pixar tradition, WALL-E was paired with a short film, Presto, for its theatrical release. WALL-E has achieved highly positive reviews with an approval rating of 97% on the review aggregator Rotten Tomatoes. It grossed \$534 million worldwide, won the 2008 Golden Globe Award for Best Animated Feature Film, and the 2008 Academy Award for Best Animated Feature, and was nominated for five other Academy Awards.

Best Director



Danny Boyle (born 20 October 1956) is a British filmmaker and producer. He is best known for his work on films such as *Shallow Grave*, *Trainspotting*, *28 Days Later* and *Slumdog Millionaire*. For the latter Boyle won numerous awards in 2009, including the Academy Award for Best Director.

Personal Quotes:

"You don't realize it, but often people are frightened of the director."

"I learned that what I'm better at is making stuff lower down the radar. Actually, ideally not on the radar at all."

"I don't want to make pompous, serious films; I like films that have a kind of vivacity about them. At this time of the year you think about awards and if you want to win one you think you should make serious films, but my instinct is to make vivacious films."

"I want my films to be life-affirming, even a film like *Trainspotting* (1996), which is very dark in many ways. I want people to leave the cinema feeling that something's been confirmed for them about life."

Acting

Best Actor in leading role



Sean Justin Penn (born August 17, 1960) is an American film actor and director, who is also known for being a political activist. He is a two-time

Academy Award winner for his roles in *Mystic River* and *Milk*, as well as receiving a Golden Globe Award for the former and a Screen Actors Guild Award for the latter.

Personal Quotes:

"(Discussing Oliver Stone) I think that his basic pig nature keeps him from doing the best of what he ought to do. And it keeps him from being someone I want to run into."

"Hollywood is much more creatively corrupt than it is economically (corrupt). It takes \$1 for them to kill their dreams. Their dreams are worth more than \$1."

"I had a house burn down once, and everything in life burned, except my family, and it was so liberating. I didn't have a bad moment about it. It sort of reinvigorated my interest in a lot of things. I wonder if there should be some kind of anarchy."

"I can never get ahead of the game because of the movies I do."

"You build a cage based on your sense of the truth and your sense of the aspects of the character that need to tell the story. If you've done your job right, which I've had varying degrees of success doing at different times in my life, then you're able to function very freely within that cage."

Best Actress in leading role



Kate Elizabeth Winslet (born 5 October 1975) is an English actress and occasional singer. She is noted for having played diverse characters over her career, but probably best-known for her critically acclaimed performances as Marianne Dashwood in *Sense and Sensibility*, Rose DeWitt Bukater in *Titanic*, Clementine Kruczynski in *Eternal Sunshine of the Spotless Mind*, Sarah Pierce in *Little Children*, April Wheeler in *Revolutionary Road*, and Hanna Schmitz in *The Reader*.

Winslet has been nominated for six Academy Awards and won the Academy Award for Best Actress for her role in *The Reader*. She has won awards from the Screen Actors Guild, British Academy of Film and Television Arts, and

the Hollywood Foreign Press Association, as well as being nominated for an Emmy. At the age of 22, she became the youngest actress to receive two Oscar nominations;(1) at age 33, she is now the youngest actor of either sex to receive six nominations. David Edelstein of New York Magazine hails her as "the best English-speaking film actress of her generation".

Personal Quotes:

In 2002 she had this to say about doing nude scenes: "I like exposing myself. There's not an awful lot that embarrasses me. I'm the kind of actress that absolutely believes in exposing myself."

"I'd rather do theatre and British films than move to L.A. in hopes of getting small roles in American films."

"It's very important for me to make the statement that I am English and just because I've done one really big film, it doesn't mean that I don't want to keep a finger in the fantastic British film industry and do films like this."

About her spur-of-the-moment marriage to Sam Mendes - "We hadn't been planning to do it but we thought it was rather a good idea, so we just did it."

"After Titanic (1997) it would have been completely foolish for me to go and try and top that. I'm an English girl, I've always loved England, I've never felt the desire to leave it for any particular reason. And whilst I'm ambitious and care very much about what I do, I'm not competitive. I also don't want to act every day of my life. ... So it was important to me after Titanic (1997) to just remind myself of why it was that I was acting in the first place, which is of course because I love it."

Best Actor in supporting role



Heath Andrew Ledger (4 April 1979 – 22 January 2008) was an Australian television and film actor. After performing roles in Australian television and film during the 1990s, Ledger moved to the United States in 1998 to develop his film career. His work includes nineteen films, most notably 10 Things I Hate About You (1999), The Patriot (2000), Monster's Ball (2001), A Knight's Tale (2001), Brokeback Mountain (2005), and The Dark Knight (2008).(1)(2) In addition to his

acting, he produced and directed music videos and aspired to be a film director.

Personal Quotes:

"I only do this because I'm having fun. The day I stop having fun, I'll just walk away. I wasn't going to have fun doing a teen movie again.... I don't want to do this for the rest of my life....I don't want to spend the rest of my youth doing this in this industry. There's so much I want to discover."

"I prefer to date older women because they don't try to act older like younger girls but because they try to act younger."

(On playing "The Joker" in *The Dark Knight* (2008)) "The Joker, so far, is definitely the most fun I've had with any character. He's just out of control -- no empathy, he's a sociopath, uh, a psychotic, mass-murdering clown. And, uh, I'm just thoroughly, thoroughly enjoying it. It's just exceeded any expectations I had of what the experience would be like."

"I never had money, and I was very happy without it. When I die, my money's not gonna come with me. My movies will live on - for people to judge what I was as a person. I just want to stay curious."

Best Actress in supporting role



Penélope Cruz Sánchez (born April 28, 1974), better known as Penélope Cruz, is a Spanish actress. She gathered critical acclaim as a young actress for films such as *Jamón, Jamón*, *La Niña de tus ojos*, and *Belle époque*. She has also starred in several American films such as *Blow*, *Vanilla Sky*, and *Vicky Cristina Barcelona*. She is perhaps best known for her work with acclaimed Spanish director Pedro Almodóvar, in *Volver* and *Todo sobre mi madre*. Cruz has been awarded three Goyas, two European Film Awards, and the Best Actress Award at the Cannes Film Festival. In 2009, she won an Academy Award for Best Supporting Actress, a Goya, and a BAFTA for her role in *Vicky Cristina Barcelona*. She is Spain's first female Oscar winner and second-Hispanic actress since 1961.

Personal Quotes:

"The most difficult thing in the world is to start a career known only for your looks, and then to try to become a serious actress. No one will take you seriously once you are known as the pretty woman".

"I'm strong and opinionated. Those qualities brought me a lot of problems since I was a little girl in school, saying 'I don't agree' and fighting with the children. It's part of my curiosity for life".

"There's so much more I want to do. I refuse to get to 50 and wait at home for the phone to ring. In Spain, actresses work until they are old. That's my plan".

"I love Salma Hayek, we've been friends for a really long time. I admire how she has come such a long way and always remained grounded and who she is. She never compromises to follow her vision and she is loyal. Such qualities only mark the great stars".

Appendix F – Post-test

Please rank help sources you have used during your task accomplishment, leaving blank any that you did not use. Rank them from 1 (least useful) to 5 (most useful).

Microsoft Word help system	_____
Reference book	_____
Search the Web	_____
Video	_____
The researcher	_____

Appendix G - Sequences of Interaction with Help Sources (62 participants)

Participant	Sequences
P1(TPF)	T(T3 & T4) → V → T(T1) → V → T(T2) → V → T(T5)
P2(TPF)	T → F1 → T(T3 &T4) → F1 → T(T1) → F1 → T
P3(HSF)	W → T → W → T → W → T → W → T(T3 & T4) → W → T(T1) → W → T → W → T → W → T → W → T → W → T → W → T → W → T → W → T → W → T(T5) → W → T(T2)
P4(HSF)	V → T(T3) → V → T(T4 & T1) → V → T(T2) → L → T(T5)
P5(TPF)	T(T3, T4, & T1) → W → T → W → T → W → T(T5)
P6(HSF)	F1 → T(T3 & T4) → F1 → T → L → T(T1) → F1 → T
P7(HSF)	B → T → B → T(T3) → B → T → B → T → B → T → B → T → B → T → B → T → B → T → B → L → T(T1)
P8(HSF)	W → T(T1) → W → T(T2) → W → T(T3 & T4) → W → T → W → T → W → T → F1 → T(T5)
P9(HSF)	F1 → T → F1 → T(T3) → B → T → F1 → T → B → T → F1 → T → F1 → T(T1)
P10(HSF)	F1 → T(T3 & T4) → F1 → T(T1) → F1 → T(T2) → F1 → T(T5)
P11(HSF)	F1 → T(T3 & T4) → F1 → T(T1) → F1 → T → F1 → T → F1 → T → F1 → T(T2 & T5)
P12(HSF)	V → T(T3&T4) → V → T(T1)
P13(TPF)	T(T3 & T4) → F1 → T → F1 → T(T1 & T2) → F1 → T(T5)
P14(TPF)	T → V → T(T3) → V → T(T4) → V → T(T1 & T5)
P15(TPF)	T(T3 & T4) → W → T(T1) → W → T → W → T → W → T → B → T(T2 & T5)
P16(TPF)	T → F1 → T → F1 → T(T3) → F1 → T(T4) → F1 → T → F1 → T → F1 → T → F1 → T(T1) → F1 → T → F1 → T → F1 → T → F1 → T → F1 → T → F1 → T → F1 → T → F1 → T
P17(HSF)	V → T(T1, T2, T3 & T4) → W → T → W → T → W → T → W → T(T5)
P18(TPF)	T(T3 & T4) → F1 → T(T1) → F1 → T → L → T(T2) → L → T(T5)

P39(TPF)	$T \rightarrow W \rightarrow T(T1, T3 \& T4)$
P40(TPF)	$T \rightarrow F1 \rightarrow T(T1, T2, T3, T4 \& T5)$
P41(TPF)	$T \rightarrow B \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T3) \rightarrow F1 \rightarrow T(T4) \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T$
P42(TPF)	$T(T3 \& T4) \rightarrow B \rightarrow T \rightarrow W \rightarrow T(T1) \rightarrow F1 \rightarrow T$
P43(TPF)	$T \rightarrow W \rightarrow T \rightarrow V \rightarrow T(T1, T2, T3 \& T4)$
P44(TPF)	$T \rightarrow F1 \rightarrow T(T3 \& T4) \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T1) \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow B \rightarrow T \rightarrow F1 \rightarrow T \rightarrow W \rightarrow T(T5)$
P45(HSF)	$V \rightarrow T \rightarrow V \rightarrow T(T3) \rightarrow V \rightarrow T(T4) \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T1) \rightarrow V \rightarrow T(T2) \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T$
P46(HSF)	$V \rightarrow T(T1) \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T3 \& T4) \rightarrow V \rightarrow T(T2) \rightarrow V \rightarrow T \rightarrow L \rightarrow T(T5)$
P47(HSF)	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T3) \rightarrow F1 \rightarrow T \rightarrow B \rightarrow T \rightarrow F1 \rightarrow T(T1) \rightarrow F1 \rightarrow T$
P48(TPF)	$T(T3 \& T4) \rightarrow B \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T1 \& T2) \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T5)$
P49(TPF)	$T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T1, T3 \& T4)$
P50(HSF)	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T1 \& T2) \rightarrow F1 \rightarrow T(T3) \rightarrow F1 \rightarrow T \rightarrow L \rightarrow T(T4 \& T5)$
P51(TPF)	$T(T1, T2, T3 \& T4) \rightarrow L \rightarrow T(T5)$
P52(TPF)	$T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T1) \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T3 \& T4) \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T5) \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W$
P53(TPF)	$T \rightarrow F1 \rightarrow T(T3) \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T4) \rightarrow F1 \rightarrow T(T1) \rightarrow V \rightarrow T(T5)$
P54(HSF)	$B \rightarrow T(T3 \& T4) \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T$
P55(TPF)	$T(T3 \& T4) \rightarrow F1 \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T(T1 \& T5)$
P56(TPF)	$T(T3) \rightarrow V \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T(T1, T2 \& T4)$
P57(HSF)	$B \rightarrow T \rightarrow B \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T3) \rightarrow W \rightarrow T(T4) \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow B \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T$
P58(TPF)	$T \rightarrow F1 \rightarrow T(T1, T3 \& T4) \rightarrow L \rightarrow T \rightarrow V \rightarrow T$

P59(TPF)	$T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T3) \rightarrow V \rightarrow T(T4) \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1$ $\rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T$
P60(TPF)	$T(T3 \ \& \ T4) \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow V \rightarrow T(T1)$
P61(HSF)	$B \rightarrow T \rightarrow B \rightarrow T \rightarrow V \rightarrow T(T1, T3 \ \& \ T4)$
P62(TPF)	$T(T3) \rightarrow V \rightarrow T(T4) \rightarrow V \rightarrow T$

Appendix H - Subsequences of interaction with help sources before a completion of one or more subtasks

Participant	Sequences
P1	V → T(T1)
	V → T (T2)
	V → T(T5)
P2	F1 → T(T3 &T4)
	F1 → T(T1)
P3	W → T → W → T → W → T → W → T(T3 & T4)
	W → T(T1)
	W → T → W → T → W → T → W → T → W → T → W → T → W → T → W → T → W → T(T5)
	W → T(T2)
P4	V → T(T3)
	V → T(T4 & T1)
	V → T(T2)
	L → T(T5)
P5	W → T → W → T → W → T(T5)
P6	F1 → T(T3 & T4)
	F1 → T → L → T(T1)
P7	B → T → B → T(T3)
	B → T → B → T → B → T → B → T → B → T → B → T → B → L → T(T1)
P8	W → T(T1)
	W → T(T2)
	W → T(T3 & T4)
	W → T → W → T → W → T → F1 → T(T5)
P9	F1 → T → F1 → T(T3)
	B → T → F1 → T → B → T → F1 → T → F1 → T(T1)
P10	F1 → T(T3 & T4)
	F1 → T(T1)

	$F1 \rightarrow T(T2)$
	$F1 \rightarrow T(T5)$
P11	$F1 \rightarrow T(T3 \& T4)$
	$F1 \rightarrow T(T1)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T2 \& T5)$
P12	$V \rightarrow T(T3 \& T4)$
	$V \rightarrow T(T1)$
P13	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T1 \& T2)$
	$F1 \rightarrow T(T5)$
P14	$V \rightarrow T(T3)$
	$V \rightarrow T(T4)$
	$V \rightarrow T(T1 \& T5)$
P15	$W \rightarrow T(T1)$
	$W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow B \rightarrow T(T2 \& T5)$
P16	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T3)$
	$F1 \rightarrow T(T4)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T1)$
P17	$V \rightarrow T(T1, T2, T3 \& T4)$
	$W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T5)$
P18	$F1 \rightarrow T(T1)$
	$F1 \rightarrow T \rightarrow L \rightarrow T(T2)$
	$L \rightarrow T(T5)$
P20	$W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T3)$
	$W \rightarrow T(T4)$
	$W \rightarrow T \rightarrow W \rightarrow T(T1)$
P21	$F1 \rightarrow T(T3)$
	$F1 \rightarrow T(T4)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow V \rightarrow T(T1)$
P22	$V \rightarrow T \rightarrow V \rightarrow T(T3)$

	$V \rightarrow T(T1)$
	$V \rightarrow T(T2)$
	$V \rightarrow T(T4)$
	$L \rightarrow T(T5)$
P23	$B \rightarrow T(T3 \& T4)$
	$B \rightarrow T \rightarrow W \rightarrow T(T5)$
P24	$W \rightarrow T(T1)$
	$W \rightarrow T \rightarrow W \rightarrow T(T3 \& T4)$
P25	$V \rightarrow T(T1, T3 \& T4)$
	$V \rightarrow T \rightarrow L \rightarrow T(T5)$
P26	$L \rightarrow T(T3 \& T4)$
P27	$B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T(T1)$
P28	$B \rightarrow T(T3 \& T4)$
P29	$V \rightarrow T \rightarrow V \rightarrow T(T3 \& T4)$
	$V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T1)$
P30	$W \rightarrow T(T1 \& T2)$
P31	$B \rightarrow T(T3 \& T4)$
	$B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T(T1)$
P32	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T3)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T1)$
	$F1 \rightarrow T(T4)$
P33	$B \rightarrow T(T3)$
	$B \rightarrow T(T4)$
	$B \rightarrow T(T1 \& T2)$
P34	$L \rightarrow T(T4)$
P35	$V \rightarrow T(T1, T2, T3 \& T4)$
P36	$B \rightarrow T \rightarrow B \rightarrow T(T3 \& T4)$
	$B \rightarrow T \rightarrow L \rightarrow T(T1 \& T2)$
P37	$W \rightarrow T \rightarrow W \rightarrow T(T3 \& T4)$

	$W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T1)$
	$W \rightarrow T(T2)$
P38	$W \rightarrow T \rightarrow W \rightarrow T(T3)$
	$W \rightarrow T(T4)$
P39	$W \rightarrow T(T1, T3 \& T4)$
P40	$F1 \rightarrow T(T1, T2, T3, T4 \& T5)$
P41	$B \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T3)$
	$F1 \rightarrow T(T4)$
P42	$B \rightarrow T \rightarrow W \rightarrow T(T1)$
P43	$W \rightarrow T \rightarrow V \rightarrow T(T1, T2, T3 \& T4)$
P44	$F1 \rightarrow T(T3 \& T4)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T1)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow B \rightarrow T \rightarrow F1 \rightarrow T \rightarrow W \rightarrow T(T5)$
P45	$V \rightarrow T \rightarrow V \rightarrow T(T3)$
	$V \rightarrow T(T4)$
	$V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T1)$
	$V \rightarrow T(T2)$
P46	$V \rightarrow T(T1)$
	$V \rightarrow T \rightarrow V \rightarrow T(T3 \& T4)$
	$V \rightarrow T(T2)$
	$V \rightarrow T \rightarrow L \rightarrow T(T5)$
P47	$F1 \rightarrow T \rightarrow F1 \rightarrow T(T3)$
	$F1 \rightarrow T \rightarrow B \rightarrow T \rightarrow F1 \rightarrow T(T1)$
P48	$B \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T1 \& T2)$
	$V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T \rightarrow V \rightarrow T(T5)$
P49	$W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T1, T3 \& T4)$
P50	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T1 \& T2)$
	$F1 \rightarrow T(T3)$
	$F1 \rightarrow T \rightarrow L \rightarrow T(T4 \& T5)$

P51	$L \rightarrow T(T5)$
P52	$W \rightarrow T \rightarrow W \rightarrow T(T1)$
	$W \rightarrow T \rightarrow W \rightarrow T(T3 \& T4)$
	$W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T5)$
P53	$T \rightarrow F1 \rightarrow T(T3)$
	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T4)$
	$F1 \rightarrow T(T1)$
	$V \rightarrow T(T5)$
P54	$B \rightarrow T(T3 \& T4)$
P55	$F1 \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T(T1 \& T5)$
P56	$V \rightarrow T \rightarrow B \rightarrow T \rightarrow B \rightarrow T(T1, T2 \& T4)$
P57	$B \rightarrow T \rightarrow B \rightarrow T \rightarrow W \rightarrow T \rightarrow W \rightarrow T(T3)$
	$W \rightarrow T(T4)$
P58	$F1 \rightarrow T(T1, T3 \& T4)$
P59	$T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T(T3)$
	$V \rightarrow T(T4)$
P60	$F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow F1 \rightarrow T \rightarrow V \rightarrow T(T1)$
P61	$B \rightarrow T \rightarrow B \rightarrow T \rightarrow V \rightarrow T(T1, T3 \& T4)$
P62	$V \rightarrow T(T4)$

Vita

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