August 2014

Understanding Novice Users' Help-seeking Behavior in Getting Started with Digital Libraries: Influence of Learning Styles

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UNDERSTANDING NOVICE USERS' HELP-SEEKING BEHAVIOR IN GETTING STARTED WITH DIGITAL LIBRARIES: INFLUENCE OF LEARNING STYLES

by

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A Dissertation Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

in Information Studies

at

University of Wisconsin Milwaukee

August 2014

ABSTRACT

UNDERSTANDING NOVICE USERS' HELP-SEEKING BEHAVIOR IN GETTING STARTED WITH DIGITAL LIBRARIES: INFLUENCE OF LEARNING STYLES

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The University of Wisconsin-Milwaukee, 2014
Under the Supervision of Professor Iris Xie

Users' information needs have to be fulfilled by providing a well-designed system. However, end users usually encounter various problems when interacting with information retrieval (IR) systems and it is even more so for novice users. The most common problem reported from previous research is that novice users do not know how to get started even though most IR systems contain help mechanisms. There is a deep gap between the system's help function and the user's need. In order to fill the gap and provide a better interacting environment, it is necessary to have a clearer picture of the problem and understand what the novice users' behaviors are in using IR systems.

The purpose of this study is to identify novice users' help-seeking behaviors while they get started with digital libraries and how their learning styles lead to these behaviors. While a novice user is engaged in the process of interacting with an IR system, he/she

may easily encounter problematic situations and require some kind of help in the search process. Novice users need to learn how to use a new IR environment by interacting with help features to fulfill their searching needs. However, many research studies have demonstrated that the existing help systems in IR systems cannot fully satisfy users' needs. In addition to the system side problems, users' characteristics, such as preference in using help, also play major roles in the decision of using system help. When viewing help-seeking as a learning activity, learning style is an influential factor that would lead to different help-seeking behaviors. Learning style deeply influences how students process information in learning activities, including learning performance, learning strategy, and learning preferences. Existing research does not seem to consider learning style and help-seeking together; therefore, the aim of this study is to explore the effects of learning styles on help-seeking interactions in the information seeking and searching environment.

The study took place in an academic setting, and recruited 60 participants representing students from different education levels and disciplines. Data were collected by different methods, including pre-questionnaire, cognitive preference questionnaire, think-aloud protocol, transaction log, and interview. Both qualitative and quantitative approaches were employed to analyze data in the study. Qualitative methods were first applied to explore novice users' help-seeking approaches as well as to illustrate how learning styles lead to these approaches. Quantitative methods were followed to test whether or not learning style would affect help-seeking behaviors and approaches.

Results of this study highlight two findings. First, this study identifies eight types of help features used by novice users with different learning styles. The quantitative evidence also verifies the effect of learning styles on help-seeking interactions with help features. Based on the foundation of the analysis of help features, the study further identified fifteen help-seeking approaches applied by users with different learning styles in digital libraries. The broad triangulation approach assumed in this study not only enables the illustration of novice users' diversified help-seeking approaches but also explores and confirms the relationships between different dimensions of learning styles and help-seeking behaviors. The results also suggest that the designs and delivery of IR systems, including digital libraries, need to support different learning styles by offering more engaging processing layouts, diversified input formats, as well as easy-to-perceive and easy-to-understand modes of help features.

To
my parents, my husband
and
my children

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ACKNOWLEDGEMENTS

I am indebted to the students who participated in this study, giving generously of their time and effort. Their contribution to this study is immeasurable.

My warmest thanks go to my advisor, Dr. Iris Xie, who offers me invaluable advice regarding my dissertation and constantly keeps me on the right track. She is a model of scholarship and integrity. Her unwavering encouragement, generous support, patience, and inspiration helped me in my long journey during the doctoral program, without her guidance this dissertation would not be possible. I would also like to express my gratitude to my dissertation committee members, Dr. Wolfram, Dr. Zhang, Dr. Surber, and Dr. Cool, who each took the time to share their wisdom and knowledge. I am in debt to all your valuable advice and comments, which definitely helped to improve the quality of this work.

I am also grateful for my SOIS doctoral colleagues, Soohyung Joo, Carol Sabbar, Suyu Lin, Kun Lu, Dalal Abudawei, and Ed Benoit, who provided encouragement to me. They were always willing to help and give their best suggestions. I value our colleagueship and will carry it on over my life. Special thanks to Professor Li-Ping Chen, who inspired me to go for advanced studies in the field of information studies in the United States.

Finally, and most importantly, I would like to thank my family – my husband Chih-Peng, my children Austine and Minglun, and my parents Rosung Huang and Shuhui Lai for their love and support.

CHAPTER ONE INTRODUCTION

1.1 Background

Due to the rapid development of new technologies and explosive growth of Web-based applications, the amount of scholarly information being digitized is dramatically increasing. In the academic context, more and more online information retrieval (IR) systems, e.g. online databases, e-journals, and e-books are already provided in order to fulfill research and learning purposes. Libraries, as well as academic departments, have devoted much effort to creating information systems, i.e., digital libraries (DLs), to preserving their print resources digitally, and to providing access and services online. There is no standard IR system, which causes academic users to find it much more difficult and challenging to search for information to accomplish their academic purposes. They have to not only interact with various topics of collections but also adapt to diverse interfaces designs that they are not familiar with. They need to solve encountered problems and *learn* how to use the new IR systems. The main purpose of IR research is to investigate how to effectively assist users in learning new information resources or technology when searching for information.

1.2 Research Problem and Research Question

It is noted that previous research in IR has expanded from a system-centered approach to a user-centered cognitive approach to achieve the goal of assisting users in a searching environment. A user-centered cognitive approach incorporates users' characteristics of

knowledge, interest, and preference into research consideration (Ingwersen & Jarvelin, 2005). These human factors are clearly key issues for the development of Web-based applications and have led relevant research to grow significantly in the past decades. Therefore, many researchers adopted user-centered cognitive approach in their system design models (Ford, 2004; Ingwersen & Jarvelin, 2005; Saracevic, Spink, & Wu, 1997; Wilson, 1999; Xie, 2008). Marchionini (1995) described these personal characteristics as 'personal information infrastructure', which means an individual person's mental structure based on his/her own personal collection of abilities, experience, and other cognitive resources. Without the personal information infrastructure, there is no way for an individual to gather, use, or communicate information in any context. In other words, the cognitive differences influence how users seek and retrieve information. It is through the further understanding of human cognitive factors and their relationships with the user-system interactions that a better supportive design of IR system can be created.

Although previous IR research has pointed out the importance of '*cognition'* as an influential factor in the interactive behavior between system and user, the detailed dimensions and specific constructs of cognition related to information seeking and searching have not been completely identified and need further exploration. In echoing the importance of the cognitive influence, many researchers began to explore information seeking and searching as a learning process and proposed information behavior models, which incorporates cognitive concepts such as learning styles into the design (Ford, 2004; Wilson, 1997; Wilson, 1999).

In the model of information behavior, Wilson (1997) recognized the close association between information processing and learning and integrated cognitive and psychological characteristics into the understanding of the information searching situation and user need. According to Wilson, the context of the information need leads to information seeking behavior which is mediated or impacted by *intervening variables.* Wilson pointed out that users' personal characteristics are key intervening variables that would negatively influence information seeking and stated "the barriers, particularly those at the level of the person, may act to prevent the initial emergence of a coping strategy, or may intervene between the acquisition of information and its use". Information seeking behavior is directly affected by an individual's cognitive processes, which are task-specific, micro, immediate, and situational and are executed using different styles of approaches to accomplish different task types and learning objectives. One of the intervening variables of information seeking is the individual's psychological trait - cognitive/learning style - which deeply influences how students process information in learning activities, including learning performance, learning strategy, and learning preferences. Learning styles influence how users process information, including their choice of search strategies and preferred system features. Several researchers have studied the effects of learning style and the associated dimensions on users' reactions to information organization and representation, search strategy, and search performance (Ford, 2005; Ford, Miller, & Moss, 2005a; Ford, Miller, & Moss, 2005b; Ford, Eaglestone, Madden, & Whittle, 2009; Frias-Martinez, Chen, Macredie, & Liu, 2007; Lee, Cheng, Rai, & Depickere, 2005; Palmquist & Kim, 2000; Tenopir, Wang, Zhang, Simmons, & Pollard, 2008; Wang, Hawk, & Tenopir, 2000).

Since the number of new IR systems shows significant growth during recent years, users may not be familiar with many of them. When situated in totally strange searching

environments, academic users usually encounter various problems and need to seek help. However, many research studies have demonstrated that the existing help systems in IR systems cannot fully satisfy users' needs. While viewing help systems as important, people generally find these systems to be ineffective in a variety of areas. As a result, they tend to use help mechanisms less frequently (Cool & Xie, 2004; Mansourian, 2008).

According to Xie & Cool (2009), help-seeking refers to the situation where a user is engaged in the process of interacting with an IR system, and he/she encounters a problematic situation and needs some kind of help to complete the search process. In information retrieval environments, help-seeking represents a mini information search process. Therefore, cognitive factors that influence information searching may also affect users' help-seeking behavior.

It is generally accepted that the problematic situation is worsened when a novice user faces a new environment, and Digital libraries (DLs) are relatively newly developed systems (Nahl, 1999). Novice users usually encounter many kinds of problems and have to learn how to search DLs by interacting with their help features. Most DLs contain certain help mechanisms which are actually reported to be the least used functions. This may be the fault of DL systems, whose help contents and structures are hard to use. There is a deep gap between the system's help features and novice users' need (Xie & Cool, 2009). In addition to the system side problems, users' characteristics, such as users' motivation state, preference in using help, and cognitive state, also play major roles in the decision of using system help (Dworman & Rosenbaum, 2004).

Although previous research has addressed the issues of help-seeking and various cognitive factors, they are being investigated separately. There are two main limitations within the previous research: 1) while there are studies focusing on how cognitive factors affect search behaviors, less research focuses on their influence on help-seeking; 2) there is even less research examining this issue in DL environments. In order to fill the gap and provide a better interacting environment, it is necessary to have a clearer picture and understand what the novice users' help-seeking approaches are when using DLs. Therefore, the purpose of this study is to identify whether learning style affects novice users' help-seeking behaviors while they get started with digital libraries and how the related cognitive factors lead to these approaches.

The specific research questions are listed below:

RQ 1. What are the types of help features that novice users with different learning styles use in digital libraries?

RQ 2. Is there a significant difference in novice users' help feature use based on their learning styles?

RQ 3. What are the help-seeking approaches that novice users with different learning styles apply in digital libraries?

The associated null hypotheses for research question two (RQ 2) are written in a preliminary form as shown in this section. For RQ 2, the learning styles were investigated more specifically according to the associated four dimensions, including (1) Processing dimension (Active/Reflective), (2) Input dimension (Visual/Verbal), (3) Perceiving

dimension (Sensing/Intuitive), and (4) Understanding dimension (Sequential/Global) (Felder & Silverman, 1988; Felder & Soloman, 1991). The help-seeking behaviors were investigated with specific type of Help Feature identified later in this study. The hypotheses for RQ 2 are:

Hypothesis 2.1a There is no significant difference in the frequency of using Help Features between Active and Reflective users.

Hypothesis 2.1b There is no significant difference in the time of using Help Features between Active and Reflective users.

Hypothesis 2.1c There is no significant difference in the number of types of Help Features used between Active and Reflective users.

Hypothesis 2.2a There is no significant difference in the frequency of using Help Features between Visual and Verbal users.

Hypothesis 2.2b There is no significant difference in the time of using Help Features between Visual and Verbal users.

Hypothesis 2.2c There is no significant difference in the number of types of Help Features used between Visual and Verbal users.

Hypothesis 2.3a There is no significant difference in the frequency of using Help Features between Sensing and Intuitive users.

Hypothesis 2.3b There is no significant difference in the time of using Help Features between Sensing and Intuitive users.

Hypothesis 2.3c There is no significant difference in the number of types of Help Features used between Sensing and Intuitive users.

Hypothesis 2.4a There is no significant difference in the frequency of using Help Features between Sequential and Global users.

Hypothesis 2.4b There is no significant difference in the time of using Help Features between Sequential and Global users.

Hypothesis 2.4c There is no significant difference in the number of types of Help Features used between Sequential and Global users.

1.3 Research Design

A user study was designed to address the proposed research questions and associated hypotheses. Both qualitative and quantitative methods were employed to systematically collect and analyze the data. Around 60 novice users were recruited in this study, including mainly undergraduate and graduate students. Since the study was carried out in an academic setting, these participants represent general academic users with different ages, genders, ethnicities, educational levels, educational disciplines, computer skills, and other demographic characteristics. Two digital libraries (DLs) are selected for this study: the University of Wisconsin Milwaukee Digital Collection (UWMDC) (http://www4.uwm.edu/libraries/digilib/) and the Library of Congress Digital Collection (LOCDC) (http://loc.gov/ Library/libarch-gidital.html). The main reason for selecting these two DLs is that they provide rich and related content with multimedia formats. Such content represents the type of information general academic users might be interested in. Most importantly, both DLs facilitate information seeking of novice users with complete and varying help features. Multiple methods were employed in this study to collect both qualitative and quantitative data, including pre-questionnaires, cognitive instruments, think-aloud protocol, transaction log, and post-interview. Both quantitative and qualitative analyses were included in the analysis of users' help-seeking interaction and their relationships with learning style, including descriptive analysis, statistical testing, and open coding. Results from qualitative and quantitative methods were analyzed, connected, and interpreted to better understand novice users' help-seeking behaviors.

1.4 Significance of the Study

The study aims to contribute to more understanding of novice users' help-seeking behaviors and provide a theoretical model and design principles for developing helpful IR systems. As Meadows (2008) stated, "a proper understanding of human information retrieval is now seen as involving an examination of cognitive factors". He further pointed out more understanding of retrieval systems must allow a high level of interactive input from the information seeker. Even though previous research has identified many influential cognitive factors of information retrieval, very limited studies have focused on combining learning-related cognitive factors and their relationships with help-seeking behaviors. The cognitive factors and their impact on help seeking behaviors in learning and problem solving have been confirmed and therefore can also be applied in an IR environment. As stated earlier, various dimensions of learning style may influence how users choose search strategies and preferred system help features in terms of content organization and presentation format. These different dimensions and factors can be investigated to further explore how they are interwoven with users' help-seeking behaviors. It is hoped that the results of this research will help to design a user model that better facilitates users' different preferences and cognitive states. More specifically, the implication is to integrate these factors into the help-seeking process and develop a micro-user model, which serves as the theoretical basis to enhance retrieval effectiveness by compensating for cognitive weaknesses on the part of novice users (Gorrell et al., 2009).

In addition, an effective IR system interface needs to provide great affordance and facilitate correct cognitive development by presenting appropriate messages/clues and providing context-sensitive help based on detected user characteristics or behaviors (Wang et al., 2000). To achieve the affordance and facilitation, there is a need to provide personalization. Personalization can be delivered by providing adaptivity (able to adapt) or adaptability (capable of being adapted). In an adaptive system, users' cognitive preference and efficacy can be identified by either monitoring their interactive behaviors or by obtaining feedback directly from users. In an adaptive system, users' cognitive preferences and styles can be identified by either monitoring his/her behavior with data mining techniques or by obtaining this information from external surveys. Once the users' cognitive styles can be detected, the design of help features in IR systems can be automatically changed to match the preferences of each individual without the user's attention. For example, the observation of users' interactive preference can be used to provide personalized help by re-ranking search results or reformulating queries, thus helping users complete their tasks more effectively and efficiently (Liu & Belkin, 2011). In a system with adaptability, users are allowed to modify the design of an IR system themselves based on their own preference. Therefore, results of this research can be used to recommend cognitive design principles. The purpose of the recommendation is to integrate these principles into the development of help features and better support users' interactions with IR systems.

1.5 Definition of Terms

Help-seeking

Help-seeking refers to situations in which individuals encounter problems in the process of information seeking and searching. Individuals may try to seek help, either from an IR system, a human or other sources to solve the problems.

Help-feature

Help-feature refers to the features provided by IR systems that assist users in solving their problems in the search process.

Help-seeking approaches

Help-seeking approaches refer to the methods or steps taken by IR system users in setting about to resolve a searching problem.

Learning Style

Learning style refers to the preference that an individual may have for processing information in a particular way when carrying out a learning activity.

Learning Style Dimension of ILS

Index of Learning Styles (ILS) describes learners in more detailed dimensions (Felder & Silverman, 1988; Felder & Soloman, 1991; Felder & Brent, 2005). In the ILS model, there are four proposed dimensions and associated styles: Processing dimension (Active/Reflective), Input Dimension (Visual/Verbal), Perceiving Dimension (Sensory/Intuitive), and Understanding Dimension (Sequential/Global).

Novice Users

A novice user is someone who does not have knowledge and experience with the information seeking and searching in a particular IR environment.

Digital Libraries

A digital library is a managed collection of digital information with related services, accessible over a network.

1.6 Summary

In this chapter, a brief introduction to the study was provided. The background of the study was first introduced, including the challenges caused by new information sources and searching systems and the necessity of helping users to learn and adapt to different contexts of IR environments. In the next section, the research problem, research questions, and associated research hypotheses were proposed. Furthermore, the research design as well as the methods and processes of data collection and data analysis were outlined. Finally, the significance of the study and definition of terms were also briefly described.

CHAPTER TWO REVIEW OF THE LITERATURE

2.1. Introduction

The following chapter discusses the theoretical framework that shaped the study and explores the literature associated with it. The major source of previous research is from information studies with the emphasis on user-centered information retrieval. Perspectives of education are also blended and integrated into this review, particularly in the fields of educational psychology and human cognition. Information studies and education are separate academic disciplines, but they share a mission of assisting users in learning different information sources or technology.

Information retrieval is a general concept that encompasses both information seeking and information searching. Information seeking is "the purposive seeking for information as a consequence of a need to satisfy some goal" (Wilson, 2000). Individuals may interact with either manual information systems or computer-based systems within a context. Within the pre-existing external context, people would form a need to search for information. Therefore, researchers have conducted studies of information seekers in different occupations, roles, and other contextual characteristics (Case, 2006). According to Wilson (2000), "Information searching behavior is the 'micro-level' of behavior employed by the searcher in interacting with information systems of all kinds. It consists of all the interactions with the system, whether at the level of human computer interaction (for example, use of the mouse and clicks on links) or at the intellectual level (for example, adopting a Boolean search strategy or determining the criteria for deciding

which of two books selected from adjacent places on a library shelf is most useful), which will also involve mental acts, such as judging the relevance of data or information retrieved." Within the micro level, more attention is paid to the interactions between the system and users. Due to the emergence of the user-centered approach toward IR research, more emphases have been place on cognition, including human knowledge and skills, attitude and motivation, and other related cognitive factors.

For the following sections, previous literature about general human cognition factors as well as cognitive factors in relation to help-seeking were briefly examined followed by a review of help-seeking. This chapter begins with the presentation of general key concepts of cognitive factors related to information retrieval. Then, previous literature of learning style and associated impacts on learning and information retrieval are reviewed. Next, help-seeking theories developed in both educational and information retrieving settings were examined. The help-seeking theories and related research from both fields serve as a theoretical framework for this dissertation research. Finally, the last section summarizes this chapter.

2.2. Cognitive Factors for Information Retrieval

As noted by previous researchers, IR studies have shifted from system-centered approach to user-centered approach with the emergence of Web-based information applications. Human factors are clearly key issues for the development of Web-based applications, leading research involving cognitive factors to grow significantly in the past

decade. Therefore, a user-centered cognitive approach may consider users' knowledge, interests, and preference as it relates to system design (Ingwersen & Jarvelin, 2005).

The term '*cognition'* refers to the act of knowing, which includes processing of information, applying knowledge, and changing preferences (Bandura, 1997; Coren, Ward, & Enns, 1999). Other scholars define '*cognition'* from a learning perspective and state "cognition refers to thinking and mental processes humans use to make decisions, understand new information or experiences, and learn new things" (Weinstein & Acee, 2008). The mental processes of human cognition are composed of various attributes, including memory, association, concept formation, language, attention, perception, motivation, action, problem solving and mental imagery. Based on perspectives within different contexts, these cognition processes have been analyzed in the fields of linguistics, anesthesia, neurology, psychology, philosophy, anthropology, computer science, and education. Many IR scholars also recognize several attributes of human cognition as influential factors in studying information searching behavior.

In IR research, the most widely studied cognition attribute is knowledge state. Marchionini (1995) defined information seeking and searching as "a process in which humans purposefully engage in order to change their state of knowledge" (p. 5). However, not only have the cognitive differences in knowledge state been identified as a vital intervening variable in information-seeking behavior and performance, but many researchers have also placed general cognition concepts, including cognitive preference and other motivational and psychological states, as major factors influencing searching behaviors in their IR theoretical models. These models include Ingwersen's Cognitive

Model, Saracevic's Stratified Model, Wilson's Information-Seeking Behavior Model and Xie's Planned-Situational Interactive IR Model (Ford, 2004; Ingwersen & Jarvelin, 2005; Saracevic et al., 1997; Wilson, 1999; Xie, 2008).

Based on the theoretical models, many broad cognitive factors have been investigated in regard to their impact on users' IR behaviors. In Saracevic's stratified model of IR interaction, the interaction between the two sides of users and system is taken into account. On the user side of the model, three levels of interaction were presented: *cognitive*, *affective*, and *situational* levels. At the first *cognitive* level, based on users' current state of knowledge, they have to constantly search or browse for information, navigate through the organization of the content, make judgment about the retrieved results. The interaction is between the cognitive structure of users and texts and related representations. At the middle level, users have to interact with their personal *affective* factors, which include intentions, beliefs, and motivations (Saracevic et al., 1997). The first two levels of interaction are key parts, representing a broader sense of 'cognition', which determines how users interact with the system. A similar idea is raised in Marchionini's suggestion that '*attitude'* is an integral part of "personal information infrastructure" by stating that "throughout our lives we develop knowledge, skills, and *attitudes* that allow us to seek and use information". According to Marchionini, the development and change of an individual person's mental structure needs to be based on his/her own personal collection of abilities, experience, and other cognitive resources. Without the personal information infrastructure, there is no way for an individual to gather, use, or communicate information in any context (G. Marchionini, 1995).

2.2.1 Knowledge and Skills

Previous research has examined the impact of different types of knowledge on information retrieval behavior. The most extensively investigated factor in IR fields is human knowledge. The related research typically uses the difference between novices and experts to demonstrate the effects of the knowledge and skills that users bring to the retrieval context. Three types of knowledge and skills are proposed in Marchionini's personal information infrastructure: problem domain, search system, and information searching. Among the three types of knowledge and skills, domain knowledge has been studied most extensively in the information science community. Domain knowledge is concerned with the knowledge of the 'subject' of the search tasks, either a need that is self-generated or given by a certain context. Before any search can be initiated, users need to be familiar with the subject of interest and the vocabulary of the task domain (Lazonder, Biemans, & Wopereis, 2000). Studies of domain expertise have highlighted several differences between domain experts and non-experts in using library OPAC system, online databases, digital libraries, and Web search engines. These behavioral differences include: (1) search query attributes: search term selection (Allen, 1991; Duggan & Payne, 2008; Shute & Smith, 1993; Vakkari, Pennanen, & Serola, 2003; Vakkari, 2002; White, Dumais, & Teevan, 2009), query reformulation strategies (Hembrooke, Granka, Gay, & Liddy, 2005), and the number and length of queries (Duggan & Payne, 2008; Freund & Toms, 2006; Hembrooke et al., 2005; Hsieh-Yee, 1993; Hölscher & Strube, 2000; Marchionini, 1989; Wildemuth, 2004; Zhang, Anghelescu, & Yuan, 2005); (2) search strategies and tactics: Web site selection (Lazonder et al., 2000; White et al., 2009; Duggan & Payne, 2008), goal sequencing

(Bhavnani, 2002) and search tactics (Carmel, Crawford, & Chen, 1992; Vakkari, 2001; Wildemuth, 2004); and (3) search outcomes: task completion time (Bhavnani, 2001; Duggan & Payne, 2008; Lazonder et al., 2000; McDonald & Stevenson, 1998; Vibert et al., 2009), reading time (Kelly & Cool, 2002), search accuracy and success (Duggan & Payne, 2008; Kang, 2010; Lazonder et al., 2000; White et al., 2009), and search efficiency and effectiveness (Kelly & Cool, 2002, Zhang et al., 2005). In summary, domain experts are found to use domain specific vocabularies in their queries, adopt goal-oriented strategies, and be more successful in searching.

In addition to domain knowledge, system knowledge also plays an important role for users to effectively interact with IR systems. Search knowledge, including system knowledge and searching skills, helps users know general search skills and understand how particular a IR system works. It is also suggested that users should have various skills and knowledge with the system, including skills in navigating through and searching in the information system and knowledge of what content is available and how the information is organized (Chen, Houston, Sewell, & Schatz, 1998; Dimitroff, 1992). Based on previous research, experienced users are better than novice users in online searching behaviors. In a study comparing novice searchers with experts, Tabatabai & Shore (2005) revealed specific actions that are associated with experts' success in Web searching. These actions are: (1) evaluating Web sites with clear criteria, (2) not excessively navigating, (3) reflecting on strategies and monitoring progress, (4) having background knowledge about information seeking, and (5) approaching the search with a positive attitude. More researchers also pointed out the effect of system knowledge in different search behaviors, such as locating Web sites (Lazonder et al., 2000; Palmquist

& Kim, 2000), search strategies (Ellis & Haugan, 1997; Marchionini, Dwiggins, Katz, & Lin, 1993), systematically reformulating queries (Fields, Keith, & Blandford, 2005; Hsieh-Yee, 1993), monitoring the search process (Howard, 1982; Hsieh-Yee, 1993; Sutcliffe, Ennis, & Watkinson, 2000; Yuan, 1997), and search outcomes (de Bliek et al., 1993; de Bliek et al., 1994; Yuan, 1997).

The purpose of previous literature focused mainly on understanding the information searching behavior of experts of either domain or system knowledge. With this understanding, it is hoped to improve the design of IR systems and better facilitate the interaction between IR systems and novice users. However, less is known about novice users, who are the majority of IR systems users. Without the subject domain knowledge and required searching skills and experiences, many novice users still find IR systems hard to use.

2.2.2 Attitude, Motivation, and Related Factors

As stated earlier, Marchionini also identified *attitude* in the personal information infrastructure that interacts directly with information seeking. According to Marchionini, "*attitude* such as motivation, confidence, tenacity, tolerance for ambiguity and uncertainty, curiosity, and preferences for social interaction and media" determine when and how people apply information seeking knowledge and skills (Marchionini, 1995). Other researchers echoed a similar view and involved motivational factors in their models of information seeking. In Wilson's 1999 theoretical and classical model of information behavior, several behavior theories were integrated to illustrate the relationships between information-seeking behavior, psychological attributes as well as other factors. These

factors were transferred from the research advancement in social cognitive learning, decision making, psychology, and communication. In the information behavior model, Wilson emphasized that the need to seek information is not only driven by the information environment and user cognition, but is also impacted by users' psychological and motivational states (Wilson, 1999). Nahl (2004; 2005) conducted a series of empirical studies to investigate motivational factors, e.g. self-efficacy and optimism, and their impacts on information behaviors on Internet. She further integrated theories of different fields in psychology and cognitive science and proposed a conceptual framework to depict the interaction between human and system. This framework has the emphasis on the specific account of how different cognitive domains of humans are inter-dependent in processing and using information. These cognitive domains include cognitive coping skills, self-efficacy, optimism, and negative feelings of uncertainty, irritation, and frustration.

In Sense-Making Methodology, Dervin specifically enumerated factors, such as 'attitudes', 'feelings', and 'beliefs', as bridging elements of information seeking (Dervin & Reinhard, 2007). She differentiated previous studies into different conceptualizations and their relationship to information seeking from previous research. Among the conceptualizations, the first group focuses on different information seeking situations, tasks, or contexts that can cause different feelings, either positive satisfaction or negative anxiety (Bilal, 2000; Bilal, 2002; Wang & Tenopir, 1998; Wilson, Ford, & Ellis, 2002). The second group, on the other hand, conceptualizes attitudes and beliefs as the source of impact toward information searching behaviors (Heinstrm, 2005; Julien & Michels, 2000; Nahl, 1998; Nahl, 2004; Nahl, 2005; Tenopir, 1994). While some researchers

conceptualize attitudes and beliefs as a motivational state that can either activate or inhibit searching for information, others regard attitudes and beliefs as the driving forces leading to different goals and activities.

2.2.3 Other Cognitive Factors

Other cognitive factors that have also been investigated in IR research include problem solving style/ability (Kim & Allen, 2002; Wilson, 1997), attribution theory (Nahl, 2004), epistemological beliefs (Whitmire, 2003), language and reading (Bowler, 2010b), metacognition (Bowler, 2010c; Gorrell, Eaglestone, Ford, Holdridge, & Madden, 2009), and self-regulation (Bowler, 2010a).

One of the studies mentioned above was conducted by Kim & Allen (2002), which investigates the influence of problem-solving style on Web searching behavior. In their study, Kim & Allen found that problem-solving style interacted with and influenced the use of keyword searching as well as the number of Web pages viewed. Other studies explored the metacognition and self-regulation and their impacts on information seeking and searching behaviors.

Gorrell and his colleagues (2009) reported a project aiming to build interventional strategies into the design of IR systems to bring about and strengthen metacognitive skills. In such a 'metacognitively aware' IR system, an individual searcher's levels of metacognitive awareness and skills can be assessed. Based on the evaluation results, IR systems can offer specific intervention strategies designed to compensate for metacognitive weaknesses. In the first phase of the project, the research team constructed

a taxonomy of metacognition. In their taxonomy, the core metacognitive skills selected are schema-training, planning, monitoring, evaluation and transfer. Results of the study showed high overall use of metacognitive strategies among respondents. In addition, there were significant differences reported in the metacognition usage in relation to age, gender and discipline. Bowler (2010c) also identified attributes of metacognitive knowledge related to the information search process in school-based tasks. Thirteen attributes of metacognition knowledge were identified in the study, which are balancing, building a base, changing course, communicating, connecting, knowing that you don't know, knowing your strengths and weaknesses, parallel thinking, reflecting, scaffolding, understanding curiosity, understanding memory, understanding time, and effort.

In another study, Bowler (2010a) conducted a study revealing adolescents behavioral pattern in relation to self-regulation of curiosity. Results of her study showed that the curiosity experienced by adolescents during the search process was accompanied by both positive and negative feelings. Such feelings, e.g. pleasure and pain, need to be self-regulated in order to navigate a pathway through the search process. The self-regulation of curiosity was a clear and distinct strategy related to understanding one's own curiosity and the feelings attached to it.

2.3. Cognitive Factors in Relation to Help-Seeking as a Learning Process

Although previous IR research has pointed out the importance of cognition as an influential factor in the interaction behavior between system and user, the detailed dimensions and specific

constructs of cognition were not completely identified and thus need to be further explored. Current knowledge is still far from understanding the complexity of interactive behavior. In echoing the importance of the cognitive influence, many researchers began to explore information seeking and searching as a learning process using interdisciplinary perspectives of cognition research from education and cognitive psychology (Wilson, 1997; Wilson, 1999, Ford, 2004).

In the model of information behavior, Wilson (1997) recognized the close association between information processing and learning. He integrated cognitive and psychological characteristics into the understanding of search situations and user need. According to Wilson, the context of the information need leads to information seeking behavior which is mediated by *activating mechanisms* and other *intervening variables.* According to Wilson, users' personal characteristics are the key intervening variable that would negatively influence information seeking and stated that "the barriers, particularly those at the level of the person, may act to prevent the initial emergence of a coping strategy, or may intervene between the acquisition of information and its use". Information seeking behavior is directly affected by an individual's cognitive processes, which are task-specific, micro, immediate, and situational and are executed using different style of approaches to accomplish different task types and learning objectives. One of the intervening variables of information seeking is the individual's psychological trait, cognitive/learning style, which deeply influences how students process information in learning activities, including learning performance, learning strategy, and learning preferences.

Since the number of new IR systems shows an explosive growth during past years, users may not be familiar with them. When being situated in totally new searching environments,

users usually encounter various problems and need to seek help. The problematic situation becomes even worse for novice users. With the learning orientation, these models can be adopted to provide additional understanding of the problematic situations encountered by novice users, who does not have either appropriate knowledge of or experience with the new IR system. Based on the theories stated above, the learning style is selected as the focused dimension to understand novice users' help-seeking behavior.

In summary, previous research has explored different cognitive factors, including cognitive processes of strategy use and motivational states. However, the factors are investigated either in isolation or along with one other component, very few studies ever explored the factor. After reviewing all the literature related to cognitive information behavior models, this study aims to identify how learning style would affect information retrieval behavior, specifically help-seeking behaviors.

2.3.1 Learning Style

The first concept of cognition that attracts many researchers' attention is cognitive style. Cognitive style refers to a individual's preferred way of processing information (Sternberg, 2001). Individuals may process all sorts of information across many areas of activity. Cognitive style unconsciously serves as an adaptive control mechanism between the inner self-need and externally interacting environment. The cognitive style also attracted many researchers in the field of information retrieval (Wildemuth, 2009). Yuan & Meadow (1999) investigated the use of variables by authors who reported on studies of IR systems. They pointed out that cognitive/learning style serves as one of the key characteristics to the variable of human individual differences and learning. Based on

previous research, Xie (2008) also identified cognitive style and searching style as one of major components of "personal information infrastructure" in the Planned-Situational Interactive IR model.

More recently, attention has turned to cognitive styles in learning activities. It is also well accepted to adopt the term '*learning style*' in educational research. Learning styles are used to portray individual differences in the preferred way of processing information or approach learning (Dunning, 2008). Many learning styles were developed to describe and classify learners (Sternberg & Grigorenko, 1997; Zhang & Sternberg, 2005). For example, Field-Dependent /Field-Independence (Witkin, 1973), Wholist/Analytic and Verbalizer/Imager (Riding & Cheema, 1991), Active/Reflective and Sensing/Intuitive (Felder & Silverman, 1988; Kolb & Kolb, 2005) were used to categorize learners according to how they perceive, organize, and process information.

Several major dimensions will briefly be discussed in the following section, including Field-Dependence/ Field-Independence, Wholist/Analytic, Verbal/Imagery, processing, perception, input, and understanding.

Field Dependence / Field Independence (FD/FI) dimension

Among the various dimensions, Field Dependent/Field Independent (FD/FI) is probably the dimension most often studied. When processing incoming material, FI individuals would impose their own structure, take individual elements out of context, and employ analytical approaches toward learning, whereas FD persons would accept

ideas presented to them, focus on global experience, adopt more of an observer role, and easily be distracted by unimportant, yet more dominant cues.

Whilst field dependent individuals have a preference to learn in groups and to interact frequently with one another as well as the teacher, field independent learners may respond better to more independent and more individualized approaches. Field independent learners are more likely to have self-defined goals and to respond to intrinsic reinforcement, whilst field dependent learners require more extrinsic reinforcement and more structured work by the teacher. Whereas the field independent learners prefer to structure their own learning, and like to develop their own learning strategies, field dependent learners may need more assistance in problem-solving strategies or more exact definitions of performance outcomes (Witkin, Moore, Goodenough, & Cox, 1977). Field independent individuals are more able to deal with situations requiring impersonal analysis whilst field dependent individuals are better equipped to deal with situations requiring social perceptiveness and interpersonal skills.

Wholist/Analytic and the Verbal/Imagery dimensions

Riding and Chema (1991) studied many constructs and concluded that styles can be classified into two principal groups: the Wholist/Analytic and the Verbal/Imagery dimensions. The Wholist/Analytic dimension describes whether an individual tends to organize and perceive information in whole or in parts. This dimension is quite equivalent to Field dependent/ Independence. The Verbal/Verbal dimension characterizes whether people are inclined to perform better in tasks or situations that require the associated form of information represented in visual or verbal form (Riding, 2001).

Dimensions of Index of Learning Styles

While most learning style theories classify learners into few groups, the Index of Learning Styles (ILS) describes learners in more detailed dimensions (Felder & Silverman, 1988; Felder & Soloman, 1991; Felder & Brent, 2005). Table 2.1 lists the dimensions of learning styles of ILS.

Table 2.1 Dimensions of Learning Styles of ILS

Learning Styles of ILS	
Processing	Active
	Reflective
Input	Visual
	Verbal
Perception	Sensing
	Intuitive
Understanding	Sequential
	Global

In the ILS model, there are four proposed scales and associated dimensions: Active/Reflective, Visual/Verbal, Sensing/Intuitive, and Sequential/Global. The first dimension distinguishes between an active and a reflective way of processing information. The second, Visual-Verbal dimension deals with the preferred sensory channel in providing information. The third dimension covers a sensing versus intuitive approach of perceiving information. For the fourth dimension, learners are characterized according to their sequential or global ways of understanding information.

Learning style and learning

The level of learning style was positively correlated to academic performance. Witkin et al.'s (Witkin, Oltman, Raskin, & Karp, 1971) field dependence/field independence has also been found to be an important factor influencing performance of students in different

learning contexts, including business education, language acquisition, problem solving, and programming. Au (1997) conducted a study investigating the relationships between learning style and learning performance of college business majors. Using a sample of 103 students, Au concluded that FI business students tend to outperform their FD peers across all forms of assessment, which included a multiple choice test, a written report, and a final examination. In a foreign language learning context, Hansen and Stansfield (1981) found that FI learners in a Spanish class learned more effectively, as measured by achievement scores, than FD learners. Similar results were also found in computer-based learning environments. For example, compared with FD learners, FI learners do better in problem solving performance (Williams, 2001) and programming performance (Johnson & Kane, 1992).

Other learning styles were also found to be closely associated with learning performance (Backhaus & Liff, 2007; McManus, Richards, Winder, & Sproston, 1998; Riding, 2001; Zhang, 2002; Zhang, 2008). With second language learning, Riding et al. (Riding, Grimley, Dahraei, & Banner, 2003) asked the second-language teachers of French or German to rate learning of their 12-year-old pupils on a 5-point scale from very poor to very good. Overall, the Verbalizers were rated higher than that of Imagers. In a more recent study, Backhaus and Liff (2007) also examined the role of learning style and academic performance in management education. The result of their study revealed a relationship between analytical style and grade point average.

In addition to academic performance, learning style is closely related to the choice of learning strategies. Based on a study of 130 undergraduate business students, Sadler-

Smith (1999) found that Analyst learners adopted a deeper learning approach than their Intuitive peers, while Intuitive learners had a stronger preference for collaborative learning approaches than did the Analysts. FD individuals are more likely to be dominated or influenced by the prevailing field, and thus tend to be unsure about their responses. On the other hand, FI individuals are adept at overcoming the influences of the field or embedded context, and are able to experience items as separate and discrete from their backgrounds (Witkin, 1973). As a consequence, some learning strategies are especially effective for FD learners. When taking notes from a lecture, Rickards and his colleagues (Rickards, Fajen, Sullivan, & Gillespie, 1997) found that only FD learners, but not their FI peers, benefited from signaling phrases in their recall performance. The signaling phrases, which served like tags or headings, helped FD learners impose structure on the learning material.

Learning style also influence students' preference of learning material in terms of the (1) content structure, (2) mode of presentation, and (3) type of content.

(1) Content Structure: Douglas & Riding (1993) found that when 11-year-old students were presented with a passage for recall, Wholists did best when the title of the passage was given before the passage was presented, rather than at the end. Analytic and Wholistic learners showed different preferences on other content structures, e.g., Analytic learners need a large viewing window and were influenced by large step size of learning material (Riding & Grimley, 1999).

(2) Mode of presentation: In general, the verbal and pictorial are the two available modes of presenting learning related information. Providing students with either a

verbal or a pictorial version of the same learning information, Riding and Ashmore (1980) studied different preferences of 11-year-old Verbalizers and Imagers. It is not surprising that Verbalizers were superior learners with the verbal mode while Imagers perform better with the pictorial mode. Within the classroom setting, although purely verbal presentation is often an option, an alternative purely pictorial version is rarely an option as some words are also required. However, it is usually possible to present information in both modes. A similar study involves selections from students of their preferred format of learning information. When being presented with three different versions of a sheet, which contained the same information but in different formats, 16-year-old students were asked to take one p referred version from teacher's desk. The versions were (a) unstructured verbal - paragraphs without headings, (b) structured verbal - paragraphs, each with a clear heading, and (c) structured pictorial - paragraphs, with a clear heading and a pictorial icon. Most verbalizers selected the verbal version and most of the imagers selected the pictorial version. Students are attracted to materials that suit their own style. Another study, with first or second year high school students, found that the computer presentation of material in a text-plus-picture format facilitated learning. Results of the recall test showed that 50% of the imagers used illustrations as part of their answers, which is much higher than the 12% of the verbalizers (Riding & Douglas, 1993).

(3) Type of Content: With the type of content of learning material, studies associated with 11- and 12-year-old students showed that Imagers recall highly visually descriptive text better than acoustically complex and unfamiliar text, whereas the

reverse holds true for Verbalizers (Riding & Dyer, 1980; Riding & Calvey, 1981). Individuals appear to learn best when information can be readily translated into their preferred verbal-imagery mode of presentation.

Learning style and information retrieval

The cognitive dimension of human behavior has been recognized and widely explored in information seeking behavior research. Several researchers studied the effects of cognitive/learning style on users' reactions to information organization and representation, search strategy, and search performance (Belk, Papatheocharous, Germanakos, & Samaras, 2013; Dworman & Rosenbaum, 2004; Ford et al., 2009; Frias-Martinez et al., 2007; Huang, Joo, & Xie, 2012; Lee et al., 2005; Palmquist & Kim, 2000; Tenopir et al., 2008; Wang et al., 2000). Different dimensions of cognitive/learning styles are considered by IR researchers to further understand their relationships with users' retrieval behavior.

FD individuals need more guidance to assist them to find out relevant and meaningful information (Clewley, Chen, & Liu, 2010; Lee et al., 2005). Liu and Reed (1994) conducted a study and discovered a significant relationship between participants' cognitive styles and their use of hypermedia systems. The FI subjects explored the hypermedia system in a nonlinear mode, whereas the FDs navigated in a relatively linear mode. This result seemed to be supported by other web searching studies (Ford, Wilson, Foster, Ellis, & Spink, 2002; Frias-Martinez et al., 2007). In web searching, FD

individuals were also found to spend more time searching, visited more nodes (Wang et al., 2000), made more use of search operators (H. Kim, Yun, & Kim, 2004), and navigated in a passive mode (Palmquist & Kim, 2000).

Analytic individuals engaged in more active, exploratory, and serendipitous behaviors, including clearer and more focused thinking, greater change in problem perception as searches progress, greater engagement in differentiating, and more complex phrase-oriented expressions in search transitions (Ford, Miller, & Moss, 2005b; Ford et al., 2009; Frias-Martinez et al., 2007; Wood, Ford, Miller, Sobczyk, & Duffin, 1996). Compared to Imagers, Verbalisers display the most extensive and distinctive use of linguistic search transformations (Ford et al., 2009), effective reading of text-based content (Frias-Martinez, Chen, & Liu, 2008), and visiting higher proportion of Web pages in a hierarchical architecture than in a relational structure (Graff, 2005; Liu & Belkin, 2011).

Papaeconomou and his colleagues (Papaeconomou, Zijlema, & Ingwersen, 2008) conducted an exploratory study to examine the Global/Sequential dimensions of ILS and found out their influence on Web page relevance assessment and eye-tracking patterns. Global learners applied depth/scope and Web layout as a major criteria while Sequential learners depended strongly on link anchor text and the topic of the Web page criteria. More interestingly, the result also showed different eye-tracking patterns between the two styles of learners. When interacting with web pages, Sequential learners displayed the pattern by gazing from left to right and followed the layout of the page. The Global learners, on the other hand, applied more diffuse modes of gazing at the same page.

Researchers reported that it is not possible to create a common hot spot pattern of Global learners' gazing on the page.

2.3.2 Impacts of Learning Style on Learning

During past decades, the constructs of learning style have been receiving growing attention in educational research. Researchers' major focus is to examine the influence of the cognitive factors on learning performance (e.g., achievement tests, grade point average, teachers' evaluation, and problem solving). Previous research has been performed at various levels of education, including middle/high school (Zhang, 2008; Zimmerman & Ringle, 1981) and higher education (Cassidy & Eachus, 2000; Wang & Chen, 2008; Zhang, 2002). Several researchers investigated students' performance in different areas, e.g., business education (Au, 1997; Backhaus & Liff, 2007), computer science (Johnson & Kane,1992), and medicine (McManus, Richards, Winder, and Sproston, 1998). These studies show the direct and indirect effects of students' learning style on their achievements.

Other studies also investigated how learning styles impact students on their learning strategy (Sadler-Smith, 1999; Rickards, Fajen, Sullivan, and Gillespie, 1997) and preference of learning material (Riding & Douglas, 1993; Riding & Grimley, 1999; Riding and Ashmore, 1980; Riding & Calvey, 1981; Riding & Dyer, 1980). Table 2.2 briefly summarizes the related empirical research discussed above.

Table 2.2 Empirical Research Studies Investigating Learning Style on Learning

Search Characteristics	Measures	Example Research Studies Investigating Learning Style on Learning
Learning Performance	Achievement/ Performance tests	Au (1997); Backhaus & Liff (2007); Cassidy & Eachus, (2000); Hansen & Stansfield (1981); McManus et al. (1998); Wang & Chen (2008); Zhang (2002) ; Zhang (2008)
	Programming	Johnson & Kane (1992)
	Problem solving	Williams (2001)
	Teacher Evaluation	Riding et al. (2003)
Learning Strategy	Deep/surface strategy	Sadler-Smith (1999)
	Signaling phrases	Rickards et al. (1997)
Learning Preference	Content structure	Riding & Douglas (1993); Riding & Grimley (1999)
	Mode of presentation	Riding & Ashmore (1980); Riding & Douglas (1993)
	Type of content	Riding & Calvey (1981); Riding & Dyer (1980)

2.3.3 Impacts of Learning Style on Information Retrieval

Although based on the considerable amount of literature discussed above, there is a direct relationship between various cognitive factors and information seeking and searching performance. It is still not clear in what ways these factors influence the users' behavior; therefore, a closer look at the previous literature need to be taken. After

carefully reviewing the related IR user studies, it can be concluded that cognitive factors have impact on users searching strategies and perceptions, which can be measured through search time spent, search effort devoted, search strategies utilized, retrieval performance, intention, perception, and satisfaction.

Search time

Many research studies found that the search time required by users with different cognitive/learning styles differed significantly. Search time is employed and defined diversely in different research; the majority of articles measure search time based on completion of a search task (Gorrell et al., 2009; Hong, 2004; Liu & Belkin, 2011; Palmquist & Kim, 2000; Tenopir et al., 2008; Wang et al., 2000). In the study conducted by Palmquist & Kim (2000), the search time is the average period of time spent on retrieving a piece of information. The search task was performed to find information on general requirements for applying for graduate study at a southwest university. The participants were asked to make a bookmark of the Web page containing the target information once they found it. The calculation was obtained by dividing the total length of completion time spent by a participant by the number of bookmarks that he/she made during the search session. Palmquist & Kim concluded that novice field dependent users needed more time and visited more nodes than their field independent counterparts did. The second example that demonstrates the relationship between cognitive factors and search time used automatic recording techniques to obtain the search time (Frias-Martinez et al., 2008). Other researchers utilized characteristics based on total search time

(Hupfer , Detlor, Toms, & Trifts, 2009), frequency of use (Hupfer et al., 2009), move speed and pause time (Tenopir et al., 2008).

Search effort

There are many types of search efforts measured in previous research as indicators of the influence of cognitive factors. The search effort variables that have been investigated include the number of search terms or queries initiated (Wood, Ford, Miller, Sobczyk, & Duffin, 1996; Hupfer et al., 2009; Kim et al., 2004), number of URLs or documents evaluated (Wang et al., 2000; Graff, 2005), number of mouse clicks (Hupfer et al., 2009), persistence (Nahl, 1996), and number of search operator (Kim et al., 2004). Kim & Allen (2002) measured a combination of search efforts, including average time spent, average number of URLs viewed, average number of bookmarks made, and average number of times a search/navigational tool was used for completing a search task. Kim and his colleagues (2004) found that the FD group marked up to three times as many of the following factors as the FI group: the number of repeated search attempts, the number of search operators, and option-based search style. For keyword-based search style, on the contrary, the FI group showed more search attempts with changed keywords in their search queries.

Search strategies

In addition to search efforts, previous research explored other different search strategies in which different cognitive characteristics were a determining factor. The use of specific search and navigation features was the most reported strategy (Frias-Martinez

et al., 2007; Frias-Martinez et al., 2008; Hupfer et al., 2009; Kim & Allen, 2002; Kim et al., 2004; Kinley & Tjondronegoro, 2010; Wood et al., 1996). Kim and his colleagues (2004) conducted an experimental study on web searching strategies of elementary students of different cognitive styles and analyzed the variation in their searching strategies. The search strategies are categorized into two different styles: option-based and keyword-based. The tendency to depend on search options provided by the system to improve search results is called an option-based style. The tendency to provide variations in search keywords to increase the search precision/recall ratio rather than depending on operating features of information search is regarded as a keyword-based style. Results of the study indicated that the field-independent group showed much more search attempts by retrials with changed keywords. Beside the specific search feature, other strategies incorporated in research include linear/non-linear traversed mode (Palmquist & Kim, 2000; Hupfer et al., 2009), proportion of pages visited (Graff, 2005), search transformation (Ford et al., 2009), preference of presentation format (Liu & Reed, 1994), webpage relevance assessment criteria and eye-tracking pattern (Papaeconomou et al., 2008).

Search performance

The performance of information seeking and searching is identified as an indicator to demonstrate the cognitive influence. For example, Palmquist and Kim reported AVNODES as the 'search efficiency' performance, which was the average number of nodes visited for retrieving a piece of related information. The calculation was derived by dividing the total number of nodes visited for completing a search task by the number of

bookmarks (relevant website information) made. Other research also reported indicators such as number of relevant or credible references retrieved (Wood et al., 1996; Kim et al., 2004; Kim & Allen, 2002), source relevance (Hupfer et al., 2009), and performance score (Compeau & Higgins, 1995).

Search perception

Previous research also identifies that cognitive factors would affect how people perceive and feel about the search interactions. Information searching behaviors not only can be measured by the cognitive levels, such as search strategies and performance, they can also be measured from attitude or motivational perspectives, including satisfaction (Wood et al., 1996; Frias-Martinez et al., 2008; Hupfer et al., 2009), perceived ease of use and usefulness of web content (Liu & Belkin, 2011; Rains, 2008), information quality/service attitude (Rains, 2008; Hernandez, Jimenez, & Jose Martin, 2009), perceived search success (Ford et al., 2009; Rains, 2008; Wood et al., 1996), and intentions to use again in the future (Rains, 2008; Hernandez et al., 2009). In a study investigating the perception of cognitive style users toward a comparatively text-based university library catalog system, verbalizers are more satisfied with the ease of use and functions provided by the system (Frias-Martinez et al., 2008).

Table 2.3 summarizes the search characteristics, specific search features, and related empirical research studies discussed in this section. Based on the literature, the most common search characteristics adopted are search frequency, search time, and search strategy. Therefore, the observation of help-seeking behaviors conducted in this study was based on these three measurements.

Table 2.3 Empirical Research Studies Investigating Learning Style on IR

Search Characteristics	Measures	Example Research Studies Investigating Learning Style on IR
Search Time	Search time to complete a task	Frias-Martinez et al.(2007); Frias-Martinez et al. (2008); Kim & Allen (2002); Palmquist & Kim (2000); Tenopir et al. (2008); Wang et al. (2000)
	Frequency	Kim et al. (2004); Liu & Reed (1994)
	Move speed/pause time	Tenopir et al. (2008)
Search Effort	#of search terms/ Attempt/Effort	Hupfer et al. (2009); Kim et al. (2004); Wood et al. (1996)
	# of URLs visited	Graff (2005); Hupfer et al. (2009); Kim & Allen (2002); Wang et al. (2000)
	# of mouse clicks	Kim & Allen (2002)
	# of search operator	Kim et al. (2004)
Search Strategy	Use specific search/ Navigation	Frias-Martinez et al. (2007); Frias-Martinez et al. (2008); Kim & Allen (2002); Kim et al. (2004); Hupfer et al. (2009)
	Traversed mode	Hupfer et al. (2009); Palmquist & Kim (2000)
	Proportion of pages visited	Graff (2005)
	Search transformation	Ford et al. (2009)
	Preference of format	Liu & Reed (1994)
	Relevance criteria & eye-tracking pattern	Papaeconomou et al. (2008)
Search Performance	Number of relevant website information	Kim et al. (2004); Palmquist & Kim (2000); Wood et al. (1996);
	Source relevance and performance score	Hupfer et al. (2009)
Search Perception	Satisfaction	Frias-Martinez et al. (2008); Hupfer et al. (2009); Wood et al. (1996)
	Perceived ease of use and usefulness	Frias-Martinez et al. (2008)
	Perceived search success	Ford et al. (2009); Wood et al. (1996)

2.4. Help-seeking Behavior

As stated earlier, this review focuses on considering information seeking and searching as a learning process. Today, cognitive researchers are more concerned with various mental activities, such as perception, thinking, knowledge representation, and memory. These activities are related to human information processing and problem solving. The cognitive approach proposes learning as changes in knowledge, the internal representation system of human. In this view, learning is an active, constructive, metacognitive process (Shuell, 1986). Many educational scholars believe that help-seeking is one of the most important skills in overcoming learning difficulties (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Mercier & Frederiksen, 2008; Nelson-Le Gall, 1985). Since many educational and psychological theories have carefully examined how human cognitive influence people perceive, process, and apply information, perspectives of cognition from educational psychology would be adopted to explore the concept information seeking and searching in the following section.

Research on help-seeking has a long history and has evolved a sound theory indicating that help-seeking is an important academic strategy that facilitates learning (Karabenick, 1998). As stated previously, learning involves the process of bringing about changes in learners' knowledge. In order to make such changes, learners can seek help from a competent person. For example, a younger learner may encounter difficulties when solving a particular problem alone and thus seeks out teachers or classmates for help and advice. This behavior represents that learner's possible adaptive approach is trying to solve a difficult problem with help instead of just abandoning it. It is generally

believed by educators that children who seek help are more goal oriented and more engaged in the learning process. When confronting difficulties, they are more willing to put effort into their problems, not just wait there for others to help them or simply give up (Nelson-Le Gall, 1981).

2.4.1 Help-seeking in Educational Setting

In a teaching and learning setting, help-seeking allows the learner to actively create an environment that is sufficiently supportive for them to make progress. It is believed that help-seeking enables individuals to acquire and master increasingly complex skills and knowledge. Different models of help-seeking, particularly in problem solving and online learning environments, are provided to illustrate the detailed processes involved in help-seeking. In addition, influencing factors are also discussed as follows. The models are: (1) Nelson-Le Gall's model of help-seeking, (2) Newman's adaptive help-seeking model, and (3) other help-seeking models in interactive learning environment.

Nelson-Le Gall's model of help-seeking

In educational settings, two different types of help-seeking were proposed and differentiated: *executive help-seeking* and *instrumental help-seeking* (Nelson-Le Gall, Gumerman, & Scott-Jones, 1983). Executive help-seeking involves a learner's intention of having someone else solve a problem for the learner. Although it is not surprising for young learners to ask for executive help-seeking in order to solve a difficult task, it is a passive approach in problem-solving and may also be harmful to the development of independent mastery learning. Instrumental help, on the contrary, refers to situations

when only a very precise amount of help is requested. Learners only want some hint and guidance rather than the direct answer for the problem. They may decline help if they can perform the task or solve the problem by themselves. However, when facing a problem that is beyond their competence, they would immediately ask for the help they need.

Help-seeking allows the learner to actively create an environment that is sufficiently supportive to make progress. It is believed that instrumental help-seeking enables individuals to acquire and master increasingly complex skills and knowledge. The deliberate use of help-seeking as a problem-solving activity requires a fair amount of cognitive sophistication. According to a help-seeking model proposed by Nelson-Le Gall (1985), several major cognitive processes of help-seeking were outlined, including awareness, decision, identification, employment, and evaluation. First, individuals become aware that the problem is difficult and that they need help to accomplish the task. Then the learners contemplate the available resources versus the situations, and they make the decision to seek help from others. The learners would need to identify and select a suitable helper who can provide the needed resources. In the next steps, certain processes for execution of help are thus required. Learners have to use strategies to elicit help, and their choices of different strategies are normally influenced by their knowledge and skills in a traditional learning environment. Finally, the learners need to evaluate the help-seeking event in accordance with the helpfulness of the help used to solve the problem, the effectiveness of help-seeking strategies, and other peoples' reactions toward help-seeking. Based on the evaluation, the learners would decide the next movement, whether looking for further help or quitting the process.

In addition to the major cognitive processes, Nelson-Le Gall also pointed out that a learner's knowledge about the problem, task, and strategies plays an overarching role in the whole help-seeking processes component. It continuously interacts with all the processes (Nelson-Le Gall et al., 1983; Newman, 1998). The help-seeking model is depicted in Figure 2.1.

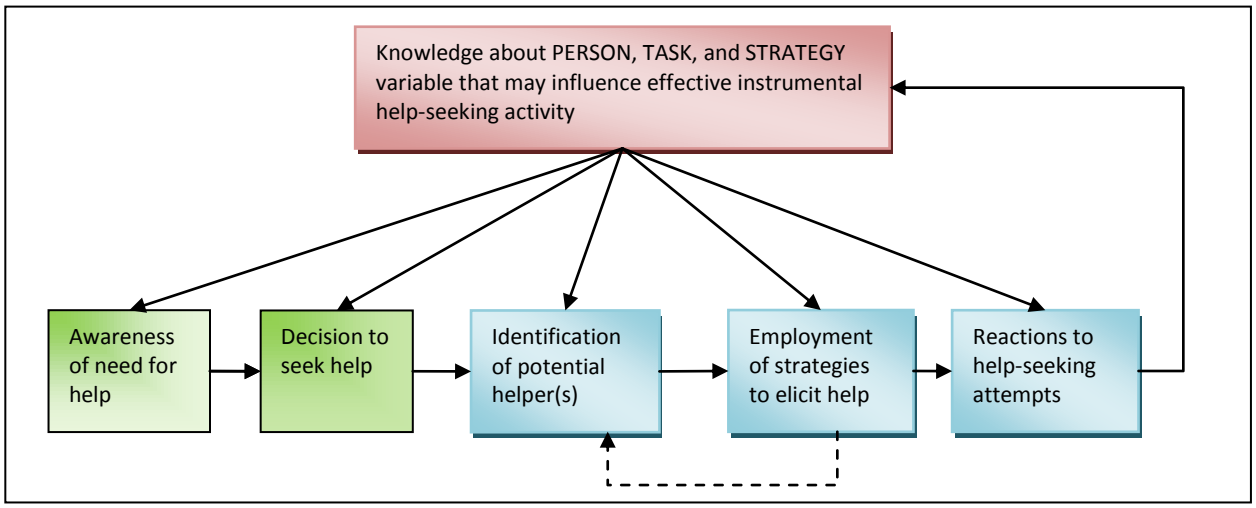

Figure 2.1 Model of Help-Seeking Processes as a Problem-Solving Skill (Nelson-Le Gall, 1983, p.270)

Newman's model of help-seeking

Newman (1994) expanded the model by emphasizing *motivation-affective* dimension in the help-seeking process. Based on the Nelson-Le Gall model, Newman (1994) proposed an adaptive help-seeking model and expanded the role of 'self-system' in the help-seeking process. By adding a cognitive dimension, Newman's model includes personal thought, beliefs, desires, values, and feelings, which all help construct learners'

choices and decisions. This cognitive dimension is depicted as a ‘motivational-affective filter’ as shown in Figure 2.3.

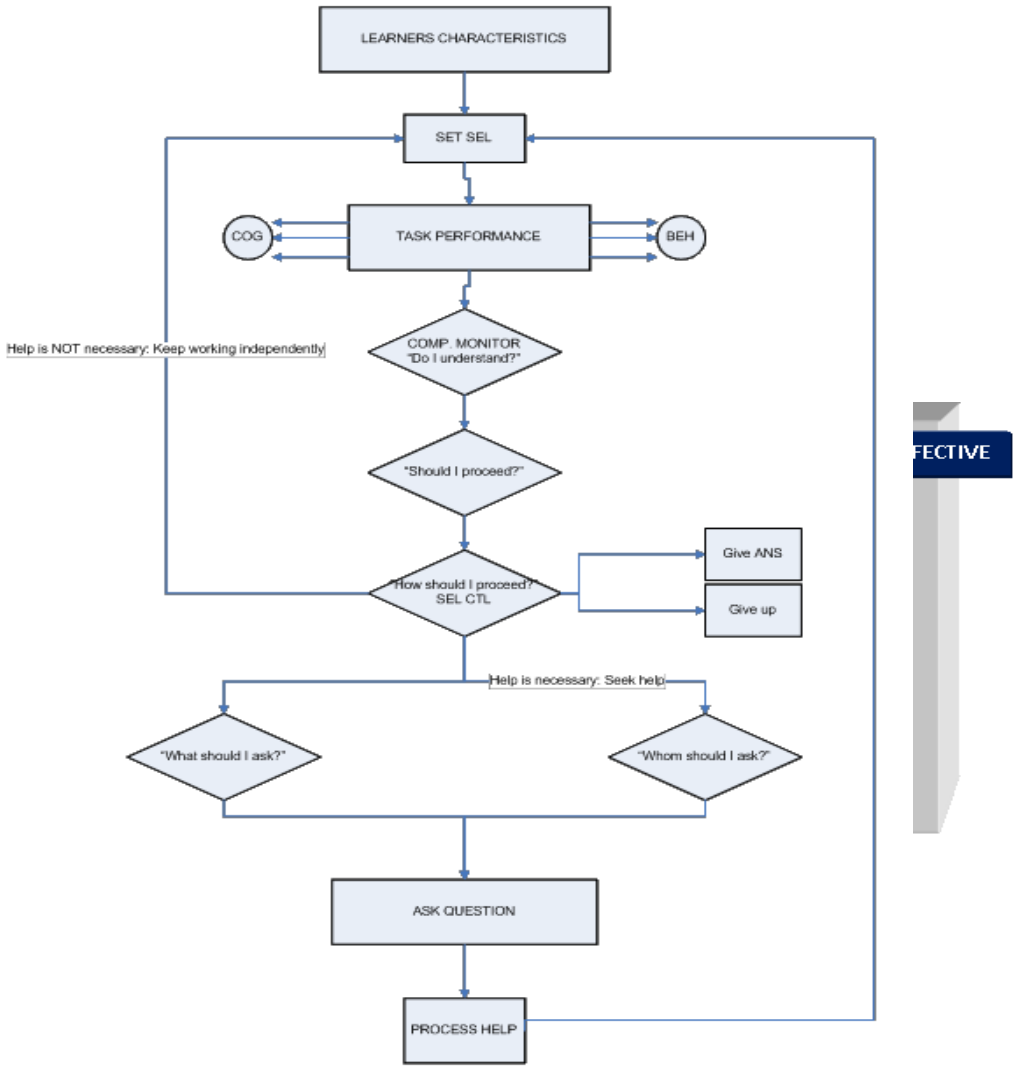

Figure 2.2 Adaptive Help-seeking Model (Newman, 1994, p.286)

While proceeding in a task, a learner can continue to monitor their comprehension with several self-questions, such as “Do I understand this?”, “Should I proceed? “, “Why should I proceed?”, “Whom should I ask?”, and etc. The processes of self-questioning is called the ‘*motivational-affective filter*’, which is a system balancing between the

confidence tolerance level (CTL) and the self-efficacy level (SEL). The CTL is already set in the self-system and is related to the intrinsic preference for challenge, natural tendency of taking risk, and involvement of task. For example, if the learner prefers a challenge, or is task-involved, or is willing to take risk, his/her CTL is probably low. SEL is the judgment of one's capability of reaching the designated levels of performance. The CTL is compared with SEL, which is dynamic, changing and task specific. If the SEL exceeds the CTL, the learner would continue to work individually and independently with increasing effort, new strategies, and some self-aid such as a dictionary, online resources, or self-questioning. However, if the SEL does not exceed the CTL, the learner might want to seek help. From the model, the learner is regarded as a *very careful and thoughtful decision maker* in the help-seeking learning process. For learners, the help-seeking is a complex process involving many factors and decisions. The motivational reason that determines whether a learner would choose a help-seeking strategy lies in the *sense of effectiveness*. The effectiveness is the evaluation result of benefits (usefulness in problem solving, mastery learning, and positive feelings such as confidence) and related cost (time, effort, and negative feelings such as embarrassment, failure, or low self-esteem). Newman's model advances Nelson-Le Gall's model in two main aspects. The first is that Newman's model strengthens the *'self-system'* role of a learner, who is self-constructing learning through means of self-questioning. The second aspect is that Newman's model depicts the help-seeking as a constructive decision-making process.

Help-seeking models in interactive learning environment

Help-seeking models proposed more recently are focusing on the computer-based interactive learning environments (ILEs). Two related models, proposed to help students in their online learning, are introduced in this section (Aleven, McLaren, & Koedinger, 2006; Mercier & Frederiksen, 2008).

Based on the Adaptive Help-seeking Model created by Newman, Aleven and his colleagues proposed a conceptual model, which illustrates how a learner makes decisions and applies different help-seeking choices to solve math problems. The model is intended to be the theoretical framework for a real help system of ILE. In comparison with traditional learning situations, Aleven and his colleagues concluded that help-seeking in ILEs basically follows the five help-seeking processes in Nelson-La Gall's model, but may also differ in some ways. As far as awareness of the need for help is concerned, they noted that in traditional learning situations, learners are not assisted in their tasks, whereas in ILEs, more detailed feedback is directly given to students. The decision to seek help may also differ across learning situations. In particular, obstacles such as the fear, worry, and embarrassment of being seen as ‘‘dumb" may not influence an ILE learner in deciding whether to seek help. However, there are limitations related to the ILE model. For example, when help systems do not provide task-specific information, learners have much more work to do in order to find applicable information (Aleven et al., 2003; Puustinen & Rouet, 2009). Based on the framework of Aleven's model on ILE, Mercier & Fredericksen (2008) further proposed a cognitive model of help-seeking embedded within problem-solving episodes. This model involves four main steps that constitute a help-seeking episode. In addition to the main steps, there is an emphasis of 'self-system' on the aspects of reflecting and monitoring.

Differences of help-seeking in classroom and information searching

The research findings based on educational settings provide valuable insights into what the processes of help-seeking are and how self-system impacts the decision to seek help. These insights benefit the understanding of help-seeking in information searching. However, it is worth noting that there are certain differences and limitations. First, the helper in the traditional classroom is usually a human (e.g., a teacher), while in retrieval systems, the human helper may be replaced by a built-in support tool, online communication, or help systems. The related costs to seek help in retrieval systems are comparatively low. These costs include help-seeking time, effort, and associated negative feelings, such as embarrassment, worry, failure, or low self-esteem. Secondly, the types of help-seeking tend to be *executive* rather than *instrumental* in information retrieval environment. Given a search task in mind, individuals are facing immediate urge to solve the problem at hand. They need to find out 'the answer' but not 'master learning' in the searching context. In summary, various models of help-seeking have been illustrated and several shared similarities and different distinctive features can be observed. First of all, all models contain the basic help-seeking processes or components as proposed by Nelson-Le Gal. These components include awareness, decision, identification, employment, and evaluation. In addition to the above major components, Newman added the 'self-system' into help-seeking and enlarged the impact of motivation and affection. It is worth noting that the help-seeking processes depicted in the models have a high resemblance to information seeking and searching processes. Thus, the help-seeking related factors, such as learners' self-system can be applied to the situation of how users seek help in IR settings.

2.4.2 Help-seeking in Information Searching

Help-seeking is generally regarded as an important problem-solving skill to achieve goals in different contexts. Many educational scholars believe that help-seeking is one of the most important skills in overcoming learning difficulties (Nelson-Le Gall, 1985). In information-seeking and searching environments, while a user is engaged in the process of interacting with an IR system, he/she may easily encounter problematic situations and need some kind of help in that search process either from the system or from a human (Xie & Cool, 2009). Previous research has demonstrated that the existing help systems in digital libraries as well as other IR environments cannot fully satisfy users' needs. Therefore, while viewing help systems as important, people generally find these systems to be ineffective in a variety of areas. Thus, they tend to use help mechanisms less frequently (Cool & Xie, 2004; Fisher, 1999; Ismail, 2010; Mansourian, 2008; Pratt, 1998). Dworman and Rosenbaum (2004) also pointed out that users do not use the help systems effectively. They hypothesized that users may not use help for many reasons, including: (1) inability to notice the existence of help within the application system, (2) aversion to leave their current task, (3) fear, based on past failed experiences in using help, (4) refusal to admit they are defeated, and (5) tendency of clicking on anything not called 'help', e.g., 'hint', 'tip', or 'quick reference'. Other researchers shared the same views and concluded that the use of help systems was often misleading or incomplete, difficult to navigate, or did not contain enough examples (Purchase & Worrill, 2002). It may even increase the level a user's anxiety (Downs & Jackson, 2001; Grayling, 1998; Pratt, 1998).

Based on the theories of Nelson-Le Gall's (1981) model of the human help-seeking process and theories of interactivity, Willis (2006) proposed a help-seeking model in a

software application context. According to Willis, help systems provided for current software applications do not adequately support the natural help seeking behaviors of human beings. More specifically, the deficiencies of support were identified to be linked with the evaluation of the help-seeking episode and three interactivity dimensions, including adaptivity, communications, and creativity. Since the number of many new IR systems has seem proliferative growth during the past decade, most users are unfamiliar with them. Novice users, who never use or rarely use IR systems, are in need of help when being situated in a new and strange searching environment. They are vulnerable in the beginning stage and need assistance to get through the search process and fulfill their information needs (Nahl, 1999).

In studying user-system interaction, Xie and Cool (2009, p.477) defined the feature of help-seeking as follows:

> " *Help-seeking is characterized by a person, who is engaged 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. In this context, help refers to assistance or clarification from either an IR system or a human in the search process when people encounter problems*."

In an information retrieval environment, ***help-seeking represents a mini information search process***. Therefore, cognitive factors that influence information searching discussed previously would also affect users' help-seeking behavior.

As Meadows (2008) stated, "a proper understanding of human information retrieval is now seen as involving an examination of cognitive factors. For example, Belkin's anomalous states of knowledge (ASK) model – which attracted considerable attention –

hinged on the point that the actual information needs of potential users are not necessarily known (Belkin, Oddy, & Brooks, 1982).” He further pointed out that the implication of such models is that retrieval systems must allow a high level of interactive input from the information seeker. As Gorrel and his colleagues (2009, p.457) stated “these findings contribute to the long-term aims of the research to develop a model of the actual and potential role of cognitive factors in information searching, and identify strategic cognitive interventions that can be built into an intelligent information retrieval system, driven by the model, capable of enhancing retrieval effectiveness by compensating for cognitive and affective weaknesses on the part of the searcher”.

Xie and Cool (2009) pointed out similar remarks and called for the identification of help-seeking situations and more associated factors. In their proposed help-seeking model, Xie and Cool identified seven help-seeking situations and their associated factors. The seven situations are: getting started, identifying collections, browse, creating search statements, refining searches, monitoring searches, and evaluating results. The associated factors are users’ personal information infrastructure (knowledge of domain/system/retrieval, experience, and search style), tasks (complexity, types, and requirement), system (interface design, search mechanism, and content coverage), and interaction outcomes. The help-seeking model is presented in Figure 2.3.

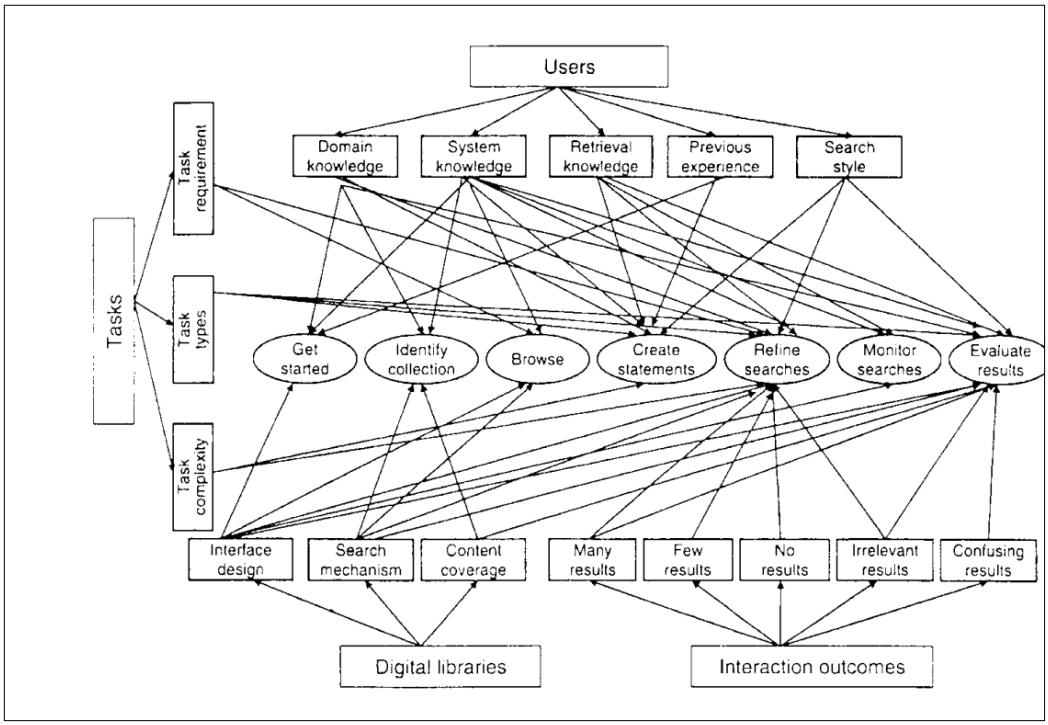

Figure 2.3 Help-seeking Model (Xie & Cool, 2009, p.490)

Previous research has identified learning styles as an influential factor in information retrieval. More specifically, the implication is to integrate the factor of learning style into the help-seeking process and develop a micro-user model, which serves as the theoretical basis for the development and implementation of more helpful IR systems. The impact of learning styles on the theoretical framework in learning and problem solving has been confirmed. It can be applied as an additional dimension to understand users' help-seeking in IR environments. For example, the learning style can be added to the personal information infrastructure in Xie and Cool's model. The combination of the dimension not only provides a more diversified facet of users but also relates these user characteristics to system design and other factors in Xie & Cool's model. As stated earlier in the previous section, learning styles may have influence on how users choose search

strategies and preferred system help features in terms of content organization and presentation format. These relationships can be further explored and interwoven with the original structure in order to provide a deeper understanding of users' help-seeking behavior.

Implications for improving help-seeking situations

According to Chang and his colleagues (Chang, Morales Arroyo, Aung, Lwin, Htike, & Kravchyna, 2008), novice users normally use online help to seek help when they encounter problems. Expert users, who use a search engine daily, don't rely on help mechanisms and prefer trial and error methods when problems are encountered in IR environment. In order to meet different users' needs, help content is recommended to be organized by users' proficiency levels, including beginners, intermediate users, and advanced users. Moreover, different types of help resources need to be offered to accommodate diverse preferences in learning, e.g., learning styles. According to Hsu (1993), learning style is related to students' learning in an intelligent system with explanation-based help system. Hsu found that FD users were more affected by different explanation types than FI. FI learners learned better with flexible and justification types of explanations than they did with rule-based explanations. In addition to the above proposed model, Xie & Cool (2009) suggested practical design implications to improve the help-seeking problems encountered by users. Table 2.4 summarizes the help-seeking situations and design implications. The suggested design implications are mainly concerned with the formats, content, organization, and types of explicit or implicit help

features. With more attention paid to these concerns, any system can accommodate different cognitive styles and motivational states of general users.

Another study identified users' help-seeking strategies when users failed to satisfy a specific information need in the web searching environment (Mansourian, 2008). In his study, Mansourian defined help-seeking as 'coping strategies' and classified them into *active* and *passive* coping approaches. Active strategies, such as revising and help-seeking, require further actions to obtain more satisfactory results. In contrast, passive strategies involve less action to modify the current situation and mainly accept existing circumstances. It is usual that searchers would prioritize their help-seeking strategies according to the importance of the search, their determination to change a failed search, and the overall contextual requirement. Therefore, more context-sensitive help was suggested to compensate for problematic situations encountered by users who are more apt to use passive strategies and less determined.

Table 2.4 Help Seeking Situations and Related Design Implication in Xie & Cool's Study

Help-seeking Situations	Design Implication	Cognitive Concern
Getting Started	• Context-sensitive domain knowledge • Overview of the structure and design of an IR system • Intuitive interface design	Content Presentation format
Identifying Collections	• Linkage between collections and different subject areas • Search mechanism for identifying specific collection(s)	Organization
Browse	• Demo of browsing options and structure • FAQs regarding when to browse	Explicit Help
Creating Search Statements	• Templates of searches based on task type and complexity • Context-sensitive knowledge assistance • Examples of how to create search statements	Explicit/Implicit Help Content
Refining Searches	• Explicit and implicit feedback mechanisms • Interactive dialog protocol • Integrating the help page into actual browsing and searching page	Explicit/Implicit Help Type of help - interactive Presentation
Monitoring Searches	• Search history and search path options	Type of help - orientation
Evaluating Results	• Different evaluation mechanisms for different types of tasks • Context-sensitive knowledge assistance • FAQs/examples for dealing with unsatisfied interaction outcomes	Type of help Content Explicit/Implicit Help

2.4.3 Impact of Learning Style on Help-seeking

Previous research generally recommends that system designers should take cognitive factors into account in the development of help features in IR systems. An effective IR system interface needs to provide great affordance and facilitate correct cognitive development by presenting appropriate messages/clues and providing context- sensitive help based on detected user characteristics or behaviors (Wang et al., 2000). However, the mismatch between individual users' cognitive styles and most of the help feature designs led users to problematic situations, such as devoting more time and effort to a task than is appropriate or failure to complete a task. The example stated earlier in this

section demonstrates that novice FD users needed more time and visited more nodes than their FI counterparts did. This implies that the novice FD users tend to have a greater chance to encounter disorientating situations and therefore needing to seek help. In order to help FD users, researchers suggested that interface designers need to consider providing help features with more orientation devices, such as graphical maps of their search progress and a visual history of visited nodes (Palmquist & Kim, 2000), an alphabetical browsing index (Frias-Martinez et al., 2008), or simply by making "help" screens that provide advice to searchers more accessible (Kim & Allen, 2002). In an attempt to accommodate different preferences of both FD and FI users, Chen and her colleagues suggested several guidelines, particularly for the design of web directory features provided in most search engines (Chen, Dimakopoulos, & Magoulas, 2005). In their study, 57 students in the department of Information Systems and Computers from a UK university participated in the experiment. The research team proposed a flexible interface called "Intelligent Directory", with a variety of means to find information. They suggested detailed design implications, including offering successive options, switching visual cues, using scrolling menus, presenting multiple frames, and providing additional support using colors or icons.

Other dimensions of learning styles also draw the attention of many researchers to improve the help-seeking situations. For example, Verbalizers have a more positive perception, as well as effective search performance, in the design of a text-based library catalog system than do other cognitive style groups. However, the design of help features cannot just support Verbalizers and ignore the needs and preferences of other cognitive styles. Thus, multimedia elements are recommended to be included in system design so

that the preferences of Imagers can also be considered (Graff, 2005). Graff also suggested that there is a need to place certain pieces of help information at particular strategic points throughout in Web architecture in order to accommodate different hypertext browsing strategies of Verbalizers and Imagers. Nonetheless, such multimedia or extra mechanisms may not suit all types of cognitive styles. Furthermore, there is a need to provide *personalization*, which can be delivered by providing *adaptivity* (able to adapt) or *adaptability* (capable of being adapted). In an adaptive system, users' cognitive preferences can be identified by either monitoring his/her behavior with data mining techniques or by obtaining this information from external surveys. Once the users' cognitive preferences can be detected, the design of help features in IR systems can be automatically changed to match the preferences of each individual without user's intervention. According to Liu and Belkin (2011), the detected and observed users' preferences can be used to provide personalized help in IR systems by re-ranking search results or reformulating queries, thus helping users complete their tasks more effectively and efficiently. In system with adaptability, users are allowed to modify the design of an IR system themselves based on their own preference. Examples like a checkbox-based form can be supplied for users to identify preferences by entering a checkmark in a suitable checkbox. The design of help features of any IR system would be changed based on their choices in the checkbox-based form (Frias-Martinez et al., 2008).

2.5. Summary

Previous research in IR has shifted from a system-centered approach to a user-centered cognitive approach. A user-centered cognitive approach incorporates users' knowledge, interests, and preference into system design. Due to the emergence of a user-centered approach toward IR research, more emphasis has been placed on cognition, including human knowledge, skills, attitude, motivation, and other related factors.

In information seeking and searching environments, while a user is engaged in the process of interacting with an IR system, he/she may easily encounter problematic situations and need some kind of help in the search process. Novice users need to learn how to use new IR environments by interacting with help features to fulfill their searching need. When viewing help-seeking as a learning activity, learning style is an influential factor that would lead to different help-seeking behaviors. Learning style deeply influences how students process information in learning activities, including learning performance, learning strategy, and learning preferences. Since there were no studies that considered learning style and help-seeking together, the aim of this study was exploring the effects of learning style on help-seeking interactions in the information seeking and searching environment.

CHAPTER THREE RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, several facets of study methodology that were used to investigate the research problem are included. It begins by describing the research questions followed by the discussion of adopting mixed method research design considerations, which include qualitative illustration and quantitative testing. The chapter then looks more specifically at the selection of digital libraries, types of tasks, sampling strategy, descriptive findings, and, finally detailed description of the procedures to collect data. Both qualitative and quantitative methods to analyze data are presented. After presenting the data collection and analysis procedures, the chapter concludes with the descriptions of methodology used in the pilot study, validity and reliability of data, and limitation of the study.

3.2 Research Questions

The overall purpose of this study is to understand novice users' help-seeking behaviors in online information seeking and searching. In supporting this purpose, the primary objectives are twofold. The first objective is to identify the types of help features that novice users with different learning styles use in digital libraries. The second objective is to further identify the different help-seeking approaches applied by novice users with different learning styles.

Research questions are listed as follows:

RQ 1. What are the types of help features that novice users with different learning styles use in digital libraries?

RQ 2. Is there a significant difference in novice users' help feature use based on their learning styles?

RQ 3. What are the help-seeking approaches that novice users with different learning styles apply in digital libraries?

The associated research hypotheses are discussed in detail in section 3.7 Data Analysis.

3.3 Research Design

A user study was designed to address the proposed research questions and associated hypotheses. Both qualitative and quantitative methods were employed to systematically collect and analyze the data. The mixed methods design consists of three major components: qualitative exploration, quantitative verification, and qualitative illustration. In this design, the qualitative data were first collected and analyzed to explore different types of help features used by users with different learning styles. After the types of help features were identified as the fundamental representative help-seeking behavior, the associated quantitative data were collected, and the relationships between learning styles and help feature use were tested to see whether or not the results would support the preliminary findings obtained in the exploratory stage. The first two components of the design serve as the foundation for the third component of qualitative illustration, which illustrates more in-depth understanding of help-seeking approaches adopted by users with

different learning styles. Results from the three major components were analyzed, connected, and interpreted to better understand novice users' help-seeking behaviors. Figure 3.1 depicts the three components of the research design.

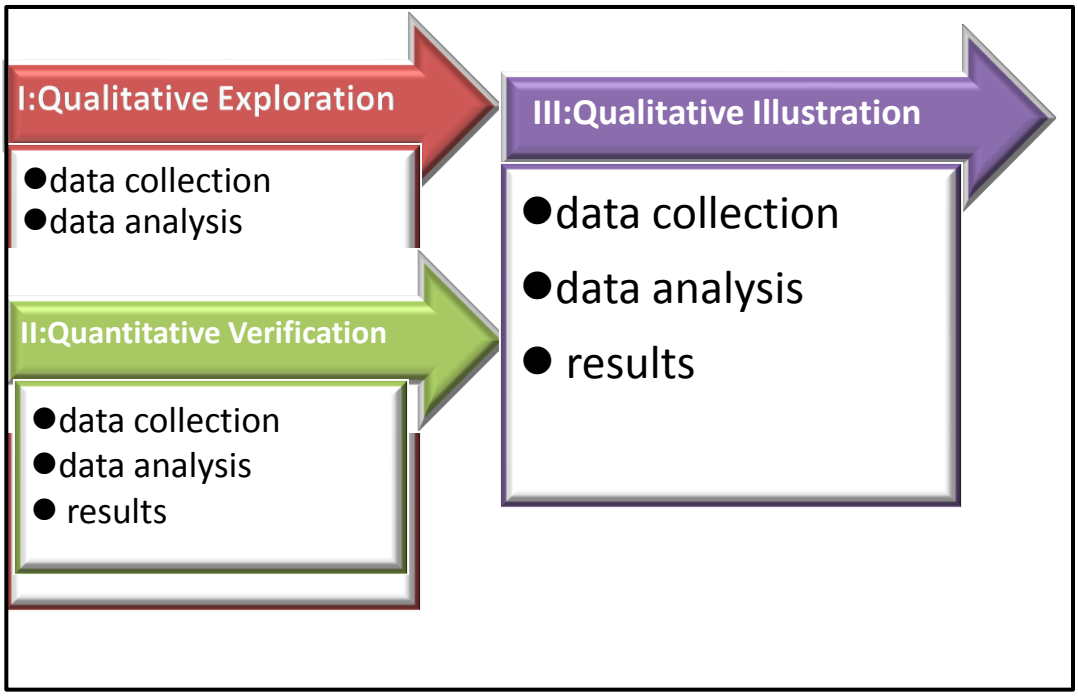

Figure 3.1 Components of the Research Design

The rationale for this approach is that the qualitative data and their subsequent analysis provide exploratory identification of the research problem. The qualitative data and their analysis explain and illustrate the results from the analyses. Case (2002) provided an answer to why researchers apply multiple methods by stating "one way to conduct research that is both valid and reliable is to be found in the use of multiple methods and multiple sources of data". It is so true that many researchers share this point of view and advocate the use of triangulation (Patton, 2002; Silverman, 2005).

Triangulation refers to the use of more than one approach to the investigation of research questions in order to enhance confidence in the findings. Denzin (1978) has suggested that four different modes of triangulation can be performed to increase research integrity— in relation to data sources, analysts, theory/perspective, and methods. These four modes are: (1) data triangulation: the use of a variety of data sources in a study; (2) investigator triangulation: the use of several different researchers of evaluators; (3) theory triangulation: the use of multiple perspectives to interpret a single set of data; and (4) methodological triangulation: the use of multiple methods to study a single problem. All these triangulation modes provide strategies for reducing systematic bias and distortion during data analysis. Since much research is found to use only one research method and thus may suffer from limitations associated with that specific approach. The application of combining several research methodologies in one research study provides the ability to double check the results and to counterbalance the weaknesses. Hence, any bias, distortion, limitation, or weakness of a method can be compensated for. In addition, the advantage of facilitation is also stressed. When two or more different research strategies are used to investigate the same phenomenon, findings from one strategy can be confirmed by the other. The focus is to carefully look for the degree of convergence (Denzin & Lincoln, 2005; Denzin, 1978). By mixing methods, researchers are allowed to address issues more objectively, resulting in richer and more comprehensive findings.

The mixed approach of both qualitative and quantitative can be used in a complementary fashion to answer different questions. The focus is to carefully look for the degree of convergence rather than a forced choice between the two approaches (Denzin & Lincoln, 2005; Denzin, 1978).

3.4 Design Considerations

Some design considerations are addressed in this section, including the selection of digital libraries, types of performing tasks, research permission, consent forms, and confidentiality.

3.4.1 Selection of Digital Libraries

Two digital libraries (DLs) were selected for this study: University of Wisconsin Milwaukee Digital Collection (UWMDC) (http://www4.uwm.edu/libraries/digilib/) and the Library of Congress Digital Collection (LOCDC) (http://loc.gov/ Library/libarch-gidital.html). Figure 3.2 and figure 3.3 show screen shots of the two DLs (Retrieved April 29, 2012).

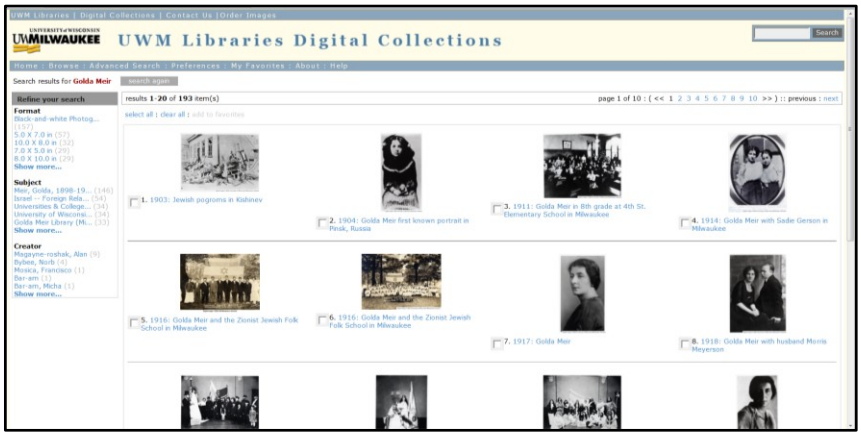

Figure 3.2 Screenshot of University of Wisconsin Milwaukee Digital Collection (UWMDC)

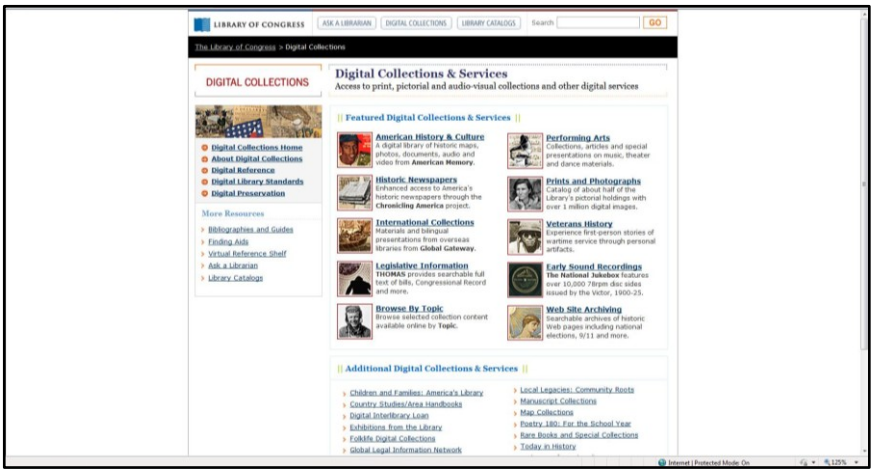

Figure 3.3 Screenshot of Library of Congress Digital Collection (LOCDC)

UWMDC is a digital library aiming to serve the University of Wisconsin Milwaukee academic community as well as the general public. It provides remote access to 30 digitized collections covering diverse topics, such as global issues and local cultural heritage. LOCDC is a national level digital library established by Library of Congress. It provides digitized materials on more than 100 thematic topics ranging from American government to world culture. LOCDC provides richness and relatedness of accessible content for general academic users. Since participants of this study are mainly UWM students, these digital libraries were selected base on the users' potential interest in and utilization of them.

In addition, the two DLs contain visual, audio, and other multimedia formats of information in various topics. Most importantly, both DLs facilitate information seeking of novice users with complete and different types of help features. Figure 3.4 and figure 3.5 illustrate the online help services of UWMDC and LOCDC (Retrieved December 10, 2011). The online help of UWMDC use the exact term ‘help’ to provide help information

on the related topics: browsing collections, using advanced search, viewing results, viewing items, viewing compound objects, and changing preferences. LOCDC also provide online help with various services but labeled in different terms, for example, Finding Aids (search by keyword and browse), Bibliographies and Guides, Virtual Reference Shelf, Ask a Librarian (chat, email, inquiries/comments form, and Frequently Asked Questions).

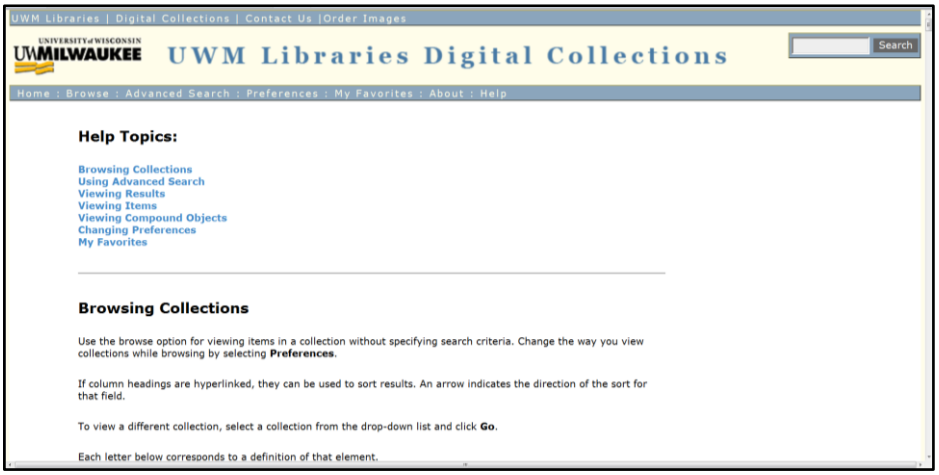

Figure 3.4 Online Help of UWMDC

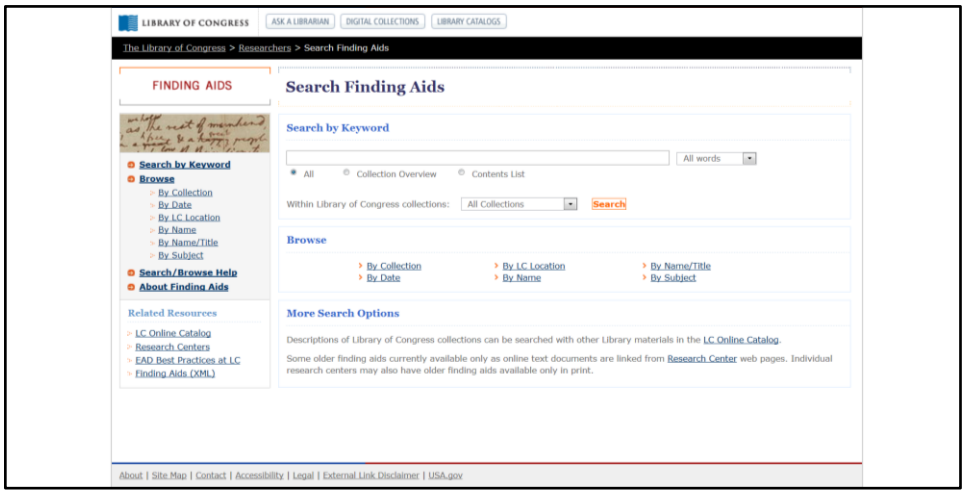

Figure 3.5 Online Help of LOCDC

3.4.2 Types of Tasks

Three types of search tasks were assigned to participants: looking for known items, looking for specific information, and looking for items with common characteristics (Xie, 2008). The first type of task - looking for known items - refers to entities that can be identified by particular information, like an author's name or book title. The second type of task - looking for specific information - refers to searching for an exact fact or data. The third type of task - looking for item with common characteristics - refers to searching for items on the same subject (Xie, 2009). Three different tasks were chosen to represent the three types of tasks that users generally pursue in digital libraries as well as to fit the coverage of the two selected DLs.

In this study, the first type of task was using three different approaches to find known items, including video clips of a Coca Cola advertisement and of Martin Luther King. The second type of task required participants to search for specific information, e.g. the names of United States presidents who were assassinated during their presidency. The third type of task was to find resources related to historical figures, such as a baseball player or a civil right activist. Table 3.1 shows the detailed tasks for each individual digital library.

In order to reduce the bias caused by the order of the two digital libraries, half of the participants searched UWMDC first, and the other half started by searching LOCDC. In addition, task difficulties were also found to influence users' search behaviors (Gwizdka, 2008; Gwizdka & Spence, 2006; Liu et al., 2010), so a range of tasks covering easy, medium, and difficult levels are included in this study. The tasks are designed to have

different levels of difficulty based on the task complexity categorization proposed by Bystrom & Jarvelin (1995). According to Bystrom and Jarvelin, the categorization is based on the determinability of task outcomes, process, and information requirement.

Table 3.1 Selected Tasks

Types of Search Tasks	**LOCDC**	**UWMDC**
Known Item Search	Find a video clip of a Coca Cola advertisement produced in 1964. [Easy Task]	Find a video clip of Martin Luther King speaking at UW-Milwaukee. [Easy Task]
Specific Information Search	Who are the four US presidents assassinated during their presidency? And in which years? [Difficult Task]	When was the Milwaukee River Dam demolished? [Difficult Task]
Subject-Oriented Search	Assume that you have to write a report on Jackie Robinson and his career as a major league baseball player. Please collect as many aspects of relevant items as possible, e.g. brief biography, major achievements and some related images that could be useful for your report. (within 10 min.) [Medium Task]	Assume that you are supposed to make a presentation in class about Lloyd Barbee's contribution to the Wisconsin's civil right movements. Please collect as many relevant aspects of relevant items as possible, e.g. brief biography, major events involved, and some related images that could be useful for your presentation. (within 10 min.) [Medium Task]

3.4.3 Institutional Review Board

In compliance with the regulations of the UWM Institutional Review Board (IRB), the permission for conducting the research was granted (IRB#: 12.353 04/30/2012). The required IRB forms, including New Study Form and Protocol Summary Form were filed. The New Study Form provided information about the investigator, the study title, study duration, type of review requested, sources of funding, and subject population; while the Protocol Summary Form contained the description of the study and its significance, methods and procedures, and risks and benefits to participants. This study was accorded an expedited type, since research data were collected from video recordings of participants for the research purpose. The informed consent form was also developed. The purpose of the form was to state that the participants are guaranteed certain rights and agree to be involved in the study, as well as to acknowledge any risks and benefits in participating in the study.

The anonymity of participants was protected by numerically coding all returned study data. The data, including pre and post questionnaires, the electronic files, interview recordings, and transcripts, were stored with a coded participant identification number to keep the responses confidential. Only the study code was used in describing and reporting the results. Coded data were made available only for use in the research analysis, and the links between the coded data and the identifying information of the individuals were destroyed after the study is completed.

3.5 Participants

3.5.1 Sampling Strategy

The sampling strategy used maximum variation. The aim was that common patterns would emerge from the experiences of participants of various backgrounds, which were the particular interests and values of the study. Recruitment was conducted using flyers, referrals, listservs, etc. within the University of Wisconsin Milwaukee (UWM) campus. Around 60 novice users were recruited for this study, including undergraduate and graduate students. Since the study took place in an academic setting, these participants represented general academic users with different ages, genders, ethnicities, as well as different disciplines, educational levels, computer skills, and other demographic characteristics. To better represent the diversified educational backgrounds of UWM student members, different educational disciplines and levels of participants were purposely recruited as shown in Table 3.2. There were three major categories of disciplines : (1) arts and humanities: art & design, communication, dance, English, film, foreign languages and literature, music, theatre, and other related programs; (2) social science: curriculum and instruction, economics, geography, journalism, advertising, political science, psychology, sociology, and other related programs; (3) science and engineering: biological sciences, chemistry and biochemistry, civil engineering, computer science, electrical engineering, geosciences, mathematical sciences, physics, and other related programs.

Table 3.2 Educational disciplines and levels of participants

Educational Disciplines/Levels	Humanities/ Arts	Social Sciences	Sciences/ Engineering	Percentage
Graduate	10	10	10	30(50%)
Undergraduate	10	10	10	30(50%)
Total	20(33.3%)	20(33.3%)	20(33.3%)	60(100%)

3.5.2 Inclusion and Exclusion of Participants

Novice users are more likely to encounter problems in searching digital libraries (Nahl, 1999). In order to understand their help-seeking interactions, only novice users were selected as subjects. Based on self-reported information on frequency of use, an individual who never uses or rarely uses digital libraries is defined as a novice user, since he/she has little experience in using digital libraries. The experience in using digital libraries was the main inclusion criterion. Any potential participant who had frequent use of digital libraries was excluded from the study. Other inclusion criteria were: (1) participants must be adult users aged 18 years or older, (2) they must be native speakers of English, (3) they must be residents in the Milwaukee area, (4) they must have basic computer literacy skills, and (5) they must have academic or general interest in digital libraries. UWM students were recruited by announcing the usability research study on flyers, referral, and various students' listservs. The potential participants sent email to one of the researchers showing their interests in participating in the study. During the initial contact, researchers asked them several questions to make sure they meet the above

criteria through email communication. The decision of inclusion and exclusion of participants were then made by the researchers.

3.5.3 Descriptive Finding

Basic information of participants is presented using descriptive analysis. The demographic data are first presented, followed by their searching and help feature experiences with information systems. Then, the distribution of individual's preference of learning styles is determined using the results of the Index of Learning Style measurement.

Demographics

Table 3.3 reveals the demographics distributions for educational level, educational discipline, age, gender, native language, and ethnicity. There were a total of sixty UWM student participants who completed the study with equal number of graduate students (50%) and under graduate students (50%). As for age distribution, most participants were between the ages of 18 and 21 (20%) or 22 and 29 (52%). About 20% of participants were between the ages of 30 and 39, and only 8% reported their age to be between 40 and 59. The percentage of female participants was 57%. There were fifty-six (93%) native speaker participants and four non-native speaker participants. Despite not being native speakers of English, they had come to the United States at their early ages and spoke English fluently and expressed their opinions without any problem, and thus were included in this study. As for the ethnicity, forty-four were Caucasian (73%), seven were

Hispanic (12%), one was African American, one was Asian, one was Native American, and six were from other ethnicity groups.

To better represent the diverse educational backgrounds, participants from different educational disciplines were carefully selected for this study, including arts and humanities (35%), social sciences (33%), science and engineering (32%). Participants came from 26 different majors. The specific disciplines were Art, English, Film, History, Linguistic, Music (History and Performance), Museum, Spanish, Global Studies, Accounting, Economics, Education, Finance/Law, Information Studies, Mass communication, Political Science, Urban Studies, Civil Engineering, Computer Science, Environmental Science, Geosciences, Healthcare Informatics, Information Science & Technology, Kinesiology, Mathematics, and Physics.

Table 3.3 Demographic Information of Participants (N=60)

Demographic Characteristics	Category	Arts and Humanities	Social Sciences	Science and Engineering	No. of participants	Percent
Educational Level	Under	10	10	10	30	50 %
	Graduate	11	10	9	30	50 %
Age	18 - 21	5	3	4	12	20%
	22 - 29	10	11	10	31	52%
	30 - 39	5	4	3	12	20%
	40 - 49	1	2	1	4	7%
	50 - 59	0	0	1	1	2%
Gender	Female	13	10	11	34	57%
	Male	8	10	8	26	43%
Native Language	English	20	19	17	56	93%
	Non-English	1	1	2	4	7%
Ethnicity	African American	0	0	1	1	2%
	Asian	0	0	1	1	2%
	Caucasian	15	13	16	44	73%
	Hispanic	2	5	0	7	12%
	Native American	0	1	0	1	2%
	Other	4	1	1	6	10%
Percent		35%	33%	32%		100%

Search experience

Although participants recruited for the experiment were novice users to DLs, the proficiency of participants' searching skills from their internet-related experience could affect their ways of thinking when carrying out the test. To confirm that all participants possess enough internet skills without any individual being significantly superior or

inferior to the others, participants were asked to self-rate their expertise level of information search skills on the Web and to provide information about the frequency of using different IR systems.

Levels of expertise

The participants were asked to assess their level of expertise with Web searching on a scale from level 1 “Little knowledge or skills” to level 5 “Expert”. All participants rated themselves according to the concrete descriptions of the levels of expertise as shown in table 3.4. The purpose of the descriptions, which provide information like the frequency of help use, IR systems, and advanced search functions, is to help participants to reflect and clarify their assessment. For example, the rating of “Little knowledge or skills” means the participant just started learning how to search information on the Web, lots of help may be anticipated afterward.

Rating results indicated that all participants possess at least an intermediate level of search skills and are capable of conducting the search tasks. Of the 60 student participants, thirty-five (58%) rated themselves as level 3 “Intermediate” level; twenty-five (42%) rated themselves as level 4 “Advanced”. No participant selected level 1 “Little knowledge or skills”, 2 “Beginner”, or 5 “Expert”. The mean rating and standard deviation (SD) are 3.42 and 0.52, respectively. So, most participants were quite confident about their search skills and anticipated no need or little need of help before carrying out the test. Table 3.4 shows the distribution of participants’ search skills levels.

Table 3.4 Self-rated Search Skills of Participants (N=60)

Search skills Levels	Category	Description of the search skills	No. of participants
1	Little knowledge or skills	Just learning how to search information on the Web, need lots of help	0
2	Beginner	I need some help to search something on the Web	0
3	Intermediate	Fluent with using commercial search engines like Google and Yahoo	35
4	Advanced	Fluent with using advanced search functions	25
5	Expert	Good at using advanced search functions, use complex Boolean operators, understand back-end information retrieval mechanisms	0

Frequency of use

The participants also estimated their frequency of use for the various IR systems, including Web pages, Web search engines (e.g. Google, Yahoo), Online databases (e.g. EBSCO, ProQuest), Library catalogs (e.g. Panther Cat), and Digital Libraries (Library of Congress Digital Collections and UWM Library Digital Collections). Table 3.5 summarizes the frequency of use in the various IR systems. Results show that participants can be regarded as frequent Web users. The mean scores were 4.73 and 4.87, which means that most participants used Web pages (85%) and Web search engines (90%) on a daily basis. As for the frequency in using online databases and library catalogs, the average numbers are 2.5 and 2.73, respectively, which indicates their occasional use of the two types of IR systems. For both digital libraries (LOCDC and UWMDC), most

participants rarely or never use the systems. Participants who reported their frequency as 'often use' or 'occasionally use' were double-checked later. All of the usage frequencies were confirmed during the experiment session that they referred to the use of portal of UWM and LOC library website instead of the portal of the selected Digital Collections.

Table 3.5 Frequency of Using IR Systems (N=60)

IR systems	1 (never use)	2 (rarely use)	3 (occasionally use)	4 (often use)	5 (use daily)	Mean (SD)
Web pages	0	1	5	3	51	4.73 (0.686)
Web search engines	0	0	2	4	54	4.87 (0.43)
Online databases	10	11	16	5	17	2.5 (1.00)
Library catalogs	7	23	13	13	4	2.73 (1.133)
Digital Libraries (LOC)	34	15	10	0	0	1.60 (0.764)
Digital Libraries (UWM)	33	17	8	1	0	1.62 (0.783)

In general, the participants recruited in this study had at least moderate experience with IR systems in terms of searching skills and frequency in using IR systems. Although they were frequent users of Web pages and Web searching engines, they did not frequently use library e-resources, in particular the digital libraries. Since participants came from diverse majors with different educational levels and were randomly recruited from campus during a six-month period, they are thus qualified to realistically represent the academic novice users investigated in this study.

3.5.4 Help feature experience

To assess the role that typical help functions playing have played in one's past searching experience before engaging in the study, four precise questions were included in the pre-questionnaire: 1. What do you typically do if you encounter any problems in using an information searching system?; 2. To what extent are help functions of an information searching system important?; 3. To what extent do you use help functions of a searching system?; 4. How do you learn to use a new searching system when you use it for the first time? Tables 3.6 to 3.9 list the corresponding frequency results answered by the participants.

Table 3.6 What do you typically do if you encounter any problems in using an information searching system? (N=59)

#	Action	No. of participants	Percentage
1	try again	8	14%
2	try different approach	31	53%
3	consult system Help	10	17%
4	ask another person	8	14%
5	change systems	2	3%
6	give up	0	0%
7	other	0	0%

It is clearly shown in table 3.6 that most participants seldom directly used the system Help features provided by the IR systems when they encountered problems. That is, choice "#3 consult system Help" scored only 17%. Instead of using system Help, table

3.6 also shows that the majority of participants chose to use other help-seeking approaches. More than half of the participants (53%) selected "#2 try a different approach" as their solution to problems encountered in an IR environment. Due to the limitations of the questionnaire, no further information was gathered about what different searching approaches were used. Other options selected by participants included try again (14%), ask for human help (14%), and use other online system (3%).

Table 3.7 To what extent are help functions of an information searching system important? (N=58)

#	Action	No. of participants	Percentage
1	not at all	1	2%
2	a little	10	17%
3	some	18	31%
4	some more	17	29%
5	extremely	12	21%

Table 3.8 To what extent do you use help functions of a searching system? (N=59)

#	Action	No. of participants	Percentage
1	never use	8	14%
2	rarely use	29	49%
3	occasionally use	18	31%
4	often use	3	5%
5	use every time	1	2%

When asked about the importance of system help, 47 participants (81%) thought that help functions can be important in a search system (as shown in table 3.7, #3 - #5). Among them, 12 participants (21%) believed that Help functions were extremely

important. However, although participants regarded Help functions as important, data in table 3.8 show that they seldom use them. More than half of the participants (63%) either chose "#2 rarely use" or "#1 never use" to represent their frequency in using help function. These results are similar to previous research findings (Cool & Xie, 2004; Fisher, 1999; Ismail, 2010; Mansourian, 2008; Pratt, 1998).

Table 3.9 How do you learn to use a new searching system when you use it for the first time? (N=59)

#	Action	No. of participants	Percentage
1	Trial and error	38	64%
2	Consult system Help (e.g. FAQ, search tips, etc.)	6	10%
3	Ask another person	14	24%
4	Other _____ (please specify)	1	2%

Finally, table 3.9 reveals the choices of actions when the participants were to use a new search system for the very first time, in which only 10% indicated they would choose to consult system Help feature functions. Comparing the percentages corresponding to the use of system help in table 3.6 and table 3.9, it is interesting to note that about 7% of the participants seemed willing to use system help when they encountered a problem, even after they became relatively familiar with a search system, that is to say, while only 10% would use system help to learn a new search system, that number increases to 17% when the user is more familiar with the system and encounters a problem. Another interesting finding resulting from comparing with table 3.6 is that the

percentage who asks for "#3 human help" increases from 14% to 24 % when they interact with a new system for the first time. The response of "#1 trial and error" is about the same at around 65%. One participant responded "#4 other" and specified that using a search engine would be the approach to help him to learn a new searching system.

3.5.5 Cognitive Measure: Learning Styles

The Index of Learning Styles (ILS) was used to measure participants' learning styles. After the experiment, the learning style scores were calculated based on the answers provided by each participant. Thus, at the time of the experiment, participants did not know their own ILS scores. According previous literature, learning style are purported to be relatively stable characteristics with some gradual change or development expected over a long period of time (Cassidy & Eachus, 2000). However, within the short period of time during the study, the learning style of participants would not change within the context of interacting with digital libraries.

For the purpose of qualitative analysis in answering the research questions, RQ1 and RQ3, only participants with at least moderate preference were carefully selected and included in the analysis. Felder & Spurlin (2005) pointed out that any researcher considering ILS as a variable was advised to examine only moderate (5-7) to strong (9-11) preferences of a particular style in order to find the differences in behavior or attitude. Based on such recommendations, the cutting criterion value for the first two research questions was set to '5' to show more distinctive characteristics of each type learning style. In other words, if the values in the Processing dimension are from +5 to +11, the preference would be considered as at least moderate to strong Active style and vice versa

for the Reflective style. The moderate to strong preference (>5) represents the effects of primary learning style dimension. While performing quantitative tests for RQ 2, the cutting value for learning styles is set to 0 instead of 5 because the groups can be more comparable.

Each participant has a set of four scores in different dimensions. The numbers of participants in each of the different learning styles are listed in Table 3.10. For the Processing dimension, 52% are Active learners and 48% are Reflective learners. The Input dimension shows a greater preference with 82% of students being identified as Visual learners, and only 18% as Verbal learners. For the Perception dimension, about 40% are Sensing learners, while more than half (60%) are Intuitive learners. Finally, for the Understating dimension, the proportions of Sequential and Global learners are 53% and 47%, respectively. For each learning style, participants were categorized into either "Typical" or "Low" groups for all four dimensions based on their scores on ILS. "Typical" indicates a score value between 5 and 11 with moderate to strong preferences, while "Low" corresponds to score value under 5. In most cases, the group of "Typical" participants is about the same proportion as the "Low" groups in all learning style dimensions with the discrepancy around 10%. The Input dimension is the only exception, with 40% more participants belonging to the "Typical" group.

Table 3.10 Number of Participants with Different Learning Styles (N=60)

Dimension	Learning Styles	Typical |score| ≧5	Low |score|< 5	No. of Participants	Percentage
	Active (> 0)	14	17	31	52%
	Reflective (< 0)	13	16	29	48%
	Sum	27	33	60	100%
	Visual (> 0)	36	13	49	82%
	Verbal (< 0)	6	5	11	18%
	Sum	42	18	60	100%
	Sensing (> 0)	11	13	24	40%
	Intuitive (< 0)	23	13	36	60%
	Sum	34	26	60	100%
	Sequential (> 0)	17	15	32	53%
	Global (< 0)	10	18	28	47%
	Sum	27	33	60	100%

The distributions of each individual dimension are statistically depicted in figure 3.6 to figure 3.9. The distributions among Processing, Perception, and Understanding are relatively balanced in which both styles consist of comparable amounts of participants. Figure 3.10 also shows that the distributions for the Processing dimension and Understanding dimension are very similar, and they appear to overlap on each other. The only exception is the Input dimension, which has a pretty skewed distribution toward the Visual style. However, since the number of Verbal styles still reaches 5, the statistical testing for the Input dimension was included in the analysis.

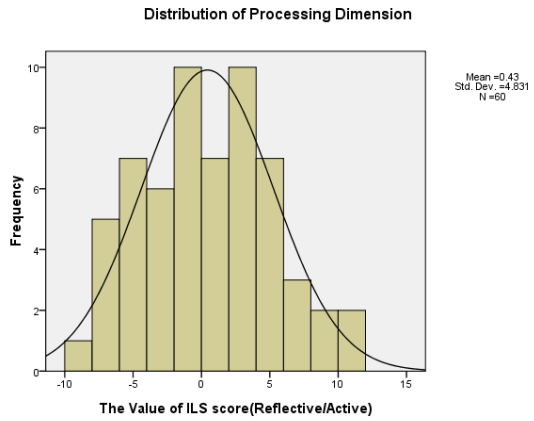

Figure 3.6 Distribution of Processing dimension

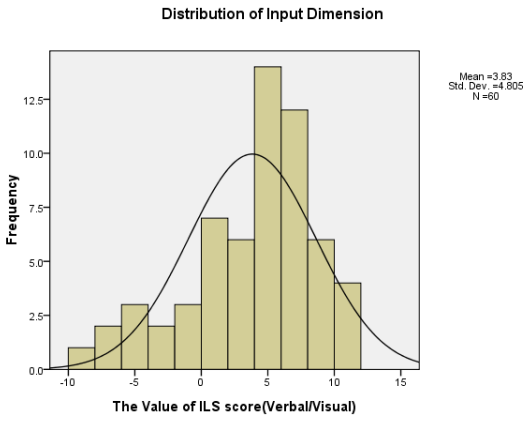

Figure 3.7 Distribution of Input dimension

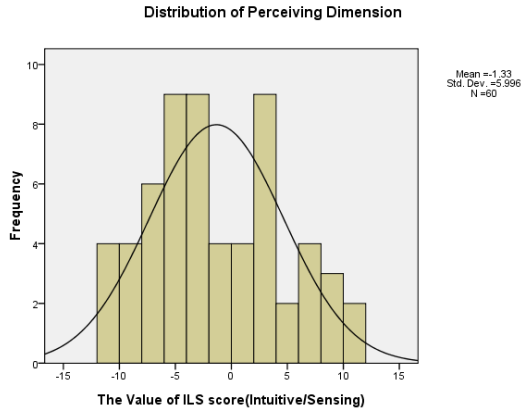

Figure 3.8 Distribution of Perceiving dimension

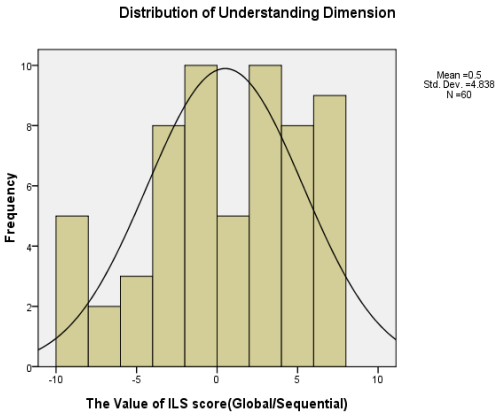

Figure 3.9 Distribution of Understanding dimension

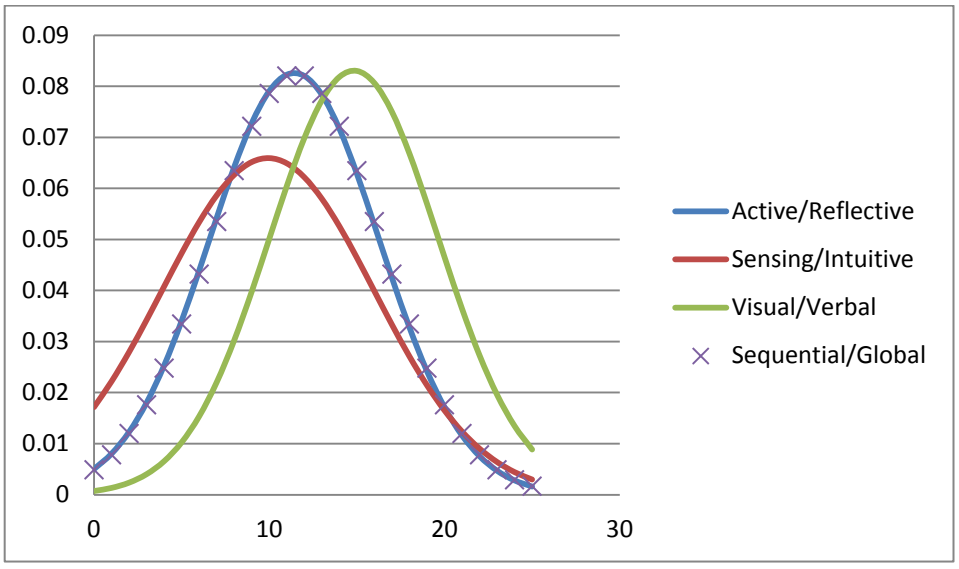

Figure 3.10 Combined distribution of four dimensions

3.6 Data Collection

Multiple methods were employed in this study, including pre-questionnaires, cognitive instruments, think-aloud protocols, transaction logs, and interviews. The researcher played as a neutral outsider and facilitator in the research process. The context of the study was designed to be in an academic setting with real academic users and real academic problems.

3.6.1 Data Collection Methods

Pre-questionnaire

The consent forms and pre-questionnaires were designed to be sent to the potential participants via email. The consent form (Appendix A) included information explaining the purpose, procedures, benefits, and risks of the study. The pre-questionnaire

(Appendix B) collected information in relation to participants' demographic characteristics, their experiences of different IR systems, and experiences and perceptions in using help mechanism in different systems. Demographic questions provided information regarding participants' age, gender, native language, ethnicity/race, and educational backgrounds. The self-developed pre-questionnaire contained items of different formats: multiple choices, asking either for one option or all that apply, self-assessment items, measured on the 5-point Likert-type (Likert scaling of 1 = Never use, 5 = Use Daily), and open-ended questions. Some multiple choice questions in the survey have an open-ended "Other (please specify)" option for participants to provide correct answers. Please refer to Appendix A and B for individual item questions

Learning style instruments

According to Choemprayong and Wildemuth (2009), employing an instrument that has been carefully developed to study cognitive factors in user – system interactions is the most effective way to do so. In this study, an appropriate measure, Index of Learning Style, was adopted to measure novice users' cognitive preferences.

The questionnaire of the Index of Learning Style ® (ILS) was used to identify participants' cognitive preferences in information processing. The Index of Learning Styles (ILS) is a forty-four-item forced-choice instrument developed in 1991 (Felder & Soloman, 1991). The learning style dimensions of ILS were adapted from a model developed by Dr. Richard M. Felder and Dr. Linda K. Silverman to assess preferences on the four dimensions, including processing, input, perceiving, and understanding (Felder & Silverman, 1988). The ILS questionnaire is one of the most popular instruments used

to identify people's learning preferences. While most learning styles measurements classify learners into few groups, ILS describes learners in more details and dimensions and to help understand facets of learners' cognitive processes. Table 3.11 presents a summary of the learning style dimensions, the associated item numbers, as well as a short description of learning preferences of each dimension; a copy of the ILS is included in the appendix so that items can be linked to the item numbers (please refer to Appendix C for individual item questions).

In addition, ILS has been reported to be a reliable and valid tool, which has significant measures of the test-retest reliability. The correlation coefficients of the instrument varied between 0.7 and 0.9 for an interval of four weeks between test administrations at the 0.01 significant level (Felder & Spurlin, 2005). According to factor analysis in three different measures, the dimensions of ILS provide orthogonal scales and validity constructs (Litzinger, Lee, Wise, & Felder, 2007).

Table 3.11 Summary of Learning Style Dimensions of ILS

Learning Style Dimensions	Associated Item Numbers	Learning Preference
Processing – Active/Reflective	1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41	Preference of processing learning by action-first or reflection first
Input – Visual/Verbal	3, 7, 11, 15, 19, 23, 27, 31,35, 39, 43	Preference of visual or verbal format of learning information
Perception – Sensing/Intuitive	2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42	Preference of concrete or abstract learning information
Understanding – Sequential/Global	4,8, 12, 16, 20, 24, 28, 32, 36, 40, 44	Sequential or holistic approach toward understanding

Each learner's preferences were measured using ILS resulting in a group of four different dimension scores. According to Felder & Soloman (1991), an individual learner has a personal distinctive preference for each of the four dimensions, which is indicated by values from -11 to +11 with an increment of 2. The values of each dimension were divided into two groups. Taking the first Processing dimension as an example, the groups are either Active (zero to +11) or Reflective (-11 to zero) preferences. These learning styles can be classified as Active/Reflective, Sensory/Intuitive, Visual/Verbal, and Sequential/Global. Other dimensions were analyzed following the same approach. According to Graf and her colleagues (2009), if the value of ILS reaches close to +11, it indicates a strong preference for one end of one particular dimension. On the other hand, if the value leans toward the other direction to -11, then it indicates a strong preference on the opposite end of the dimension. In performing quantitative tests, the cutting value for learning styles is set to 0 because the groups can be more comparable.

Think-aloud protocol and transaction logs

The methods employed to record help-seeking interactions were think-aloud protocols and transaction logs. The first method recorded perceived interactions subjectively from participant, while transaction logs recorded the performed interactions in an objective manner.

Think-aloud protocol is a data-collecting method used to understand human cognitive processes based on their verbal reports of their thoughts during problem solving (Patton, 2002).While participants engaged in activities, the researcher asked questions and probes to get the subject to talk about what he/she is thinking during the tasks. The basic strategy

of think-aloud protocols involves getting people who are doing something to verbalize their thoughts and feelings as they do whatever they're doing (Griffiths, Hartley, & Wilson, 2002). Think-aloud protocols have often been used in investigation of user system interaction. According to Nielsen (1993), think-aloud protocol is the most valuable method to perform usability testing. It helps to identify users' perceptions of a computer system, what they interpret about the interface, and what misunderstandings they may have about the system. The think-aloud protocols have been used to investigate the search tactics, processes, and strategies of people who are seeking information. Think-aloud protocols have several advantages, including ease of conducting, obtaining of participants' inner perspectives, and recording the sequence of cognitive processes. Data of think-aloud protocols are relatively easy to collect. Most of the time, participants do what they would normally do and are able to speak aloud their thinking at the same time without much training. This method also enables the possibility of investigating the inner thoughts, feelings, reactions, frustrations, and concerns that the participants experience during task performance. In addition, the data collected from these protocols allow one to record the sequential steps of the participants' cognitive processes over a given time period, rather than gathering a general overall impression at the end of a process. Moreover, this method results in richness of the detail in the collected data. Therefore, the think-aloud protocol is an appropriate design for this study. The purpose of probing is to elicit the inner cognitive processes illuminating what is going on in a participant's mind during the tasks. In this study, participants were asked to tell about what they perceived from the interactions with digital libraries.

Transaction logs are a non-intrusive method to collect data from individuals for the purpose of understanding online user behavior. It provides researchers with large quantities of search information which faithfully and accurately recorded users' searching behavior. Data collected from transaction logs can be used to investigate the query terms used by searcher, their frequencies of use, query subjects, database use patterns, navigation patterns, and information seeking behavior (Goddard, 2007; Sheble & Wildemuth, 2009; Spink, Wolfram, Jansen, & Saracevic, 2001; Wolfram, 1999). Transaction logs have been analyzed in previous studies from a variety of sources, including Web sites, search engines, digital libraries, and library catalogs (Sheble & Wildemuth, 2009). However, there are certain limitations of the collected data. Transaction log data do not include users' underlying situational, cognitive, or affective elements, such as motivations, intentions, preference, and satisfaction for searching (Jansen, 2006; Wolfram, Wang, & Zhang, 2009; Xie & Wolfram, 2009). The recommended way to overcome this limitation is to combine the capture of transaction logs with other types of data collection methods. In this study, the client side logs were collected using usability software, MORAE.

Post-interview

Interviews are the most widely used data collection method to access people's experiences within the context of research studies. It is a purposeful conversation which follows a particular organization and plan with the intent of finding out what is going on in someone else's mind. Generally, the main purpose of interviewing is to find out things that we cannot observe directly. It is impossible to observe everything regarding human

being behaviors, including feelings, thoughts, and intentions. We cannot observe people's behavior that happened at a previous point in time, nor can we observe the meaning that those events bring to them. We cannot observe how people have organized their knowledge about the world around them. The assumption of interviewing is that the perspectives of others are informed and valuable. It is through the means of interviewing that we can enter into the other people's perspectives, including how they view the world, their terminology and judgments, and the complexity of their individual experiences. Data collected from interviews consist of verbatim quotations with sufficient context to be interpretable (Creswell & Plano Clark, 2007; Luo & Wildemuth, 2009; Patton, 2002) .

The standardized open-ended interview was adopted for this study. It requires a set of questions that are carefully worded, and every interviewee is guaranteed to be asked the same questions in the same manner and order, including the same probes. The specific wording of each question provides more consistency and comparability in the answers derived from different respondents. There are several reasons for performing interviews in standardized approach. The first reason is that the interview can be highly focused and efficient. Moreover, the analysis of the responses can be facilitated by providing comparable answers. Finally, any variation caused by different interviewers can be minimized (Patton, 2002). The drawback and usual criticism of this approach can be diminished by making minor adjustments. For example, researchers can be given the freedom to choose certain questions to dig deeper when it is appropriate or when more explanations is needed from different participants in the experiment context. Appendix D lists the post-interview questions.

3.6.2 Data Collection Procedures

The study first started with recruiting participants. After the initial contact, the researcher sent out the consent form and pre-questionnaire through emails to the potential participants. The consent form included information explaining the purpose, procedures, benefits and risks of the study. The pre-questionnaire collected the background experiences of participants in regard to using digital libraries. The individual participant was asked to come to the Intelligence & Architecture Research Lab located in UWM Northwest Quadrant building B for the experiment. Upon arrival, participants were asked to answer the ILS questionnaire to assess their learning style. After the ILS questionnaire, they were instructed to perform searches in digital libraries on generic tasks assigned to them. In order to reduce bias caused by the sequence of searching the two digital libraries, participants were assigned different digital libraries to start with. While participants performed the tasks, they were asked to "think aloud" about what they were doing and why they were doing things that way during their searches. Participants were observed during the search process. Their interactions with the systems were recorded by software called MORAE. The software helped researchers capture not only audio and facial expressions of participant's but also their on-screen interactive activities. The client side log was captured during experiment sessions on the participants' machine and more control can be exerted on which data elements were included in the data set. Immediately after they performed their searches, each participant was interviewed to elaborate on their perceptions of the digital libraries based on their interactions with the help features. They were probed to recall and reflect on why they chose certain help features to solve their search problems and how they felt about the results of these actions.

3.7 Data Analysis

The researcher analyzed both qualitative and quantitative data collected from the pre-questionnaires, learning style instrument, think-aloud protocols, transaction log, and post-interviews. Table 3.12 outlines the general procedures of the data collection and analysis. Demographic characteristics were analyzed based on the data collected from the pre-questionnaire. First, dimensions of learning styles of participants were identified based on the calculation of values obtained from ILS. The descriptive data were reported in the section 3.5.3. Then, different types of help features utilized by novice users with various learning styles were explored and investigated using open coding of data collected from different sources. Next, quantitative analysis was performed to identify the effects of learning style on users' choice to use the different types of help features. The units of analysis were the frequency, the time, and the number of types of help features used. Finally, the different types of help-seeking approaches adopted by novice users with different learning styles were investigated based on open coding of data collected from different sources.

Table 3.12 Data Collection and Analysis Plan

Research Questions & Associated Null Hypotheses	Data Collection	Data Analysis
RQ 1 What are the types of help features that novice users with different learning styles use in digital libraries?	Index of Learning Styles (ILS); Think aloud protocol; Pre-questionnaire; Interview	Open Coding; Taxonomies of help features
RQ 2 Is there a significant difference in novice users' help feature use based on their learning styles?	Index of Learning Styles (ILS); Think aloud protocol;	Scores of different dimensions of

Research Questions & Associated Null Hypotheses	Data Collection	Data Analysis
H2.1a There is no significant difference in the frequency of using Help Features between Active and Reflective users. H2.1b There is no significant difference in the time of using Help Features between Active and Reflective users. H2.1c There is no significant difference in the number of types of Help Features used between Active and Reflective users. H2.2a There is no significant difference in the frequency of using Help Features between Visual and Verbal users. H2.2b There is no significant difference in the time of using Help Features between Visual and Verbal users. H2.2c There is no significant difference in the number of types of Help Features used between Visual and Verbal users. H2.3a There is no significant difference in the frequency of using Help Features between Sensing and Intuitive users. H2.3b There is no significant difference in the time of using Help Features between Sensing and Intuitive users. H2.3c There is no significant difference in the number of types of Help Features used between Sensing and Intuitive users. H2.4a There is no significant difference in the frequency of using Help Features between Sequential and Global users. H2.4b There is no significant difference in the time of using Help Features between Sequential and Global users. H2.4c There is no significant difference in the number of types of Help Features used between Sequential and Global users.	Transaction Log	learning styles; t-test
RQ 3 What are the help-seeking approaches that novice users with different learning styles apply in digital libraries?	Index of Learning Styles (ILS); Think aloud protocol; Pre-questionnaire; Interview	Open Coding; Taxonomies of help-seeking approaches

3.7.1 Qualitative Analysis

The grounded theory approach (Creswell, 2007) was used in this study to analyze qualitative data gathered to address all the research questions. Three primary elements in qualitative analysis suggested by Wolcott (1994) were included in the analysis: (1) description, (2) analysis, and (3) interpretation.

For description, information gathered were the source data for analysis. Since the sampling in qualitative analysis is usually done purposefully, the text from data sources can produce a description, along with expressions from participants reflecting how they view and perceive the world. By this means, the perspective of the producers of the text can be better understood (Berg, 2004). In order to explore the help-seeking interactions, the qualitative data gathered through pre-questionnaires, think-aloud protocols, and post-interviews were transcribed verbatim and aggregated as the source for analysis. Next, the collected text was analyzed using open coding.

The analysis of qualitative data goes beyond merely counting words. The researcher extracts objective content from texts to examine meaning, themes, and patterns that may be evident or latent in a particular text. The central process is applying coding to identify essential features and the interrelationships among patterns and themes. Coding represents the "operations by which data are broken down, conceptualized, and put back together in new ways" (Strauss & Corbin, 1990). The process of coding needs to examine, compare, conceptualize, and categorize pieces of concepts and then connect the concepts and categories together in a meaningful way. In this study, the coding scheme was developed following this approach.

In the third interpretation element, the researcher tried to make sense of the context. The major themes emerged and were selected. For this study, different types of help-seeking interactions adopted by participants were linked and related to different dimensions of cognitive factors. Section 4.1 and 4.3 will show the coding schemes for the data analysis. The purpose is to identify relationships between learning styles and help-seeking behaviors and related theories.

Qualitative research techniques were adopted to explore help-seeking behavior. The qualitative approach reveals the fascinating complexity of human behavior, beliefs, and preference. It also enables the collection of rich visual, verbal, and contextual data and brings the meaning and understanding along with it (Crystal & Wildemuth, 2009). However, the measurement is often criticized by researchers. According to Case (2008), qualitative method brings a great deal of validity to the research, yet it may raise issues about the reliability of what is observed and measured for the reason that specific context and measurements are difficult to replicate. Case also pointed out the self-reporting from participants can cause problems for reliability, because of the unreliability of human memory. To ensure the quality of qualitative research, Silverman (2005) pointed out that researchers should try as much as possible to explain and describe the procedures used to ensure that the methods are reliable and thus the conclusions are valid. He suggested adopting techniques like triangulation and member check to improve research validity. As for strengthening research reliability, field-note convention and inter-coder agreement are also recommended.

On the other hand, Creswell& Plano (2007) argued that the stress of reliability has limited meaning in qualitative research due to the nature and focus of natural inquiry. Moreover, Lincoln and Guba (1985) proposed that reliability and validity should be replaced with new terms that have a better fit with naturalistic epistemology. They proposed the term "trustworthiness" to represent the quality and evaluation of qualitative research. Trustworthiness involves establishing credibility, transferability, dependability, and confirmability. It is by the evaluation of trustworthiness that the research findings can prove truly valuable, be transferred to another context, and demonstrate consistency and neutrality. Several operational techniques to establish the quality of research are proposed by researchers (Lincoln & Guba, 1985; Patton, 2002). Among these, the most important are: triangulation, member checking, prolonged engagement and persistent observation, peer debriefing, and negative case analysis. To establish credibility, useful techniques include thick description to facilitate transferability and auditing to establish dependability and confirmability. To validate the findings and provide credibility of this study, five primary techniques mentioned previously were adopted in the qualitative analysis of the study: (1) triangulation: describe how different sources of information are interwoven; (2) member checking: getting feedback from the participants on the accuracy of the recorded data; (3) transferability: providing rich and thick description of the findings; (4) inter-coder reliability: improving the consistency of coding textual data among two or more coders; and (5) auditing: asking a person outside the project to conduct a thorough review of the study and report back (Creswell & Miller, 2002; Creswell, 2003).

3.7.2 Quantitative Analysis

Pre-questionnaire items, including age, gender, educational background, experience with information retrieval, and experience and perception of using help features in IR systems, were summarized in the text and reported in tabular form. Learning styles of participants were next identified and described based on the values obtained from the measurement. In order to obtain participants' help-seeking interactions, the recorded video from MORAE was transformed into a readable format and client side transaction log data were extracted for statistical testing. Statistical analysis was conducted on data collected from logs and a cognitive instrument to answer the second research question:

RQ 2 Is there a significant difference in novice users' help feature use based on their learning styles?

For the second research question and associated hypotheses, the independent variable is learning styles. The dependent variable in this study is the help-seeking behavior of using help features, which was be measured by (1) the frequency of using help features, (2) the time of using help features, and (3) the number of types of help features used by participants. According to previous literature in section 2.3.3, the three measures, including the frequency, the time, and the number of types of help feature used, are the most identified measures for IR behaviors. Thus, these measurements are employed to represent users' help-seeking interaction with the two digital libraries. For the independent variable, the determination of learning style is done using a psychological instrument, Index of Learning Style (ILS). Based on the results of ILS, each participant was categorized into four dimensions of learning style: Processing dimension

(Active/Reflective), Input dimension (Visual/verbal), Perception dimension (Sensing/Intuitive), and Understanding dimension (Sequential/Global). Thus multiple null hypotheses were generated. Since the research interest is to identify the difference between two means, *two independent samples t test* was performed to test the null hypothesis in which the difference between two means is equal to zero.

The detailed hypotheses are listed in table 3.12. The typical help features used by specific styles of participants were identified in previous analysis. The data collected for the use of help features were analyzed with the help of Statistical Package for Social Sciences software (IBM® SPSS® Statistics 19). An alpha level of .05 was used for all statistical tests in this study.

There are two assumptions associated with related statistical testing methods: (1) normal distribution, and (2) homogeneity of variance (Kirk, 1995). The former assumes that the two samples are independently distributed, which can be easily fulfilled by procedures of random assignment. The latter requires that the variances of the two populations be equal. When the data were collected, the distribution and variance were first checked to see whether there were any violations of the assumptions. Some alternative approaches were considered and performed when the data were not normally distributed or with unequal variance (Kirk, 1995). For example, if the data distribution is positively skewed, applying the logarithmic or square root transformation methods helps the data achieve near normal distribution. When data are negatively skewed, square normal transformation can be used. Other alternative analysis methods, i.e. non-parametric approaches, can also be applied for data with a small sample size and unusual

distribution (Pett, 1997). The approaches include Man-Whiney U test and Kruskal Wallis test as well as other tests. Although the non-parametric approaches make fewer assumptions, it is worth noting that they tend to be more conservative.

3.8 Methodology of Pilot Study

A pilot study of 27 participants was first carried out in March 2010 – February 2011 (Huang & Xie, 2011). Based on the results of the pilot study, several issues related to the selection of DLs and level of difficulty of the tasks as well as the post-test questionnaire were identified and revised. The issues and related solutions are listed as follows:

(1) Issue of selection of DLs: Two digital libraries were selected for the pilot study. They were the University of Wisconsin Digital Collection (UWDC) and American Memory (AM). However, the search function of UWDC has a major drawback: when participants enter the same keywords to search for information on different Web pages, e.g. portal and collections, the DL showed inconsistent results. Such inconsistent situations led participants to experience anxiety and frustration. Thus, the solution is remove UWDC from the study and replace it with the University of Wisconsin Milwaukee Digital Collections (UWMDC).

(2) Issue of level of difficulty of the tasks: In the pilot study, some of the assigned tasks were found to be too easy for the participants. They found the information right away without experiencing any help-seeking situations, which is not a typical consequence that novice users would encounter in a natural setting. As a consequence, major modifications were made accordingly for the tasks. The tasks for which

participants could not find the answer right away are expected to provide a chance for participants to have rich searching experiences for interacting with the digital library.

(3) Issues of data collection: In the pilot study, there was an open-ended post-test questionnaire designed to collect self-assessment and self-reflection data when participants finished the assigned tasks. However, due to time limit or lack of interaction, the written responses did not allow participants to express their inner thoughts freely and completely. The researcher often needed to verify each answer orally again from participants. As a result, the questionnaire was replaced with a standardized open-ended interview to directly assess participants' help-seeking experiences.

3.9 Validity and Reliability of Data

To validate the findings and provide reliability and credibility, several primary techniques previously mentioned were adopted in the study:

(1)**Triangulation**: Several triangulation approaches in relation to data source, analysts, and methods were performed to make research quality valid and reliable (Case, 2002; Denzin, 1978). Different sources of data were analyzed using both quantitative and qualitative approaches. Collected data include interviews, questionnaires, think-aloud protocols, and transaction logs. The focus was to integrate data in a complementary fashion and weave interpretation into convergence. In addition, different researchers were involved in the analysis procedures.

(2) **Inter-coder reliability**: In order to produce objective analysis and minimize bias, two researchers analyzed the same data and compared the consistency of their findings.

For example, two coders independently coded the help-seeking situations and associated factors on selected cases which were randomly selected from the total number of participants. The inter-coder reliability was calculated using Holsti's (1969) reliability formula:

$$\text{Reliability} = \frac{2\text{M}}{\text{N}\,1 + \text{N}\,2}$$

In the formula, M represents the number of coding decisions which two coders agree upon, and N1 and N2 refer to the total number of coding decisions by the first and second coder, respectively (Austin & Pinkleton, 2006). Inter-coder reliability turned out 0.95, which ensures the coding consistency.

(3) **Reliable and valid assessment:** Index of Learning Styles (ILS) was used to measure participants' learning styles. The instrument was adopted by previous research and had proven to result in reliable and valid measurements (Felder & Spurlin, 2005; Cook & Smith, 2006; (Litzinger et al., 2007).

(4) **Member checking**: Participants will be given an opportunity to verify the accuracy of the recorded data. They were encouraged to make corrections and offer additional information.

(5) **Auditing**: A person outside the research project was asked to conduct a thorough review of the study and report back (Creswell & Miller, 2002; Creswell, 2003).

(6) **Transferability**: Rich and thick descriptions of the research context, methods, and data were provided in detail so that results of the findings can be applicable to other contexts or settings (Lincoln & Guba, 1985; Patton, 2002).

3.10 Summary

This chapter summarizes research questions and design considerations, as well as the methods and processes of data collection and data analysis. Methodology of the pilot study and validity and reliability of the study are also discussed.

The purpose of this study is to understand novice users' help-seeking behaviors in online information seeking and searching. In supporting this purpose, several research questions are first addressed then followed by the section which depicts the design settings, including the selection of DLs and types of tasks. The data collection section describes the detailed plan about the methods and procedures. Multiple data collection methods were employed in this study, including pre-questionnaires, cognitive instruments, think-aloud protocols, transaction logs, and interviews. Both quantitative and qualitative analyses were performed to answer the research questions. Several statistical analysis methods are to be included: descriptive analysis and independent samples *t* test. In addition, open coding was used to analyze the users' help-seeking interaction and their relationships with learning style.

A pilot study, first carried out in 2010 was descried. Based on the results of the pilot study, several issues related with the selection of DLs and level of difficulty of the tasks

as well as the post-test questionnaire were identified and revised. Finally, validity and reliability of data the study are discussed.

CHAPTER FOUR FINDINGS AND RESULTS

The purpose of the study is to understand novice users' help-seeking approaches while they get started with digital libraries and how learning styles lead to these approaches. This chapter reports the results based on the analysis of both qualitative and quantitative data collected from sixty participants. This chapter illustrates the major findings of the study as they centered on the investigation of the three research questions namely RQ 1, RQ 2, and RQ 3. A brief summary of findings and results is available at the end of this chapter.

4.1 RQ 1: What are the types of help features that novice users with different learning styles use in digital libraries?

In order to answer the first research question, the verbal protocols, interview data were collected to investigate the help-seeking behaviors. 'Help-seeking' is defined as the situation when an individual encounters problems in the process of information seeking and searching. The help-seeking behaviors are '*the interactions that an individual may try to seek, either from an IR system, a human or other references to solve the problems'*. There were 60 participants in this study and it was found that participants adopted a wide range of help-seeking behaviors to solve their information problems. It is not surprising to know that when encountering an impasse, participants tried every possible way to explore and interact with the digital libraries for seeking system assistance. The system provides a variety of Help Features assisting *the interactions* between participants and the two digital libraries.

Results of the study find out that participants tended to use specific features out of the eight types of Help Features identified in the two digital libraries. The types of help features used by novice users with different learning styles during the interactions with digital libraries are presented in Table 4.1, including the definitions that were created during coding. They are grounded in the data and are described more thoroughly from sections 4.1.1 to 4.1.4.

The Help Features adopted were not universally applicable to every participant. Some participants adopted certain help features in individualistic ways. While processing information in digital libraries, Active and Reflective participants respectively selected Interactive Help features and Reflective Help features. Visual participants applied a Visual Help features, and Verbal participants adopted Verbal Help features and Exploring Help features to help them identify their preferred format of information. Intuitive participants were willing to perceive and accept the assistance from Scaffolding and Channeling Help features. Sequential participants adopted Sequential Help features to make sense of the functions provided by digital library.

Table 4.1 Types of Help Features

Research Questions	Learning Style Dimension	Types of Help features	Types of Help features: Definition	Types of Help features: Example
RQ 1 What are the types of help features that novice users with different learning styles use in digital libraries?	Processing Dimension (Active/ Reflective)	Interactive Help	Help features that encourage more interactive actions	Ask a Librarian, Email, Inquiry Form, FAQs , Online Chat, Human Help
		Reflective Help	Help features that encourage users to turn thoughts back to previous steps	Breadcrumbs, Search history, Save a copy
	Input Dimension (Visual/ Verbal)	Visual Help	Help features that facilitate viewing in the interaction	Gallery View, Grid View, How to View, Item Viewer (enlarge, shrink), scrolling in pdf, Prints and Photographs, Screen Shot
		Verbal Help	Help features that are expressed in short summary description formats	About, Digital Library Overview, Short descriptions of collections
		Exploring Help	Help features that provide a structure of subject categories	Browse by topics, Browse by collection
	Perceiving Dimension (Sensing/ Intuitive)	Scaffolding Help	Help features that provide relevant assistance based on the actions taken by users	Assisted search, Auto-complete, Relevance feedback
		Channeling Help	Help features that provide relevant categories of different aspects of the retrieved results	Refining Categories (Original format, Online format, subject, Contributor, Language)
	Understanding Dimension (Sequential/ Global)	Sequential Help	Help features that contain the sequential order	Next Page, Back, Flowchart, Timeline

As we described in section 3.4.1, the help features provided by both digital libraries are complete and different from each other. When being given the searching tasks, participants were found to use diverse help features and topics provided by various levels of collections from both digital libraries, including the general collection, main collection, special collections as well as their sub-collections.

According to Xie (2007), there are two different types of help features, 'explicit help features' and 'implicit help feature'. The explicit help feature refers to any features provided by the two digital libraries that has 'help' as part of the function label, e.g. Help - Browse by Collection, Help - Viewing Results. These help features were selected with the awareness and intention when the users needed help. The help features and topics along with different levels of collection that the features belong to are also summarized in Appendix E & F. Results of this study show that participants didn't use explicit help frequently and used implicit help features instead. The implicit help feature refers to any help feature without 'help' as part of the feature name. Examples of implicit help features like FAQs, Ask a Librarian, auto-complete, About, etc.). Although Xie categorized help features into two types, she also addressed that they are not mutually exclusive. Some help features could have multiple properties. For example, if a specific implicit feature, FAQs, is placed under the 'Help' function, it would be then taken as an explicit help. Explicit help features are provided by both UWMDC and LOCDC in different topics, including 'HELP', 'Live Help', how to search, browse, and view. In this study, both implicit and explicit help features are included in the results for RQ 1.

In order to show how many participants with different dimensions of learning styles actually adopted a specific type of help features, the participants with their assigned numbers are listed in the tables in the following sections. The information were extracted by reviewing all the collected data and looking for evidence of using each type of help features at least once by each participant in the study.

4.1.1. Help features used by users with Active and Reflective styles

Active learners love to learn by doing and demonstrate active ways of processing information, while Reflective learners tend to process information by reflection and introspection. The types of Help features used by Active and Reflective participants are Interactive Help Features and Reflective Help Features respectively. The examples of the Interactive Help Features and Reflective Help Features and how they were used are provided in details as follows.

Interactive Help Features

The Interactive Help Feature is defined in this study as any help feature that encourages more interactive actions. The characteristics of such help pertain to a two-way communication between the system and the user. It is not like unidirectional expression of information without any involvement from the participants. Although there are standard help-seeking approaches to solve information problem, evidence gathered in this study show that Active participants show strong preference of Interactive Help Features. 'Ask a librarian' is an example of Interactive Help. It was designed as different channels of format intended to allow users to request assistance from librarians. These channels

include electronic mail, inquiry form, or Facebook as shown in Table 4.2. After a request has been sent out, users usually get a written follow-up response at a later time from librarians. The questions and answers are usually aggregated and shared with other online users, since they may also learn from the interactions of other users. For example, the Frequently Asked Questions (FAQs) provides various questions raised by previous users and the corresponding answers provided by the digital librarians.

Not only do digital libraries provide asynchronous help, they also have synchronous text messaging feature 'Online Chat' that allow users to interact with librarians in real time. The advantage of 'Online Chat' is that users get the help from information professionals online without being physically present. In addition to timeliness, 'Online Chat' also provides an interacting platform for users and librarians to exchange their information and knowledge. If the response provided by 'Online Chat' is not adequate for the initial inquiry, users have the chance to ask again immediately for clarification. The process is similar to a face-to-face reference interview. Although users prefer 'Online Chat' service, they are not able to consult it at any time. One of the disadvantages of 'Online Chat' is that the service is only offered during certain times. For example, the hours of 'Online Chat' are Monday through Friday 14:00-16:00 Eastern Time for LOCDC and 9:00-17:00 Central Time for UWMDC. Users from different geographical regions need to be aware of the time differences in order to get in touch with information professionals of the two digital libraries. Additionally, not all collections of LOCDC offer Chat service. Only three collections offer the Chat service, i.e. American Memory Historical Collections Chat, Digital Reference Section: Chat with a Librarian, and Newspapers/Periodicals Collections Chat.

Table 4.2 Interactive Help features

Interactive Help features	Participants	Number of Participants	Frequency
Ask a librarian (Email, General Inquiry form, Web Site Comments Form)	P1-2, P5, P8, P12, P16-17, P22, P33, P35, P45-47, P49, P52-55	18	154
Ask a librarian (Facebook, Twitter)	P8, P12, P16, P33, P35	5	42
Frequently Asked Questions (FAQs)	P13, P14, P16, P31	4	31
Online Chat (American Memory Historical Collections Chat, Digital Reference Section: Chat with a Librarian, Newspapers/ Periodicals Collections Chat, UWMDC Online Chat)	P16, P42, P49, P53, P55	5	7

Active learners provided reasons explaining their behavior about frequent trying out of Interactive Help features. P2 stated: "Probably I am more interactive type of person. I just go into it and try it." P5 stated his preference of Interactive Help by saying:

> "If you go to the Library of Congress Digital Collection, 'Ask a Librarian' is kind of handy, so I used it right away…. And I looked over it a few times at that and gotten great help from it."

One participant (P49) tried several ways to find the information regarding the Milwaukee River Dam. He did get a related document but failed to find the specific information that he wanted. At this point, he was disappointed and asked the researcher whether he could use 'Online Chat' and said:

> "I don't understand. I think I will go back to the main digital collection. What I would do in real life if I have this question is to ask a librarian. I see there is a 'LIVE HELP' button on the bottom of UWMDC. Is it allowed? [Researcher: You can try]. This is what I would do in real life situation. I didn't find the information that I was looking for. Plus, I don't see any other good ways, so my next option is to ask. I would go to 'Online Chat' for help."

Reflective Help Features

Reflective help are features that would facilitate users to recollect thoughts from previous searches and deliberate possible uses in the future. 'Search History' is a reflective help that records previous search terms or strategies that users have done as well as the number of items found for each search. Since during the search processes, participants may be drowning in series of slightly varied search terms. Taking a look at the 'Search History' would help users evaluate different search strategies, weigh the selections of search terms, and change the following terms accordingly for the next steps. The 'Location Breadcrumb' is static and shows the path to where the current page is located. It also provides links to various levels of digital library hierarchy that participants have visited previously. If a user gets lost in the middle of a sub-sub collection of one of the digital library, he/she may easily find direction simply by clicking the breadcrumb to go with the right orientation.

Users may sometimes use some memory strategies to assist themselves in remembering previous search results, e.g. write a summary note, print out a copy, or

download digitized items for future reference and then reread to clear and verify about the meaning. The reflective help features are summarized in Table 4.3.

Table 4.3 Reflective Help Features

Reflective Help Features	Participants	Number of Participants	Frequency
Thinking about past and future (Search history, Location Breadcrumb)	P29, P40	2	4
Memory strategies (Reread, Make a note, print or save a copy)	P19, P30, P36, P40, P42	5	5

Here is an example of when participants start to use Reflective Help. The situation is that P36 found a document about Lloyd Barbee. He tried to use enlarge tool to take a closer look at the text-based document. He planned to use the download feature and save a copy for future reference and said:

> "Let's see what it says. [The texts shown on the page were quite small and condensed which made P36 looked tired. He decided to save a copy.] Ok. Here's what I would do. When I do research like this, I look for things that I think are somewhat relevant. And if I think they're somewhat relevant, I save them. I am going to copy this image and later decide whether to use or not."

Another reflective participant (P29) talked about the Reflective Help provided by LOCDC helped him navigate in digital libraries and said:

> **"**Of course I noticed other one, such as the 'breadcrumb' type of feature. It has a lot of the 'breadcrumbs' that is what I called them. You see where you are. I have a little problem getting back to the top level at certain points. For some reason, it

just … at certain point, I have to take some time to go back. I have to think about it. The 'breadcrumb' makes the navigation quite …it felt like straight forward… smoother."

4.1.2. Help features used by users with Visual and Verbal styles

Visual learners tend to show visual preferences, while Verbal learners are more comfortable with expression in written forms. Participants showed their preferred format of help features in this study. Visual participants select Visual Help features. Verbal participants choose to use both Verbal Help Features and Exploring help Features. The examples of the three types of Help Features and how they were used by Visual and Verbal participants are explained next.

Visual Help Features

Help features that facilitate viewing in the information retrieval interaction in digital libraries are defined as Visual Help Features. Visual Help is designed to help viewing or inspecting objects. These Visual Help features include different viewing options in presenting groups of objects like 'Gallery View' as well as inspecting individual item, e.g. 'Item Viewer' and 'View Larger". 'How to View' and 'How to View - Prints and Photographs' provide information regarding how to operate viewing functions for different formats of objects. Examples of the viewing operations include enlarging, shrinking, and rotating. Another type of Visual Help is to provide guiding content in visual format. 'Screenshot' is usually incorporated in the help content in guiding participants what they would be prompted in the search process. A more dynamic

presentation in guiding participants is to demonstrate search processes from virtual librarian's desk top or instructions in Youtube. Table 4.4 lists all the Visual Help features discussed.

Table 4.4 Visual Help Features

Visual Help Features	Participants	Number of Participants	Frequency
Viewing options (Gallery view, Grid view, Highlights of the collection, and List view)	P15-17, P21, P23, P30-31, P35, P39, P40, P42, P44, P52, P57	14	182
How to view (Sound Recordings, Documents - Text and Page Images, Maps, Prints and Photographs, Video)	P17, P22, P24, P28, P30, P34, P42, P51, P60	9	72
Item viewer	P1-10, P12-60	59	65
Object viewer	P1-3, P5-10, P13-14, P16-20, P22-31, P33-40, P42-46, P48-51, P53-54, P56, P60	50	61
Help content in visual format (Screenshot, Youtube Instruction)	P12, P29, P41, P46, P51	5	7

To show the timing when participants may start to use Visual Help, one participant's reaction can be used as an illustrative example. While trying to find some biographical information of Jackie Robinson, P21 first found the collection, 'Baseball and Jackie Robinson' and discover a timeline sub-collection that contains chronological biographical information. Later, when she decided to find some images of Jackie Robinson, P21 clicked the 'Gallery View', which helped her quickly find three pictures, including two pictures depicting Jackie Robinson in the baseball field and one picture of him and his family. P21 felt the pictures she found were very nice pictures which made her interested in the topic of Jackie Robinson.

Visual learners talked about how the Visual Help features helped them understand the content of digital libraries. P2 stated: "I am probably more of a visual learner and [the Visual Help feature in] UWM has more actual visual documents and it makes easier to actually see the items." P40 also explained his frequent use of the Visual Help feature which helped him activate his sense:

> "I like those [Gallery View]. That is the first thing you want to see. And your eyes are activated what you are looking here. I think that would be a good layout in my sense… For me, this layout [Gallery View] is better, because it highlights the images. I can access these images and know what kind of data they present and that sort of things."

Verbal Help Features

Help features that are expressed in written or spoken words to facilitate reading and listening in the interaction are defined as Verbal Help Features. The feature 'About' is one example of Verbal Help feature. It summarizes background information about the collection mission, history, related projects services, financial support, and awards. The feature 'About' contains several different types of overview data in both digital libraries, including 'About this Collection, 'About the Project', and 'About Digital Collections'. Likewise, LOCDC provides' About' for other help features, which help users to effectively use these features, such as 'About Finding Aids' and 'About Browse by Topic'. One example of Verbal Help is the short description under each featured collection and service of LOCDC. The description provides a brief summary explaining the content and scope covered by the collection (please refer to Figure 4.1). The

description of 'Historic Newspaper' provides the information that the collection content is from 'Chronicling America' project, while the brief summary of 'Prints and Photographs' informs that there is a large amount of image items contained in the collection.

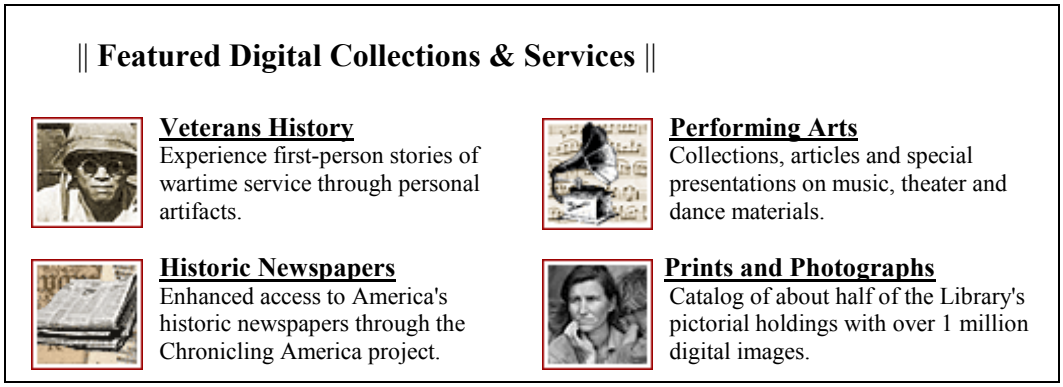

Figure 4.1 Summary descriptions for each sub-collections of LOCDC

All other Verbal Help approaches observed from participants of this study are inspecting descriptive titles, examining descriptive information for the results page or assessing the relevance of the detailed information provided for each individual item (Table 4.5).

Table 4.5 Verbal Help Features

Verbal Help Features	Participants	Number of Participants	Frequency
About ('About this Collection, 'About the Project', 'About Digital Collections', About Finding Aids' and 'About Browse by Topic)	P2, P4, P11, P17, P20, P23, P30, P35, P37, P54, P56, P60	12	12
Summary description under collection title	P49, P59	2	3
Descriptive title of individual item, descriptive information for the results page or individual items	P32, P39, P46, P59	4	7

The following is an example regarding participants' initiation of using Verbal Help. When P59 tried to find out the year that Lincoln was assassinated, she typed in 'Lincoln assassination' in the search box and obtained more than fifteen hundred results. Instead of clicking any of the items, P59 scanned the first result page for a while and found some information that was listed under the first item to be useful, 'Lincoln Paper: Lincoln Assassinations: Introduction'. She continued to read out the description under the first item:

> "[Abraham Lincoln Papers. The Library of Congress, Stern Collection, Rare Book and Special Collections Division. On the evening of April 14, 1865, while attending a special performance of the comedy……..' Site: LOC gov web pages, Original format: Web Page.] I got it. It was 1865, April 14. Well, I think I knew it already. "

Exploring Help Features

Help features that provide a structure of subject categories of the overall scope or different topical aspects of the sub-collections are defined as Exploring Help Feature. 'Browse by' feature is the major type of Exploring Help that uses descriptive titles to depict the content coverage in various subject categories ('Browse by category', 'Browse by topic'), or collection topics ('Browse by collection'), in the digital libraries. The structured topics and categories serve as critical reference points for participants to match

their knowledge and needs at the very beginning or during their search processes. Table 4.6 lists the Exploring help features of the two digital libraries observed in this study.

Table 4.6 Exploring Help Features

Exploring Help Features	Participants	Number of Participants	Frequency
Browsing features: UWMDC: Browse, Collections of the American Geographical Society Library, Collections of the Archives, Special Collections LOCDC: Featured Collections & Services, Browse by Topic, List All Collections, Browse by Topics (American History - 1945 to the Present, American History - Multiple Eras , Government, Politics & Law, News, Journalism & Advertising, Sports, Recreation & Leisure), American Memory (Browse by, Browse by category, Browse by collection), American History - Browse by Topic, Arts & Culture - Browse by Topic	P1-P60	60	236

After given the first task of finding out a Coca Cola advertising video using LOCDC, P32 scanned the LOCDC homepage quickly and started to browse 'Featured Collections & Services' to find out related information. She said:

> "So I'm looking through the 'Feature Digital Collections and Services' to see if any of them might help. I can scan the page. But my eyes immediately go up here to the digital collections. I think I would browse through the featured collections and their headlines. So, it's like different topics area. [While not finding anything related, P32 chose to use 'Browse by Topic' instead of 'Search'] I guess I could use the search function, but… I'm tempted not to do that. I'm tempted to browse by topic to see if there is any advertising collection… That's something I would

click on ‘Browse by Topic’. Just in case. How it works. Ok so…I went to the more topics.”

4.1.3. Help features used by users with Sensing and Intuitive styles

Intuitive learners prefer to perceive information as relationships while Sensing learners prefer solving problems by standard methods. Intuitive participants are more comfortable to adopt help features that support their preference. Intuitive participants welcomed and accepted the contextual assistance from Scaffolding Help Features and perceived Channeling Help Features as helpful when they find out the relationships between the results and the search task. Sensing participants, on the other hand, tend to create search terms without exploring the system. They did not show particular preference of using any type of help feature.

Scaffolding Help Features

Scaffolding Help Features are features designed to provide relevant assistance based on the actions taken by users. By default setting, the Scaffolding Help Features are contextual and responsive, i.e. the appearance of the feature is not triggered to show on the searching environment, unless a threshold input from users is entered. If the threshold is met, the system provides the feature automatically. Table 4.7 lists the Scaffolding Help Features observed in this study.

Table 4.7 Scaffolding Help Features

Scaffolding Help features	Participants	Number of Participants	Frequency
Relevance Feedback	P29, P41	2	2
Auto-complete (or word completion)	P1, P3, P8, P15, P17, P24, P27, P30-33, P38, P43, P44, P48, P52-53, P57, P59	19	35
Assisted search	P4, P9, P16, P22-24, P27, P30-31, P35, P37, P40-41, P43-46, P50, P52, P58, P59	21	124

Usually users might mistype their search term and get 'Relevance Feedback' messages from digital libraries. The example messages like: "We were unable to find any matches for your search" and "Check for spelling errors and typos". The feature, auto-complete, is one of the examples of Scaffolding Help Features and is especially useful for such situation when users are not so confident about their selection or spelling of the search words. Figure 4.2 shows the auto-complete feature provided by LOCDC. It was happened during the study when one of the participants tried to find out who are the four presidents that were assassinated during their presidency. When the participant typed in only the first four characters of the search term, 'assassination', the help feature showed a series of suggested terms, including the intended term 'assassination' and other terms starting with the same four characters, e. g. 'assam', 'assault', and 'assassins'. Some participants perceived the suggestions and accepted it without typing the whole search terms.

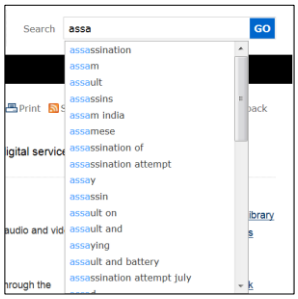

Figure 4.2 Auto-complete of LOCDC

While looking for biographical information of Jackie Robinson, P41 did not accept the suggestions made by auto-complete when she tried to type in several specific search terms in her mind, e.g. 'Jackie Robinson biography', 'Jackie Robinson', and 'Jackie Robinson story'. She finally noticed the terms suggested by the digital library and said:

> "I like that the 'auto complete' comes up here. You kind of getting an idea. You don't have to type everything. And if I do, I can go to the bottom. [P41 moved the mouse to select the suggestions made by auto-complete. She chose 'Jackie Robinson Baseball' and got 391 items.] I got the color line. It is amazing that there are more pictures here. That is what I am looking for."

The 'assisted search' is presented as word clouds once the users select a collection. Figure 4.3 shows an example of the assisted search of March on Milwaukee Collection in UWMDC. It is a depiction of the focus of specific subjects presented as a list of subject terms with different font size and colors. The more frequently a word is searched by other users, the bigger it gets in size and different colors. This characteristic tool helps participants quickly catch the main subject of the whole collection by scanning the page.

In the given tasks, participants quickly scanned through the page and found the words ‘segregation’, and ‘protest’ to be the largest and most colorful in the word cloud.

Figure 4.3 Assisted Search of UWMDC

Channeling Help Features

Channeling Help Features are system features that provide a system of relevant categories for a set of retrieved results. This type of feature helps users to narrow or broaden to other related sources of information based on the results of a previous search action. Both digital libraries provide Channeling Help Features for participants. The different categories of the Channeling Help Features include original format, online format, subject, sites and collections, creator, contributor, location, and language. When beginning the search in the digital library, the user normally has a rough idea about a particular historical subject. They may get hundreds or thousands of hits when they enter the first search term. The Channeling Help Features provides a knowledge matching place. Participants need not directly retrieve their own knowledge. Instead, by scanning the different channeling categories, they can easily find out the relationship between their searching results and their search task and filter the results toward some particular courses. Table 4.8 lists the Channeling Help features adopted by participants in this study.

Table 4.8 Channeling Help Features

Channeling Help Features	Participants	Number of Participants	Frequency
Refining Categories: Original formats (3D Object, Audio Recordings, Books, Film/Video, Legislation, Manuscripts, Maps, Newspapers, Notated Music, Periodicals, Photos/ Prints/ Drawings, Web Pages), Online formats , Subject, Sites and collections, Creator, Contributor, Locations, Languages	P1, P3-6, P8-10, P12-15, P17, P19, P21-22, P24-26, P28-30, P33-34, P38-41, P43, P47, P49, P51, P53-54, P58-59	37	94

P41 searched 'Jackie Robinson baseball' from homepage and obtained 391 items. She looked at the result page and found the Channeling Help. P41 started to click 'Jackie Robinson' from 'contributor' and refined the result to two items. She clicked the second item, 'Jackie Robinson: a register of his papers in LOC and the related bookmarks'. She found several refining sections included in the document and said:

> "Collection summary, organization of the papers, administrative info, biographical note, scope and content note, and…. Oh, wait. Oh, BIOGRAPHY. This might be something. Hum. Let's see. This could be something here but I am sure.. Yeah, there is a list of his major achievements here too. I did not know that. The list here is excellent. If I were doing a report, the biographical note is very helpful. I want to copy it all here."

4.1.4. Help features used by users with Sequential and Global styles

Sequential and Global learners applied their preferred strategies to make sense of and understand DLs and their functions. It was observed that Sequential participants adopted Sequential Help features to solve their problems when interacting with the two digital libraries. Global participants did not show observable pattern in using particular type of help features. Since participants were allowed to search for each task within the time limit of ten minutes, they did not have sufficient time to demonstrate specific behavioral pattern of using help features in such settings.

Sequential Help Features

Help features that contain sequential order are defined as Sequential help. Sequential help features facilitate participants' navigation behaviors by two approaches: browsing in logical order and utilizing directional navigation guide. 'Timeline' and 'Browse by Date' are examples of Sequential help features that provide chronological cues when participants start browsing for historical events. 'Timeline' provides several periods of time and related major events for reference that helps participants to understand the order of time and trends for a specific subject. Sequential help also provides directional navigation guidance which could help participants in moving forward, backward, upward, or downward. Table 4.9 lists the Sequential help features adopted by participants in this study.

Table 4.9 Sequential Help features

Sequential Help features	Participants	Number of Participants	Frequency
Timeline; Browse by Date	P4-5, P12, P15, P21, P28-31, P39, P41	11	15
Step-by-step guide	P10, P48, P50	3	3
Flowchart, numbered list	P36	1	1
Next page	P1-60	60	247
Back to previous page	P1-60	60	989

Here is the situation when P30 started to use Sequential Help in LOCDC. While trying to find who were the four presidents assassinated during their presidency, P30 first searched 'assassination years' and obtained 128 items. Without the intention to go into each individual item, P30 just scanned the tiles on the first page of result. She did not find any satisfactory item, so she clicked Next Page and proceed to the second page of results. Not finding anything relevant, P30 clicked Next Page again and proceed to the third page.

4.2 RQ 2: Is there a significant difference in novice users' help feature use based on their learning styles?

In the previous sections, results of the exploration analysis for RQ 1 demonstrate that participants with diversified learning styles show unique qualitative help-seeking behavior in using Help features. Thus, the major finding of this section focuses on answering the second research question in regard to whether or not there is a significant difference in using different types of Help features based on their learning styles. The analysis for RQ 2 intends to find out quantitative evidence that will support the preliminary results obtained in the previous exploratory stage in section 4.1. As discussed

in 3.6.1, help-seeking behavior was obtained by three measurements: (1) frequency of using help features (hypotheses H2.1a-H2.4a), (2) time of using help features (hypotheses H2.1b-H2.4b), and (3) number of types of help feature used by participants (hypotheses H2.1c-H2.4c). Based on the three different measurements and types of Help Feature adopted by participants with different learning styles, the associated hypotheses were specifically generated and rearranged in Table 4.10.

Table 4.10 Twelve Hypotheses Arranged in the Order of Learning Style Dimensions

Learning Style	Measurements	Hypotheses
Processing (Active/ Reflective)	Frequency Time # of Types of Help Feature used	H2.1a There is no significant difference in the frequency of using **Interactive** Help Features between Active and Reflective users. H2.1b There is no significant difference in the time of using **Interactive** Help Features between Active and Reflective users. H2.1c There is no significant difference in the number of types of **Interactive** Help Features used between Active and Reflective users.
Input (Visual/ Verbal)	Frequency Time # of Types of Help Feature used	H2.2a1 There is no significant difference in the frequency of using **Visual** Help Features between Visual and Verbal users. H2.2b1 There is no significant difference in the time of using **Visual** Help Features between Visual and Verbal users. H2.2c1 There is no significant difference in the number of types of **Visual** Help Features used between Visual and Verbal users. H2.2a2 There is no significant difference in the frequency of using **Exploring** Help Features between Visual and Verbal users. H2.2b2 There is no significant difference in the time of using **Exploring** Help Features between Visual and Verbal users. H2.2c2 There is no significant difference in the number of types of **Exploring** Help Features used between Visual and Verbal users.
Perceiving (Sensing/ Intuitive)	Frequency Time # of Types of Help Feature used	H2.3a1 There is no significant difference in the frequency of using **Scaffolding** Help Features between Sensing and Intuitive users. H2.3b1 There is no significant difference in the time of using **Scaffolding** Help Features between Sensing and Intuitive users. H2.3c1 There is no significant difference in the number of types of **Scaffolding** Help Features used between Sensing and Intuitive users. H2.3a2 There is no significant difference in the frequency of using **Channeling** Help Features between Sensing and Intuitive users. H2.3b2 There is no significant difference in the time of using **Channeling** Help Features between Sensing and Intuitive users. H2.3c2 There is no significant difference in the number of types of **Channeling** Help Features used between Sensing and Intuitive users.
Understanding (Sequential/ Global)	Frequency Time # of Types of Help Feature used	H2.4a There is no significant difference in the frequency of using **Sequential** Help Features between Sequential and Global users. H2.4b There is no significant difference in the time of using **Sequential** Help Features between Sequential and Global users. H2.4c There is no significant difference in the number of types of **Sequential** Help Features used between Sequential and Global users.

Not every help feature emerged from the exploration phase was able to be quantified into measureable units. Only some of the approaches identified in section 4.1 were adapted to measure help-seeking behaviors. For the purpose of answering the second research question, included types of help features are Interactive Help, Visual Help, Exploring Help, Scaffolding Help, Channeling Help, and Sequential Help. Two types of help features, Reflective Help and Verbal Help, were not selected for quantitative analysis due to the very low number of occurrences observed in the analysis. These data may not provide enough statistical power to analyze the relationship between learning styles and the use of help features. T-tests were used to analyze the relationship between learning style dimensions and help-seeking behaviors. Comparisons between the two groups for each learning style dimensions were made using the three measurements. Statistical results show that the learning style is associated with the use of help-seeking features in most dimensions except for the Understanding dimension. Detailed statistical results for different dimensions of learning styles are described in sections 4.2.1 to 4.2.4.

4.2.1. The Influence of Processing Dimension

The hypotheses H2.1a to H2.1c examine the effects of learning style of Processing dimension on novice users' use of Interactive Help Feature. Active participants demonstrate active ways of processing information using Interactive Help features, thus the Interactive Help Features were selected for testing the hypothesis to verify the effect of learning style. As discussed in section 4.1.1, the various Interactive Help features adopted by the participants include Ask a Librarian, Email, Facebook, FAQs, Inquiry Form, and Online Chat.

Independent-samples t-tests were conducted to compare the three different measures, frequency, time, and number of types of Interactive Help features used, based on participants' learning style in the Processing dimension. Table 4.11 summarizes the results obtained from t-test analysis.

Table 4.11 T-tests results of Processing Dimension (Active/Reflective Styles) (N=60)

Measurements	Active (n=31)		Reflective (n=29)		*t*	Note
	Mean	SD	Mean	SD		
Frequency of Interactive Help use (H2.1a)	6.77	5.33	0.86	3.64	2.83**	p = 0.006
Time of Interactive Help use (H2.1b)	261.03	156.49	207	129.24	1.42	p = 0.159
# of types of Interactive Help used (H2.1c)	2.16	1.86	1.04	0.92	2.89**	p = 0.005

Results of this study demonstrate that there was a significant difference in the frequency of using Interactive Help for Active (M = 6.77, SD = 5.33) and Reflective (M = 0.86, SD = 3.64) style participants, t (58) = 2.83, p = .008. In addition, Active participants had a higher tendency to choose to use Interactive help. The average number of types of Interactive help features used by Active participants (M = 2.16, SD = 1.86) is significantly higher than those adopted by Reflective participants (M = 1.04, SD = 0.92), t (58) = 2.89, p = .005.

These results reveal that Processing dimension of learning style can impose an effect on novice users' help-seeking behaviors. Specifically, when searching in DL environments, Active participants are more likely to seek help in terms of engaging more frequently in, spending more time on, and adopting more types of Interactive Help Features. In other words, novice participants with Active learning style showed higher

tendency to seek for Interactive Help, while Reflective participants, on the other hand, relatively relied on self-exploration.

4.2.2. The Influence of Input Dimension

The hypotheses H2.2a to H2.2c examine the effects of learning style of Input dimension on novice users' help-seeking behaviors in three different measures. In the analysis of RQ1, Visual participants in this study preferred Visual Help features because the pictorial formats would help them process information quickly and better comprehend the content in digital libraries. At the verifying stage, Visual participants are expected to show visual preferences in interacting with Visual Help Features, while Verbal learners are more comfortable with expression in words, either in oral or written forms.

Independent-samples t-tests were conducted to compare frequency, time, and number of types of help features used based on participants' learning style in Input dimension (Table 4.12). To emphasize the different characteristics of the two styles, Visual and Verbal, the t-test of the three measurements were carried out in accordance with the two different approaches, namely Viewing and Exploring Help, respectively. In table 4.12, results associated with these two approaches are respectively listed as parts a and b.

Results of this study demonstrate that Visual participants are apt to select Visual Help Features, such as Item Viewer and Gallery View (Table 4.12, part a). There is a significant difference in the frequency of using Viewing Help between Visual ($M = 7.16$, $SD = 3.51$) and Verbal ($M = 3.55$, $SD = 2.42$) participants, $t(60) = 3.24$, $p = .002$. It is also shown that Visual participants spent more time ($M = 101.59$, $SD = 66.46$) in using

Visual help than their Verbal counterparts (M = 91.45, SD = 77.49), although the differences did not reach a significant level.

Table 4.12 T-tests Results of Input Dimension (Visual/Verbal Styles) (N=60)

Measurements		Visual (n=49)		Verbal (n=11)		t	Note
		Mean	SD	Mean	SD		
Part a.	Frequency of Visual Help use (H2.2a1)	7.16	3.51	3.55	2.42	3.24**	p = 0.02
	Time of Visual Help use (H2.2b1)	101.59	66.46	91.45	77.49	0.45	p = 0.66
	# of types of Visual Help used (H2.2c1)	3.65	1.01	3.64	1.21	0.048	p = 0.96
Part b.	Frequency of Exploring Help use (H2.2a2)	3.73	2.19	5.9	3.64	- 2.52*	p =0.014
	Time of Exploring Help use (H2.2b2)	50.76	37.56	85.45	56.99	- 2.50*	p =0.015
	# of types of Exploring Help used (H2.2c2)	2.94	1.49	3.73	2.10	-1.46	p = 0.15

Results of RQ 1 show that Verbal participants tend to choose Exploring Help Feature as their preferred feature. In addition, they are patient in examining detailed verbal description Therefore, the Exploring Help was chosen to examine the influence of Input dimension (hypotheses H2.2a2 to H2.2c2). Verbal participants showed the tendency that they prefer to comprehend information through browsing textual presentations. This particular behavior also occurs in information-retrieving contexts where they prefer to choose Exploring Help Features, including ‘About this Collection’, ‘Featured Collections & Services’, ‘Browse by Topics’, ‘American History - Browse by Topic’, as well as other different browsing features (for a complete list of Exploring Help Features, please refer to Table 4.6).

Results of this study reveal that there is a significant difference in the frequency and time of using Exploring Help between Visual (M =3.73/50.76, SD = 2.19/37.56) and Verbal (M = 5.9/85.45, SD = 3.64/56.99) participants, t (58) = - 2.52/- 2.50, p = .014/.015 (please refer to Table 4.12). In other words, Verbal participants used Exploring Help Features significantly more times than Visual participants. In addition to frequency of using Exploring Help, Verbal participants significantly spent more time in using Exploring Help Features than Visual counterparts. These results suggest that Input dimension of learning style does have an effect on novice users' help-seeking behaviors. In summary, Verbal and Visual participants showed clear tendency of utilizing help of their preferred types.

4.2.3. The Influence of Perceiving Dimension

Regarding Perceiving dimension, the relationship between of learning style and the use of different types of help features were also examined to test hypotheses H2.3a to H2.3c. The Scaffolding and Channeling Help Features were chosen to verify the influence of this learning style dimension, in which extracted characteristics were emerged from the exploratory stage in section 4.1. Sensing participants tend to choose their standard way of interacting with the digital library help features. Therefore, the additional assistance provided by Scaffolding Help and Channeling Help from the digital library systems was used less effectively by the Sensing participants. Intuitive participants, on the other hand, were willing to perceive and accept the assistance from Scaffolding and Channeling Help, e.g. 'Auto-complete', 'Relevance Feedback', and 'Refining Categories' when comparing to their Sensing counterparts.

The three different measures were used to testify the hypotheses H2.3a1 to H2.3c1 in order to find out the effect of learning style in Perceiving dimension. Among the three measurements of Scaffolding Help, only the frequency of using Scaffolding Help shows significant difference between the Sensing and Intuitive styles of participants. As indicated in Table 4.13 (part a), the mean frequencies of the two groups of participants are Sensing (M = 3.54, SD = 4.89) and Intuitive (M = 6.31, SD = 4.22), t(58)= -2.33, p =.034.

Table 4.13 T-test Results of Perceiving Dimension (Sensing/Intuitive Styles)(N=60)

Measurements		Sensing (n=26)		Intuitive (n=34)		t	Note
		Mean	SD	Mean	SD		
Part a. Scaffolding Help	Frequency of Scaffolding Help use (H2.3a1)	3.54	4.89	6.31	4.22	-2.33*	p = 0.03
	Time of Scaffolding Help use (H2.3b1)	68.61	76.69	106.57	71.11	-1.91	p = 0.06
	# of types of Scaffolding Help used (H2.3c1)	0.92	0.97	1.38	1.55	-1.32	p = 0.19
Part b. Channeling Help	Frequency of Channeling Help use (H2.3a2)	1.42	1.63	1.68	2.23	-0.49	p = 0.20
	Time of Channeling Help use (H2.3b2)	31.85	52.33	40.76	61.69	-0.59	p = 0.31
	# of types of Channeling Help used (H2.3c2)	0.96	1.038	1.06	1.23	-0.32	p = 0.41

Similarly, the three measurements were adopted to compare the use of Channeling Help features between Sensing and Intuitive groups of participants. Results revealed no significant differences between the two groups (Table 4.13, part b).

4.2.4. The Influence of Understanding Dimension

Results of RQ 1 show that Sequential participants preferred Sequential Help. Therefore, the Sequential Help Features was chosen to examine the influence of Understanding dimension (hypotheses H2.4a to H2.4c). There is no significant difference in novice users' frequency in using help features based on their learning styles in Understanding dimension (Table 4.14). Comparison of the other two measurements of Sequential Help features for Sequential and Global participants also revealed no significant differences between the two groups. Although, results do not reject any of the three null hypotheses, they show a consistent pattern that the mean score of Sequential participants are higher than Global participants in three measurements.

Table 4.14 T-test Results of Understanding Dimension (Sequential/Global Styles) (N=60)

Measurements	Sequential (n=32)		Global (n=28)		t	Note
	Mean	SD	Mean	SD		
Frequency of Sequential Help use (H2.4a)	21.87	5.24	19.75	4.14	1.30	p = 0.39
Time of Sequential Help use (H2.4b)	7.11	3.15	6.27	2.79	1.08	p = 0.28
# of types of Sequential Help used (H2.4c)	3.94	0.97	3.88	1.55	1.32	p = 0.98

4.2.5. Mann-Whitney U Test

Since the parametric statistical testing should meet the assumptions of normal distribution and homogeneity of variance, the observation regarding the skewed distributions of the learning style implies that such results might need to be further

verified. The Mann-Whitney U test, which is a non-parametric equivalent of t-test, was next selected to perform additional verification of the quantitative results. The testing results of Mann-Whitney U test show consistent pattern of results with those of t-test (Table 4.15 – 4.18).

Table 4.15 Non-parametric results of Processing Dimension (Active/Reflective Styles) (N=60)

Measurements	Active (n=31) Mean Rank (Sum of Ranks)	Reflective (n=29) Mean Rank (Sum of Ranks)	Mann-Whitney U	z	p
Frequency of Interactive Help use (H2.1a)	35.48 (1100)	25.17 (730)	295	-3.171	0.002
Time of Interactive Help use (H2.1b)	33.58 (1041)	27.21 (789)	354	-1.413	0.158
# of types of Interactive Help used (H2.1c)	34.95 (1083)	25.74 (746.5)	311.5	-2.141	0.032

Table 4.16 Non-parametric Results of Input Dimension (Visual/Verbal Styles) (N=60)

Measurements		Visual (n=49) Mean Rank (Sum of Ranks)	Verbal (n=11) Mean Rank (Sum of Ranks)	Mann-Whitney U	z	p
Part a. Visual Help	Frequency of Visual Help use (H2.2a1)	33.88 (1660)	15.45 (170)	104	-3.177	0.001
	Time of Visual Help use (H2.2b1)	31.28 (1532)	27.05 (297.5)	231.5	-0.726	0.468
	# of types of Visual Help used (H2.2c1)	30.04 (1472)	32.55 (358)	247	-0.449	0.653
Part b. Exploring Help	Frequency of Exploring Help use (H2.2a2)	28.12 (1378)	39.2 (392)	153	-1.878	0.06
	Time of Exploring Help use (H2.2b2)	28.4 (1391.5)	39.86 (438)	166.5	-1.968	0.049
	# of types of Exploring Help used (H2.2c2)	29.28 (1434.5)	35.95 (395.5)	209.5	-1.167	0.243

For the Processing dimension, the null hypotheses of H2.1a (Frequency of Interactive Help use) and H2.1c (# of types of Interactive Help used) were found to be rejected when

using Mann-Whitney U test (please refer to Table 4.15). For the Input dimension, the testing results also rejected the null hypotheses of H2.2a1 (Frequency of Visual Help use) and H2.2b2 (Time of Exploring Help use). The testing of hypothesis H2.2a2 (Frequency of Exploring Help use) did not show 'significant' under the non-parametric testing, the p-value (0.06) is very close to the result of t-test (0.05).

For the Perceiving dimension, only result for the frequency of using Scaffolding Help (H2.3a1) indicates significant difference between the two groups of participants. The Mann- Whitney U tests for the rest of the hypotheses did not show significant findings.

Table 4.17 Non-parametric Results of Perceiving Dimension (Sensing/Intuitive Styles) (N=60)

Measurements		Sensing (n=26) Mean Rank (Sum of Ranks)	Intuitive (n=34) Mean Rank (Sum of Ranks)	Mann-Whitney U	z	p
Part a. Scaffolding Help	Frequency of Scaffolding Help use (H2.3a1)	20.35 (488.5)	37.26 (1341.5)	188.5	-3.678	0.001
	Time of Scaffolding Help use (H2.3b1)	26.08 (626)	33.44 (1204)	326	-1.618	0.106
	# of types of Scaffolding Help used (H2.3c1)	28.98 (695.5)	31.51 (1134.5)	395.5	-0.581	0.562
Part b. Channeling Help	Frequency of Channeling Help use (H2.3a2)	30.71 (737)	30.36 (1093)	427	-0.079	0.937
	Time of Channeling Help use (H2.3b2)	29.77 (714)	30.99 (1115)	414	-0.273	0.785
	# of types of Channeling Help used (H2.3c2)	30.75 (738)	30.33 (1092)	426	-0.096	0.924

Table 4.18 lists the results of the Mann-Whitney U test for the Understanding dimension. In which the proposed null hypotheses were found 'not rejected'. Such result is consistent with the conclusion of the t-test results.

Table 4.18 Non-parametric Results of Understanding Dimension (Sequential/Global Styles) (N=60)

Measurements	Sequential (n=32)	Global (n=28)	Mann-Whitney U	z	p
	Mean Rank (Sum of Ranks)	Mean Rank (Sum of Ranks)			
Frequency of Sequential Help use (H2.4a)	32.86 (1051)	27.80 (778.5)	372.5	-1.121	0.262
Time of Sequential Help use (H2.4b)	31.86 (1019.5)	28.95 (810)	404.5	-0.645	0.519
# of types of Sequential Help used (H2.4c)	29.91 (957)	31.18 (873)	429	-0.391	0.696

In summary, results of the quantitative verification phase demonstrate that the hypotheses are partially approved and the summary of the testing results are shown in Table 4.19. Among the four dimensions of learning styles, the first three dimensions show significant differences, which indicates that the Processing, Input, and Perceiving dimensions were proven to have influence on participants' use of different types of help features. For the Processing dimension, Active participants had a higher tendency to choose and spent more time to use Interactive Help Features than Reflective participants. In terms of selecting different input format of help features, results of this study demonstrate that Visual participants were more inclined to select Visual Help Features, while Verbal participants showed interesting preference in adopting Exploring Help Features. Regarding the perceiving of the help features, results indicate that Sensing participants use the Scaffolding help less effectively than their Intuitive counterparts. No significant differences were found between Sensing and Intuitive participants in using

Channeling Help Features. For Understanding dimension, there is no significant difference in novice users' help-seeking behavior between the groups of Sequential and Global participants

Table 4.19 Summary of Testing Results of RQ 2 and Corresponding Help-Seeking Behaviors Identified in RQ 1

Learning style dimension	Hypotheses	Measurement of Help-seeking	RQ 2 T-test Results	Corresponding Help Features Identified in RQ 1
Processing (Active/ Reflective)	H2.1a	Frequency	Significant	Interactive Help Features
	H2.1b	Time	NS	
	H2.1c	# types of help	Significant	Interactive Help Features
Input (Visual/ Verbal)	H2.2a	Frequency	Significant	Visual Help Features; Exploring Help Features
	H2.2b	Time	Significant	Exploring Help Features
	H2.2c	# types of help	NS	
Perceiving (Sensing/ Intuitive)	H2.3a	Frequency	Significant	Scaffolding Help Features
	H2.3b	Time	NS	
	H2.3c	# types of help	NS	
Understanding (Sequential/ Global)	H2.4a	Frequency	NS	
	H2.4b	Time	NS	
	H2.4c	# types of help	NS	

As previously stating in section 4.1, the qualitative finding illustrates how learning styles affect users' use of help features in information search process. The analysis in this section intends to find out quantitative evidence that can support the preliminary results obtained in the previous stage. The connections between the qualitative finding for RQ 1 as well as the quantitative results of RQ 2 are also examined.

It should be noted that not all the Help Feature use can be properly converted to quantitative measurements. Six out of eight Help Features are selected to perform the quantitative analysis, while the remaining Help Features are not suitable to be represented with the three variables. The 'Reflective Help' and 'Verbal Help' cannot be reasonably quantified by the current experiment setup. Both 'Reflective Help' and 'Verbal Help' can only be observed for very low number of occurrences. The corresponding help features are shown in the last columns of Table 4.19.

Based on the help features analyzed in the quantitative analysis, a comparison between the results of RQ 1 and RQ 2 reveals three similar patterns. First, the qualitative finding shows that learning styles affect participants' use with different help features of digital libraries. Similar findings can be concluded in the quantitative analysis, in which the t-tests results reject null hypotheses showing that the effects of learning styles on users' help feature interactions are significant.

Secondly, the effects of learning styles on users' help feature use can be partially identified in three dimensions, namely Processing (2/3), Input (3/6), and Perceiving (1/6) dimensions. For Processing dimension, two out of three of the t-tests results reject null hypotheses of H2.1a and H2.1c. For Input dimension, three (H2.2a1, H2.2a2, and H2.2b2) out of six of the t-tests results also support the qualitative findings. As for Perceiving dimension, one (H2.3a1) out of six of the t-test results reject null hypotheses.

Thirdly, t-tests results of the rest of hypotheses (H2.1b, H2.2b1, H2.2c2, H2.3a2, H2.3b1-2, and H2.3c1-2) testing provide insignificant evidences to support qualitative findings of the learning style dimensions. However, when comparing the corresponding

Mean values, these quantitative results still show consistent tendency in terms of usage counts. For the analysis of H2.1b, Active participants spend more time in using Interactive Help than their Reflective counterpart participants, yet the difference does not reach a significant level. The similar pattern can also be observed in H2.2b1, H2.2c2, H2.3a2, H2.3b1-2, and H2.3c1-2. However, the t-test testing results for H2.2c1 for Visual Help indicate no differences between Visual and Verbal participants. The different groups of participants demonstrate almost the same number of types of Visual Help Features used. The probable reason might be the low statistical power caused by the scarce number of types of Visual Help Features observed.

Finally, the testing measurements for the Understanding dimension do not show any significant results (0/3). The testing measurements for the Understanding (Sequential/Global) dimension did not indicate significant differences between the two groups of participants and thus provide no clear supportive evidence. It is not known exactly what might cause the discrepancy. The possible reasons are the context of learning may not be transferable for Understanding dimension in the information seeking environment.

The learning style dimension of Understanding in traditional educational setting usually takes longer to take place. For example, a unit of subject concept in a classroom environment might need to take several days or weeks for students to gain the understanding or learn it. While in the IR environment, users don't have that much time. The pace for help-seeking interactions is much shorter, sometimes just taking a couple of minutes. The influence of Understanding dimension is not easily observed in such a short

period of time. Besides, the classification of participants' learning style is based on the self-report data of Index of Learning Style. Participants report what they believe their preferred way of understanding in learning environment. However, while getting started with digital libraries environment, such preference of learning may not reveal in their interactions with digital libraries.

4.3 RQ 3: What are the help-seeking approaches that novice users with different learning styles apply in digital libraries?

The major finding of this study focuses on answering the third research questions in regard to how learning styles affect their corresponding help-seeking interactions with digital libraries. According to Felder & Silverman (1988), students learn in many ways. In traditional educational settings, students learn by actively engaging in activities, or through reflective introspection. They receive external information by seeing and hearing and try to reason the perceived information logically and intuitively. Then, they progress to understand the meaning steadily in fits and starts. Learners bring their unique prior knowledge, preferences, and beliefs to a learning situation. It is through the learning cycle that students gradually develop and grow. The Index of Learning Styles classifies students according to where they fit on a number of dimensions, which refers to the ways they receive and process information.

In the previous section, representative behaviors of participants regarding their uses of various types of help features were summarized. During the searching tasks, some participants with different learning styles were found to use different types of help features when searching for the given tasks. Some participants obviously adopted certain

help features in their particular ways and perhaps more interesting is why they go about doing so. Section 4.2 also provides quantitative evidence to prove the effects learning style. To further understand the effects of participants' learning styles on their help-seeking behaviors, the representative behaviors of participants with different learning styles were investigated based on various help-seeking approaches observed from typical novice users of DLs. Results of this study show that participants with different learning styles exhibit various dimensions of help-seeking interactions while searching information in digital libraries. When interacting with help features, Active and Reflective learners in the Processing dimension show different preferred approaches of engagement. For the Input dimension, Visual and Verbal learners have their preferred interaction format and content of help features respectively. While engaging in examining help features, Sensing and Intuitive learners have different preferences in relation to help content, structure, and design. Sequential and Global learners apply their preferred strategies to make sense of and understand DLs and their functions. Table 4.20 summarizes participants' learning styles and the associated categories and types of help-seeking influence.

Table 4.20 Types of Users' Help-seeking Approaches

Research Questions	Learning Style Dimensions	Help-seeking Approach Category	Types of Help-seeking Approach
RQ#3 What are the help-seeking approaches that novice users with different learning styles apply in digital libraries?	Processing Active/ Reflective	Engagement in selecting and using help features	Trying with different types of help features Choosing straightforward help features Selecting interactive help features Limited use of help features Adopting help features after thoughtful planning
	Input Visual/ Verbal	Interaction with both formats and content of help features	Preferring visual help features Selecting syntactic & semantic help content in visual formats Preferring verbal help features Examining semantic verbal description
	Perception Sensing/ Intuitive	Engagement in examining help content, structure, and design	Selecting help features with concrete information Avoiding exploring unfamiliar help features Judging the logical design of help features Examining the structures of help features
	Understanding Sequential/ Global	Application of strategies to make sense of and understand DLs and their functions	Understanding help content in a sequential way Interacting with different help features in order to make sense

4.3.1. Processing dimension: Active learners vs. Reflective learners

The most typically observed behavior of Active learners is that they usually take many actions within a short time as instant reactions without much thinking (Ford et al. 2002; Kim, Yun, and Kim 2004). Active learners like to quickly try things out rather than tackling long and passive reading. This preference can be reflected by how they interact and navigate through the online information (Graf, Liu, and Kinshuk 2010). Therefore,

while interacting with help features in digital libraries, Active learners interact with different types of help, choose straightforward help features, and prefer interactive help features. Reflective learners, on the other hand, use restricted help features and adopt the features after thoughtful planning.

Trying different types of help features

Active learners tend to work actively with the digital libraries and try as many help features as possible. According to Ford and his colleagues (2002), Active learners change their mind relatively readily in information retrieval. They do not speculate on the help features. While trying help features out, they do not think beforehand nor do they contemplate about the results provided by the system. As one Active participant stated, "I just go into it and try it. (P2)" P2 further explained that he was more inclined to keep actively trying:

> "I have to go and try my own instead of going with the instructions, because they did not help for me. That is how I do it though. I know a lot of people learn by 'reading out loud' or just by looking at the instruction. For me, I like to do things in my own way, like I am tired of sitting there reading or listening to people talk, it gets pretty tiring especially for college students."

Many participants replied that 'actively involving' is their major way of learning a new system. P9 explained "Yeah, a couple of things. I learn by doing things. I don't .. I don't …I learn much more by doing." P17 replied with the similar manner: "I am more learning by doing, I like to do the activities and that is how I learn."

It is interesting to note that Active learners prefer active engagement in selecting help features not only mentally but also physically. This specific preference was observed during the time when P33 answered how she learns to use a new system in the post-interview. With her face expressing great excitement, she mentioned that her particular way of learning is to actively poke around. Additionally, she also showed passionate body movements by raising both her hands with fingers pointing in the air like poking for several times. She replied with enthusiasm: "I learn by just going and poking around. I know I will never click on a help like. I just poke and poke and poke."

Since younger generation users grew up with the internet, they don't think they need to 'learn' it. P35 provided her point of view that she will keep trying new systems and adjust the differences. The process of justifying the new features is the most effective way of learning. She said:

> "I use computer every day since I was little, so I don't really have to LEARN a new system, you know. Just have some differences than what I usually do. It's mostly the same and I can justify it quickly. So, in general, I don't really know, because I don't really learn new things. Using it, that would apply a lot."

Choosing straightforward help features

Active learners seem impatient with long and complicated help features. Instead, they tend to choose simple, short, and straightforward help features. One Active learner replied his preference of help feature: "the simpler the better for me at least. (P17)" P35

explained how simple features help her know what actions to take along the search process. She said:

> "UWM was really simple. What I need to do is just type in and search which is really helpful. Just by looking at the basic layout, and then you just continue to use it and done more searches. It would become a lot easier. This is nice."

Active learners do not tolerate complicated system design. The interactions with a difficult system would bring negative feelings about Active learners themselves, which is detrimental for learning. P5 reflected her inner feeling about a complicated system:

> "If it is complicated, I would battle myself, because a lot of these are self-explanatory and I am a computer illiterate. I can't figure it out. I don't want to feel stupid, and this make me feel stupid. I don't feel like it helped me learn how to use it at all."

P52 also complained about and suggested that both DL systems require more than baseline skill level and great patience to learn to use them. She preferred to have simple and straightforward system and stated:

> "You have to have some skills to go into and a lot of patience to look for something. Whereas I feel like, at this time of age, the search engines are available, you just don't have time anymore. You just don't have the patience anymore, because you have something like Google and Yahoo, which are so intuitive and simple and it is right away. For these two DL systems, I have to go

> through so much to find something. The two DL systems should be much simpler, this is way too much. There is no way to go through."

In addition to the simple design, P35 also mentioned the Google-like design did not take as long to search. She raised her voice while comparing about her experience with both digital libraries and Google. She said:

> "Mama! That is difficult. Yeah, when you search in Google you don't have to complete like everything. So you don't have to be specific when you type in anything and it doesn't take me as long for searching for something."

Selecting interactive help

This study shows that Active learners learn best by working actively with the learning material and applying what they have learned in the real world. They want to be actively involved in the presentation, including talking, moving, and interacting with the learning material instead of passively reading, watching, and listening. Active learners not only explore simple and straightforward functions provided by digital libraries, they also prefer more Interactive Help features, e.g. 'Online Chat' and 'Ask a Librarian' to solve their problems. Interactive help features are required to be easy for users to start interaction and to act upon. Moreover, interactive features provide real-time, dynamic, and relevant feedback.

Active learners like to easily start interaction with digital libraries. P17 criticized UWMDC for not being interactive enough for him at the beginning of his searching and said "It was kind of hard to see where to start. Obviously, I couldn't find anything on

UWM." Another participant also expressed that the help features should be easy to reach from his experience: "If you go to the UWM one, it doesn't have that one like right on hand. It does not say anything like 'Ask a Librarian' or anything. You have to look for it. (P5)" In addition, Interactive Help features need to be easy to act upon for Active learners, because they learn from doing. P16 said "if I have further question, I like the interactive Chat where I can see how to do it myself."

For Active learners, perhaps the most attractive characteristic of interactive help is its responsiveness and effectiveness. Active learners do not learn passively. On the contrary, they learn by actively involving in the process of communication. When first looked at the homepage of UWMDC, P2 noticed the FACEBOOK icon and stated: "I like the FACEBOOK [social media feature provided by UWMDC] and I felt like more connected." Moreover, Active learners like to have immediate feedback without a delay of time in the interaction. One of the Active participants expressed his preference of online chat over email. He said:

> "I think because 'Live Chat' is a lot quicker. It is someone instant waiting for you. Email make you feel like ... I don't trust that. Because it could take a day or two to respond and it is too long. For Online Chat, you get the answer immediately. You just sit there and waiting for them to type. It is nice. So I like to have an immediate feedback from them. (P16)"

However, just being responsive may not be enough for some of the Active learners. The negative example for interactive help is the 'Online Chat'. Compared to communicating in detail with a librarian or a professor, P17 replied that reading the

written texts from ‘Online Chat’ may not be sufficient and effectively enough. He said: “When I have technical problem, I never go to live help, because it explains something on the typing. It can’t be as detailed like talking. I would go to librarian or my professors.” Participants expressed their preference of turning to people in their network of relationships who they believed would provide the more interaction than ‘Online Chat’. Since participants are from an academic environment, the help interaction comes from people in their everyday life – their family members, classmates, professors, and librarians. P1 reflected her great experience consulting a librarian from UWM library: “I might ask a librarian, because I have in the past I have used it in UWM and I’ve always gotten great help from it, so I would try it in the future.” P9 also said “Just being able to walk through the problem with my professor at the same time is very helpful.”

Limited use of help features

When comparing with Active learners, Reflective learners are more analytic, and prefer to think about and reflect on the learning material. In other words, they prefer to process information through self-introspection. They try to retrieve their own knowledge and experiences and figure out what is best for their learning situation. When encountering a search problem, Reflective learners show limited use of help features and select help features after thoughtful planning.

Reflective learners use relatively limited help features. They tend to think over the usefulness of help features before trying them out and are less willing to take risks.

While searching in Digital Library environments, Reflective learners are conservative in trying out new help features when they encounter problems. Just like P6 said about his uncertainty in clicking one of the features showing on the page:

> "It was a lot more difficult to understand the results that were showing. And I don't know…I mean the …., I don't know what these were... And that's what I feel like I can't click those because it won't help me".

Another Reflective participant, P8, also expressed his worry and confusion in trying one help feature. He has problem connecting to the label of the sub-collections:

> "This drop down list of all collection is a little confusing to me. There are so many archives here. Yeah, if you click up here at the drop down menu, like this one 'AGSL Digital Photo Archive: North and Central America'. I don't know why this drop down list is kind of intimidating to me."

P40 offered a reason for his hesitation in trying out help features. When he processed the information in the DL environment as a novice user, he did not know what question to ask in the "Ask a Librarian" feature. He said:

> "It is not clear where I can start my search based on the browsing categories here. Oh, 'Ask a Librarian'. I don't have to ask questions, because I don't know what question to ask at the very beginning. By the time I know which question to ask, there is no point asking, because they have already been answered. (P40)"

Unlike Active learners, who like to communicate with others, Reflective learners regard talking as a demanding job. One Reflective participant expressed his feeling about

'Online Chat' by saying "you know I have trouble talking to somebody live or something like that. Like that 'Chat' thing. I don't want to try that. (P11)"

Adopting help features after thoughtful planning

Reflective learners prefer to think about and reflect on the learning material. One Reflective participant replied in the interview that she also likes to try things out but most of the time she prefers to think beforehand as her way of learning. "Because I am the type of person who likes to think about it, read and find out. I also like to try and see but more inclined to think about it first. (P51)" In the study, Reflective participants are more deliberate, and willing to plan and monitor their search process before they take further actions. P29 replied how the features helped him monitor search results so that he could plan for his next search term. He said:

> ""I definitely have some situations where I am trying different combination of terms. And I do want "Oh, this is a good search term, and let's see whether I could find something related to it." I can't remember how good the search result was. When those features like 'Search History' are available, especially you are going a lot of slight variations of search terms. When I have 'Search History', it is really convenient.""

During the search process, Reflective learners also carefully think about the navigation plan. They tend to continuously check where they are and think about strategies of moving around the digital libraries. P18 appreciated one particular way-finding help feature after she examined the obtained results: "It has a lot of the

'breadcrumbs'. You can see where you are." Another Reflective participant also reflected on his top-down strategy of navigation and said: "Once I went into a little deeper, I remember, OK, this homepage can help me with this, so here, just in case you are the person who likes to see everything from the top, you can click here. They help you less confused. (P3)"

Reflective learners are more analytic. They have the tendency to de-structure the learning process into different parts of aspects of elements where they feel most comfortable to start thinking and learning. They are not so certain about their learning if they don't clearly understand the individual elements which constitute the overall learning task.

During their search process, Reflective participants expressed their feelings of uncertainty because of the constant reflections on their behavior. In order to reduce the uncertainty in the help-seeking process, they appeared to keep asking themselves "Where should I go? ", "Do I understand the problem?", "How should I avoid some common mistakes?" and "Would I remember this?" The questions Reflective participants asked helped them become alert of where they are and where they are going at the same time. P40 described how he used the strategy of re-read, maybe re-reading twice or even more times, to reduce such uncertainty. The strategy of self-help made the 'current problem' clear for him before he can start searching. He wanted to make sure where he said "when I read a problem for the first time, I go back and reread so that I would have in my mind what I am looking for."

Reflective learners tend to consider every possible situation before they begin searching. They hope for the best and prepare for the worst. As a novice user, P40 thought about the mistakes that he might make and the resources that would help him conquer those mistakes. By reading and thinking about the mistakes which others have been made becomes a driving force for him to start actions. He said:

> "And I can correct my mistakes and go along. And there is a list of online resources, where I can go to just bunch of different places on websites, so there will be like one of the places, or the online manual. And there will be other places, where people have private discussion, sort of like forums, web forums. Someone would say if you are learning this for the first time, this is the sort of mistakes that beginners are making, and this is how you are going to avoid them that sort of thing. I just want to have everything on my finger tips so that I can do it myself."

While conducting a searching on hand, Reflective participants frequently reviewed the past and prepared for the future. Not only did P40 plan before his searching, he also thought about it afterward. After searching for a while and obtaining a relevant record, he tended to write himself a summary note in case he might forget what this was for in the future. He said:

> "It's a link that I might want to come back to. And we have an image of him, which is a great place to start. So I will just copy the link. Just write a brief summary of what this contains. I will write myself a note."

4.3.2. Input dimension: Visual learners vs. Verbal learners

While being presented with different input format of information, learners with different styles would use preferred verbal or visual strategies to represent their knowledge and fit their particular way of thinking. People with Visual style prefer visual aids such as graphics, diagrams, icons, images, videos, demonstrations, conceptual maps, and color information in the learning contexts (Graf et al. 2007; Hong and Kinshuk 2004). In a searching environment, Visual learners are more inclined to select visual help features (Kinley and Tjondronegoro 2010; Wood et al. 1996) and Verbal learners prefer syntactic and semantic features of help content.

Preferring visual help features

Visual learners in this study preferred visual help features because the pictorial formats would help them process information in terms of quickly interacting with information, better memorization, and easy to learn and comprehend. Visual participants regarded pictorial features as more effective formats during the interactions of identifying, responding to, and grasping meaning of information. P23 talked about when viewing the list of long results, the icons helped him feel easier to identify the needed information:

> "Personally I am a very visual person, so I like having the icons there. I think the icons make it easier because you can see exactly what each one is. See what I have to click through and try to figure out which one is which that way I think the icons are a lot more helpful."

In addition, imaged cues are more comprehensible for Visual learners. One Visual learner (P21) said: "I would say that people naturally lean toward to things that are making more sense to them. So I would think that I am more of a visual one, and I will go to these images." When being given the options of different presentation formats, P27 acknowledged that she would go for the images rather than list of texts and said "if you have to choose one or the other, I would go with the images, instead of the list. Because I think people would respond a lot better to the images." She further explained that it is easier to catch the meaning of images: "I think the images are the most important thing, and it draws your attention in these things and people grasp images a lot better than grasp texts."

As can be expected, while being presented with non-visual format information, Visual participants tended to feel difficulty, find time consuming, and thus skip a lot of information. P12 said: "I don't think it is easy. Not enough visual, I am a visual person. So I would like to see how the search mechanism happens before I do it."

Another Visual participant also commented the longer time spent on non-visual feature: "the list view, um, it takes a while to read comparing to the pictures. I prefer to have pictures. (P1)" As a result, given the non-visual feature, Visual participants tended to skip textual information. P30 reflected her feeling about the counter example of non-visual feature and said:

> "Is it for me to judge the relevancy of the subject? What I am looking for is the picture rather than having scan reading the texts, because I am not a good reader, so I feel like I would skip over a lot of important things. So the pictures here will

> help me from not skipping too much and detect more information from the presentation."

She also explained that the non-visual feature would be difficult for her and take her more time to understand: "I might forget and I am pretty good at remembering once I get to see it. But if I have to read it, then it is more … confusing and time consuming to comprehend. (P30)"

Selecting syntactic and semantic help content in visual formats

Visual learners show a tendency to notice different levels of the help content in visual formats, including syntactic and semantic content. Participants with Visual style selected various syntactic help features (e.g. composition, layout, color, and other visual arrangement) in their experiences while interacting with both digital libraries. P13 described how clear composition helped her find target information by saying:

> "So, having really clear design of the webpage is really helpful, like the way LOCDC broken up into different spots, you know that helps too. Because I am a visual person, I can find what I am looking for by glancing. And I think people are increasingly visual that way."

The location of the layout also affected their selections in the help content. P41 specifically referred to the left column of the homepage layout of the webpage. Any information placed on the left column indicates its importance. She said:

> "Your eyes naturally go to the left column for clues. Just because I think it is on that side and it is effective. The left hand column, we read from the left, so, at

> least in USA. I think putting it on the left is important. I like left hand column. It is more important than the right hand column. My eyes tend to look at that part of the page. Part of it is effective because it is consistent. I think that is very effective."

Besides the layout and composition, the participants mentioned their preferences on visual help content on the syntactic structures of color, font size, and density of text. P10 said "the 'Go to PDF' of UWMDC just make the words a little bit bigger. I did not even see this. Oh, here, open a new window and here you have a whole screen. See, it would be nice if you have this bigger or different color." Another participant expressed her preference in text density by saying: "I would say LOCDC looks a little bit clustered, because there are so much information. I think that would be something useful to decrease the clutter. Although, I would agree to have the topping over there, you know just have the brief description maybe a little bit less, and does not look so cluttered. (P5)"

Visual participants also preferred interacting with semantic help content, which refers to the meaning of the visual help elements. It is interesting to note that P9 immediately identified the meaning of the image, which is the subject of the Featured Digital Collections of LOCDC. He also commented about the two different types of objects that he recognized, including the specific famous people (Jackie Robinson) and the generic objects (two unknown people):

> "Honestly, I am very visual, so when I look at this picture of Jackie Robinson and all I see in the picture is him, and the rest of it, the catcher and umpire behind the

> plate, is kind of blurred. For me, I prefer to have more images to explain what is going on."

Sometimes the visual elements can be abstract objects, like symbolic icons used for representing something else. Visual participants also preferred symbolic icons provided by the gallery view in both digital libraries. P23 commented on the clear icons which helped her understand the represented formats of documents: "I think you can see what it is by looking at the result page of UWMDC. Like, this one is an audio file, this one is a video clip, and this one is a document." However, not every symbolic icon could facilitate her searching. By looking at the icons in the result page of LOCDC, it was difficult for P23 to identify what type of information the iconic refer to. P23 had to click on every individual link and explored for a while to understand. The visual icons of both digital libraries compared by P23 are listed in Table 4.21. P23 continued to explain:

> "And the other one (LOCDC), the icons are not as precise. Like the 'legislation icon' or the 'webpage icon'. I found these icons kind of vague. You still kind of need to figure it out. Like this one, you are supposed to figure this is a webpage, but I have no idea what this is supposed to be. And this icon is a book? Maybe, these images are not as clear as those in the other website (UWMDC)."

Table 4.21 Examples of icons used in LOCDC and UWMDC

LOCDC Icons			UWMDC Icons		
Webpage	Legislation	Book	Book	Audio	Video
					

Preferring verbal help features

Unlike Visual learners, Verbal learners prefer to engage more in verbal help features, which facilitate their interaction, understanding, and learning in the DLs environment. They comprehend information through browsing textual presentations, including both written and spoken explanation. This particular behavior occurs not only in general learning environments, but also in information-retrieving contexts. One Verbal participant commented her natural tendency in selecting verbal help at the first glance of LOCDC:

> "When I first looked at the page, the first impression of the homepage, I noticed that… even there is an image on the page, I would ignore it. I would somehow go back to the description. I did go to the text, and I didn't think about that. I mean potentially or unconsciously. (P32)"

Verbal participants tended to be more oriented to the use of text-based language than images. She continued to explain how the organization of text directed her in a useful way: "I did read the text a lot. I also think it is the way the text is written helps me

understand what I am looking at. The images felt less important. Yeah, but it is funny, at here, the text felt really useful." P39 expressed his dislike of photographs and chose to interact with written words:

> "My primary documents are like novels, poem, or whatever, right. Um, I don't normally look at photograph. Typically, I read and respond more to text than I do to images, because I don't like different kinds of photographs. So sometimes I read only the written descriptions."

Verbal learners learn and comprehend learning material through browsing written texts or spoken words, which they believe contains the most important information. P11 said, "I remember when I learn by myself or listen to teacher's lecturing, the most useful information is words and data."

Examining semantic verbal description

In the study, Verbal participants presented the tendency of choosing verbal approaches while performing the searching task. Verbal participants were patient with and enjoyed evaluating verbal description of help features. They inclined to take longer time to interact with the semantic characteristics of information in order to grab the deeper meaning. For example, when presenting several related documents with the same topics, e.g., pictorial documents or a personal letter, P59 replied with her preference:

> "For the research that I have done, I haven't found a picture being helpful. I can see how a personal letter being helpful, it would give personal insight to Abraham Lincoln's shot."

P46 also talked about her preference of descriptive help of UWMDC because abstract form feature has details in it which helped her understand the essence of help content:

> "I think the UWM search results have pretty descriptive titles and so it is kind of a really short version of abstract. This is something that I would look into. So I think it is pretty helpful. Yeah, it has details in it. So I think that was good…It would be nice to make it more descriptive to help you find interesting things better. (P46)"

During the interactions with both digital libraries, Verbal participants selected and examined semantic verbal help features, moreover, they wanted to construct their own interpretation from the experience. P39 shared his view of how reading semantic descriptions is vital in his learning of using a new digital library system:

> "But I still feel like the best way about it is like a human being who is familiar with the material just going through and write a short paragraph or description. So I was reading the written descriptions."

He later emphasized reading and interpreting played a critical role in his learning. It was through continuous interpretation that made him construct his own knowledge. He said:

> "Yes, of course, the way it is presented is incredibly important, because I mean in my field my subject and my discipline is of course very hermeneutic. Right, we never take anything as a given. Like this poem is passively conveying meaning to

me. For me, interpretation is the 'key'. And because of my particularly intellectual commitment, it affects the way I think about interpretation."

4.3.3. Perceiving dimension: Sensing learners vs. Intuitive learners

While engaging in analyzing help features, Sensing and Intuitive learners had different preferences in relation to help content, structure, and design. Sensing learners like concrete information in help materials and prefer solving their problems by standard methods and dislike surprises. While interacting with help features in digital libraries, Sensing learners also prefer selecting help content with precise information and adopt only familiar help features. Intuitive learners, on the other hand, prefer to perceive help information directly from the internal insights, such as relationships and underlying principles or theories. In searching in the digital library environment, intuitive learners have the tendency to analyze the structure and judge design principles of help features.

Selecting help features with concrete information

Sensing learners prefer perceiving help-related information through their senses. They prefer learning from facts, data, and experimentation in order to relate the learned material to the real world. One example is that Sensing learners are sensitive to factual data, such as numbers. Every time when there was a result page showed up, what P48 immediately noticed is the exact number of documents retrieved from the DL system. During the search process, P48 kept read out or mention the numbers as his preferred way to perceive information.

> "I got six hundred and ninety-five articles pop up…. Well, I still got two hundred and three.... So, only eight things pop up. Four hundred and fifty-four, so a little more like the other. …I think this one returns like five hundred, and that is more specific as it only returns maybe like a hundred."

For the IR environment, based on what Sensing learners gather through their senses, they can develop a better picture of an IR system. In this study, Sensing participants tried several functions that contain factual information in the digital libraries. After searching for a while in one of the digital libraries, P34 wanted to learn more factual information about Jackie Robinson and said, "But one thing I noticed, now that I'm back on this page, because it has a map and a timeline. I wonder maybe go back and click on the timeline." Moreover, another participant explained that the timeline built up a knowledge base for his learning: "Looking at the page of Jackie Robinson, first place I go is the 'Timeline', so that gives chronological order in time. The timeline tells you exactly when and what happened in that period of time. (P26)"

When the factual information, such as date, is not presented in an easy way for perceiving, Sensing learners tend to have difficulty in the search process. P1 expressed how she struggled to find the date information in UWMDC. She continued to elaborate how an automatic presentation of date in LOCDC helped her retrieve knowledge from her memory:

> "For UWM, everything here it is slightly cut out, honestly it is a big deal. I don't know. They just seem so broad, and all over and not related to it. Just add the date and make the date show up. But the other one, the date is automatically. I don't

remember for sure. I don't know when it was. The date comes up for you and you will be able to narrow it."

Avoiding exploring unfamiliar help features

Sensing learners prefer solving problems by standard methods and dislike surprises (Felder & Silverman, 1988). While interacting with help features in digital libraries, Sensing learners are more comfortable with their own standard routines in searching digital libraries and avoid exploring unfamiliar functions. One participant reflected the consistency in her search habit:

> "I think if there is a type of search that I do frequently, I would be able to find the way to do it and then I will stick with that one way of doing it. So I think that would be best just pick one way to do it. (P54)"

One Sensing participant commented how familiar design of help features help him comprehend the functions. P17 talked about his preference on Google-like feature which would affect how he learned to use the system:

> "If there is some type of system, I won't use anything else other than Google. I don't like anything else that looks like Yahoo. I just care how Google looks, and those kind of things makes sense to me. So you know this one when I see stuff like the featured categories on this [LOCDC] homepage. This is good to me. This is something I know how it looks. And that one [UWMDC] does not look good to me. That affect my ability to comprehend how it works."

Selecting familiar help features built a base for P17 to adjust to the searching environment, which always gave him positive feeling so as to help him learn to use a new system. He continued to explain:

> "It takes time to really learn to use and adjusting it. You don't really know what you are looking at. What is in the system? Is this an article? Is this a book? I don't know. [P17 felt lost and confused in the DLs searching environment.] This is how I struggle in the search process. So, if I had a positive experience and I learned from it."

Moreover, searching in a total strange environment makes the Sensing learner felt confused and not learning anything. P56 remembered how frustrated she was when she did not see familiar features in UWMDC. She reflected:

> "This system did not do a good job on helping me learn how to use this system. I can't see anything I am familiar with. I searched, I searched and I searched again, and I was always confused even after the third tasks. (P56)"

As a result, the decision of providing familiar help features or not would either facilitate or hamper Sensing learners' learning progress in DL environment.

Judging the logical design of help features

Intuitive learners are more interested in learning abstract material, such as concepts, theories, and the underlying meanings. They prefer to perceive the relationships, meaning, and possibilities through internal intuitive insights, speculation, and unconscious

imagination. Instead of perceiving individual objects of the digital libraries, P35 talked about how intuitive layout design guided her in the search process:

> "It was really simple to use. You can either type in a search which is really helpful or you have the options to browse the different categories, which is nice. By just looking at the basic layout, and then you just continue to use it and done more searches. It would become a lot easier. That is nice then."

Intuitive learners don't take all the features for granted; on the other hand, they speculate the relationship between the resulting items and their search terms. According to P14, he did not get the information of sorting order when he looked at the result page. He was wondering what were the criteria used to sort the results:

> "Yes, the result come back one, two, and three, and I don't know if the come-back order of importance? It is not in alphabetical order. Is it coming back to my search word?"

Intuitive participants also liked to analyze specific system functions critically. One Intuitive participant realized that the search feature limited him to just one category. He said:

> "So I would like to have access to both, rather than just one. I would be very annoyed if I can only search within the category and I would also be very annoyed. I had to search the whole library every time I look for something. (P15)"

Intuitive learners adopt a broad-to-narrow approach of interacting with DL. While being given a certain list of results, Intuitive learners are not satisfied. In order to

determine when to start examining individual item, they want to precisely know about how exhaustiveness and how many types that the whole DL content could be. When finding their way in the navigation, they want those features that can definitely indicate what position they are currently in. Just like giving them a map, so they would know the orientation of major streets before turning into small pathways. P42 revealed a similar thread of thought by saying:

> "I'd like to know the scope of the collection. And you get more of the feel for that when you look at the DL, they have that .. even right here, the featured collections and services. It gives you a nice kind of overview of what kind of things that you might expect to find there."

After getting the overview, P42 shared her transition to the detailed information of individual item: "I would go to overview first, and then flip it back to the list view to get additional information. I would skim through the information before I open it [the individual item] up."

P7 also pointed out the importance of overview feature by saying:

> "Provide for some kind of overall pictures of how many we have. Then you are pretty sure this is what I am looking for and this is not. And this item is relevant for 50 % and that one is relevant for 80%. Those kind of features, you can't tell what it is, but you want those kind of help from DL."

P7 continued to describe her speculation in selecting a collection from a list when she was not sure of the degree of exhaustiveness of the list. The awareness of such

information helped her as a novice user to make the decision whether to continue searching or not. She said:

> "For this one [LOCDC], it said 'featured', so I am pretty sure that it is not exhaustive. But in here [UWMDC], it does not say featured, so I don't know. It might be or might be not. I don't know whether this list is exhaustive or not. I could guess they give this dropdown menu would lead to everything possible. But then it seems like an odd list that I don't know certain things would fit. I wonder that it is exhaustive. The trouble is I don't know how extensive either system is so I don't know I found everything that I could possibly found there. So I never know that my search is done or when I should continue."

Examining the structures of help features

Intuitive learners tend to analyze the desired structure of help features. P59 mentioned that bad structure of help feature confused her during the search process: "These individual collections the way that they organize it, I find it to be not... not the best, and it can be confusing sometime. Because they just give you the long list and it is hard to browse I think." Another participant expressed her dislike of the rigid organization of help feature: "because I feel like I had more options in LOCDC so I can search and explore through. But this one seems very structured and rigid." (S30)

P38 criticized the linearly structural design of help feature that did not allow her to channel to information in different collections. She expressed her disappointment: "When you are in a particular collection, you can't immediately go into another collection. You

have to go to the top level. Or maybe, for some reason, I am going back and forth between two collections, the results page or like the general browsing." She explained how the linear structure should be changed to integrate other collateral sub-collections:

> "For instances, this Africa, instead of clicking 'digital collections' at the top level, then we can select from the list. It might be nice that all of the links of 'browse collection list' are incorporated into the left hand side or perhaps the dropdown menu was incorporate into one of each page, like Africa, Asia, or Europe. I can just click on the collections. That would be like kind of convenient."

4.3.4. Understanding dimension: Sequential learners vs. Global learners

Sequential and Global learners applied their preferred strategies to make sense of and understand DLs and their functions. Sequential learners understand help features in a sequential way, while Global learners experience different help features in order to make sense.

Understanding help content in a sequential way

Sequential learners tend to gradually gain understanding in a linearly incremental way. When solving problems, they follow linear reasoning processes and prefer logically ordered learning materials (Felder & Silverman, 1988; Lee et al., 2005). Results of this study show that Sequential learners understand help content in a sequential way. They prefer sequential help, navigate in linear way, and select sequential organization of help content.

Three Sequential participants stated their preference of step-by-step help content. P48 said, “They give a step-by-step instruction to help. I think it’s really helpful.” P50 echoed in similar expression: “But I also like to have steps to follow. So someone gives me directions to do the steps I will do it.” According to P10, a step-by-step instruction suited her need and had fastened her learning progress. She said:

> “I like those. It is quicker than asking for someone for help. If I can learn from those and fix the problem by myself, I would choose to do so. It is so quick, because you can see what they do and just copy exactly what they do and that is how I learn fast.”

Sequential learners also tend to navigate through the learning materials in a linear and logical way to make sure their pace of learning. One example of such navigation is that they like to click on the NEXT or the BACK buttons in the search process. Participant 19 selected those directional buttons to navigate the contents and said: “Once you are done with that, you can click back [OC: the Back button provided by the browser] and back and go back to where you were staying.”

Sequential participants preferred to understand help content with sequential organization. For example, P36 talked about how numerical ordered organization of the refining feature would help his navigation. In addition to the numbers, he preferred to add ‘indent space’ and ‘line with arrow at one end’ to show the sequence of order. He said:

> “Maybe like this LOCDC refining, I think that would help navigate and maybe put something more. I suppose that is what it is but I don’t know it applies or not.

> And I guess down here, I can see 7 and these headings underneath can be marked as 7-1 and 7-2 and so forth. And after that, put lines, put it over like indent and that is my ideas. Put 7-1 and then 7-2 and then information after that. [P36 drew a graph when he explains the sequential help feature as shown in Figure 4.4] So I think maybe putting these little lines and these spaces, I can tell that they are different pages with that."

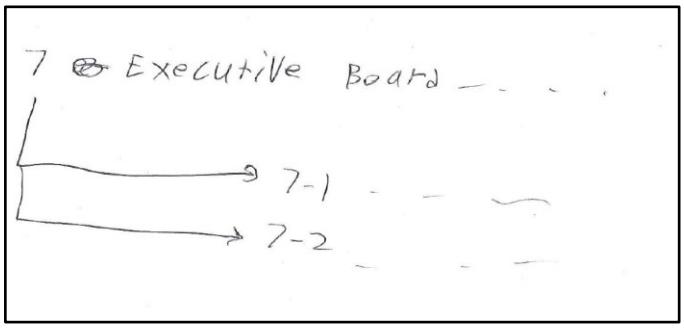

Figure 4.4 A sequential organization of help feature hand drawn by P36

However, if information is presented without sequential order, they tend to be confused in the learning environment. P36 continued to talk about his confusion: "I would say this digital library is a little bit confusing about what this is exactly used for." Later, he also suggested using flowchart as a tool to organize the sequence of help content:

> "Perhaps maybe if it looks like some kind of flowchart, instead of just the headings. I think maybe changing the style into the layout of a flowchart and make pretty like page one, page two, or page three. Yeah, cause as I said this is confusing. It's like use a computer and you have like a folder and opening up and like a flowchart

things. I will describe it like computer program maybe. This is my suggestions. I have seen this in computer programs. This is just my ideas."

Interacting with different help features in order to make sense

Global learners are inclined to learn help materials in a large leap instead of a linear way. At first, they don't see connections among the learning materials. After they have learned enough about and gotten the point of it. They then impose their own structures on unstructured fields. They prefer global context and relevance to step-by-step progression.

In this study, Global participants demonstrated unique ways in understanding help content in digital libraries. They interacted with different help features in order to make sense. P9 reflected that he did not need given instructions beforehand when learning. On the other hand, firsthand experiences with failure trials would help him to get the gist of it. He said:

"Right, that is how I like to learn things a lot by just messing around. I don't know. I am a guy that does not like to ask for directions. It is like failed twenty times and then figure out rather than know how to do it and then do it right. That is the way I learn and click my head. I would prefer [failed] trials over like a book of telling me what to do."

As an example of demonstrating 'making sense', the interaction of P58 is shown in the following. In finding out information about Jackie Robinson, P58 tried different types of help in order to make sense. He went through navigating, help-seeking, and making sense phases.

In the navigating phase, P58 tried several browsing and searching functions in order to find an image of Jackie Robinson. He tried 'Browse by subject', 'Searching within one specific collection', and 'Teacher resources'. He also tried 'Advanced Site Search' and said: "Let's see if we can do the advanced search. No, it does not let me search by the media. It's very text-focused." He wanted to see the search bar on every page. However, the design of the LOCDC webpage did not provided such consistency. He felt confused during search process and complained, "Cause sometimes like it is not continuous, and you are not really using the same websites. Like when you searching on Google, nowadays, the search bar never goes away. It stays there and you feel like you are using this, but you know." Without finding any satisfactory results, he realized that he encountered problems and decided to seek help from DL.

In help-seeking phase, P58 looked at the information on 'Site Search Help'. He tried typical tips such as 'Capitalize proper nouns' and 'Use a plus sign to require and a minus sign to exclude' but failed to find new results. He felt disappointed and confused. He said: "Maybe it just depends on the search engine inside the site. I was getting the results, basically the same results. It didn't help me with my task. I am always confused with library websites because there are so much content. They kind of have the same approach. They have a page where you navigate to learn how to use it and you can use it."

In the making sense phase, he gave up the use of Search Help provided by LOCDC and reflected that the browsing features are making more sense to him by saying:

> "When I am learning, because I like to try things out and then I get really interested in it. I mean it is a system and you need to know where or how to use it.

Like each of the 'browsing category', it got a title and put a lot of time to organize it, and it is well structured. Sometimes the search and you can get to happen when I am trying to find."

4.4 Summary

This chapter presents the major research findings in view of the three research questions raised in this study. The findings reported for RQ 1 present a comprehensive picture of the types of help features that participants used in both DLs observed for the study. Results of the qualitative analysis for RQ 1 show major types of Help Features adopted by participants. The findings from RQ1 serve as a base for answering RQ 2, which aim at verifying how learning styles affect users' interactions with help features. Statistical tests for RQ 2 reveal quantitative evidence to support the relationships between learning styles and the use of Help Features. In order to understand the overall picture of help-seeking interactions, various help-seeking approaches applied by participants with different learning styles are further identified. The broad triangulation approach assumed in this study not only explores and confirms the relationships between different learning styles and Help Features use, but also enables the illustration of novice users' diversified help-seeking approaches.

CHAPTER FIVE DISCUSSION AND CONCLUSIONS

5.1 Introduction

The objectives of the current study are to identify novice users' help-seeking approaches while they get started with digital libraries and how the learning styles lead to these approaches. In this chapter, the findings from this study are discussed in terms of their theoretical, practical, and methodological significances, including the potential contributions to the current literature,. Finally, the limitation of the study, and suggests areas for further research are also addressed.

5.2 Theoretical Implications

The most profound contribution of the present study to the body of literature related to information seeking is the understanding of novice users' help-seeking behaviors in digital library environment. In order to illustrate a picture of help-seeking behaviors, the test results were obtained from 60 academic users. The purpose of the research questions is to uncover the thoughts, feelings and actions of novice users as they search for information. The studied themes include the exhibition of diversified use of help features, as well as users' help-seeking approaches when they encounter various problematic situations in digital library environments.

5.2.1. Types of Help Features

The help-seeking behaviors are defined as '*the interactions that an individual may try to seek, either from an IR system, a human or other references to solve the problem*s'.

When interacting with digital libraries, the best possible situation for users is that they don't encounter any problem during searching. Under such situation, users don't need help owing to well-designed system with good, intuitive, context-sensitive, and easy to use functionality. However, most of the time users encounter an impasse, therefore, users may try to explore and interact with the digital libraries for seeking system assistance based on their personal style and preference. The help features are adopted by users with various learning styles in individualistic ways.

In this study, the help systems of the two digital libraries provide a variety of help features assisting the interactions between participants and the digital libraries. Since the help system is designed to serve various types of users, each individual may have his/her own preference in choosing certain help features. The eight types of help features are identified to be used by users with different learning styles: (1) Processing dimension: Interactive Help Features and Reflective Help Features; (2) Input dimension: Visual Help Features, Verbal Help Features, Exploring Help Features; (3) Perceiving dimension: Scaffolding Help and Channeling Help Features; (4) Understanding dimension: Sequential Help Features. Previous research identified different types of help features in digital libraries (Xie, 2007; Xie & Bowser, 2009). In addition to the types of help features, results of this study further identify users in various learning styles utilize their preferred types of help features to solve problems during the interaction with IR environment.

To support the exploratory results concluded from section 4.1, quantitative analysis using t-test was carried out to verify the influence of learning style on help-seeking behavior. The help-seeking behavior was evaluated by three measurements, "Frequency"

of using help features, “Time” of using help features, and “Number of Types of help feature” used by participants. Based on these three different measurements and Learning Styles, associated hypotheses were generated to analyze the statistical data associated with the four learning style dimensions.

For the Active/Reflective learning style dimension, significant differences between the two styles can be found in the “Frequency” and “Number of Types” measurements. This shows that Active participants had a higher tendency to use the Interactive Help features than Reflective participants. The behavior of frequent visits to online activities by Active learners was also found by Graf and her colleagues (Graf, Liu, & Kinshuk, 2010).

For the Input (Visual/Verbal) dimension, the two corresponding styles show significant differences in the “Frequency” and “Time” measurements. Visual participants frequented Visual Help features, while Verbal participants respectively spent relatively more time in their favorable Exploring Help features. This result is consistent with the finding stated by Ford and his colleagues (2009) in which the preference for Verbal users of orienting to the use of written language as oppose to images was reported by. In their study, Verbalizers displayed effective reading of text-based content. In addition, the Verbal users’ tendency of selecting Exploring Help features for verbal design and scanning characteristic were also supported by other researchers (Chen et al., 2005; Frias-Martinez et al., 2008; Kinley, 2010).

Regarding the Perceiving (Sensing/Intuitive) dimension, the two specific styles exhibit significant differences only in the “Frequency” measurement of Scaffolding Help.

It was found, as can be expected, that Intuitive participants used the Scaffolding help more effectively than their Sensing counterparts.

Finally, the testing measurements for the Understanding (Sequential/Global) dimension did not indicate any significant differences between the two groups of participants. Thus, no clear quantitative evidence were found to support for the qualitative analyses for the first research question carried out in section 4.1 in which certain different tendencies between the two groups were found existed. However, the study conducted by Papaeconomou and his colleagues (2008) showed that Sequential users adopted significantly more sequential strategy to navigating web pages.

In summary, the t-test results indicate the existence of significant effects for learning styles on users' use of different types of help features. Except for the Understanding (Sequential/Global) dimension, the significant effects were found for three learning styles dimensions of Processing (Active/Reflective), Input (Visual/Verbal), and Perceiving (Sensing/Intuitive). The study conducted by Graf and her colleagues (2009) also found similar results for Active/Reflective, Visual/Verbal, Sensing/Intuitive, but no results for Sequential/Global.

Several studies in the literature have investigated users' behavior in online information searching environments with respect to learning styles (e.g. Ford et al., 2009; Frias-Martinez et al., 2007; Graf et al., 2007; Liu & Reed, 1994; Lee et al., 2005; Palmquist & Kim, 2000; Tenopir et al., 2008; Wang et al., 2000). However, this study is different in several ways. First, the study aimed at investigating the help-seeking behavior in typical digital library environments. Therefore, the study was based on two real digital

libraries commonly used by academic users rather than in a specific prototype system. Second, while many other studies looked at general search behavior in terms of how users formulate queries or visited specific kinds of web nodes, this study has focused on exploring help-seeking behavior. Thirdly, this study identifies the effects of various learning styles in four dimensions of ILS on help-seeking behavior rather than focusing on just one particular learning style. Furthermore, this study is based on a learning style theory which is commonly used in information retrieval and online learning environments, and thus the corresponding findings seem relatively more widely applicable.

In educational environments, learning is to change. Learning involves the process of bringing about changes in learners' knowledge. This study considers information seeking and searching as a learning process and adopts the construct of 'learning style' in investigating help-seeking behavior. Previous literatures in education field had identified that learning styles deeply affect how students process information in learning activities. These learning activities include learning performance, learning strategies, and learning preferences (Felder & Silverman, 1988; Rickards et al., 1997; Sadler-Smith, 1999; Wang & Chen, 2008). In this study, results indicate that learning styles influence users' help-seeking approaches, yet not all dimensions of learning styles were verified to have similar influence on users' help-seeking behavior or their specific use of help features. The pace of learning and that of help-seeking interactions in information retrieval are quite different, thus the corresponding dimensions of the selected learning styles are not as applicable in the IR settings as in the educational environments.

5.2.2. Help-seeking Approaches

Participants with different learning styles exhibit various dimensions of help-seeking interactions when searching information in digital libraries. Help-seeking highlights how users deal with problems they encounter in the information search process. Learning styles determine how users approach the problems encountered in their help-seeking process. Different learning styles affect the types of help features which users identify and the help-seeking approaches that users might engage in different of digital libraries. For the Processing dimension, Active and Reflective learners present their respective types of engagement in the interactions with help features. These two types of learners prefer different types of help features and different ways to approach help features. For the Input dimension, Visual and Verbal learners also prefer help features with their respective formats. Regarding the Perception dimension, Intuitive and Sensing learners prefer different types of information for help. Intuitive learners learn how to utilize help features by analyzing the structure of the help design and matching between different help features.

This research is one of the few studies that investigates multiple dimensions of learning styles on help-seeking, and characterizes users' interaction patterns in the help-seeking process. Simultaneously, the findings of this study also reveal the problems of existing digital libraries that are unable to support multiple types of learning styles. Moreover, this study offered specific and concrete system design suggestions based on results of this research.

5.2.3. Linking Help-seeking Approaches to Help-seeking Process

By introducing the concept of help-seeking earlier in section 2.4 of this study, the Nelson-Le Gall's model explains that help-seeking behavior is generally accepted as consisting of five major cognitive processes: the five phases of the help-seeking processes are Awareness (awareness of need for help) ; Decision (decision to seek help); Identification (identification of potential helpers); Employment (employment of strategies to elicit help); and Evaluation (reactions to help-seeking attempts) (Nelson-Le Gall et al., 1983; Nelson-Le Gall, 1985). For the sake of theoretical precision and usefulness, it would be profitable to link the taxonomy that emerged from this study to the general model of help-seeking. As can be expected, making connections to a broader model enriches our understanding of the specific qualities of help-seeking behavior and helps to answer the research questions.

In interpreting the linking data, the various types of influence of learning style appear to link to the four processes of the model simultaneously. In other words, one type of influence could represent at the same time more than one model's process. The linking is not restricted to a one-to-one relationship. For example, the 'Engagement in selecting and using help features', which is the associated influence with the Active/Reflective dimension, can be linked to 'Decision', 'Identification' and Evaluation', while the influence category of 'Application of strategies to make sense of and understand DLs and their function' represent the anticipated link to 'Identification' and 'Evaluation'. The linking also provides an insight into the effect of respective characteristics of each learning style dimension on the Help-seeking processes and shows the precise relation in

which each influence items contained several processes. Since the participants were asked to consider the use of help features at the beginning of the test, the Awareness process was presumably a pre-existing condition for all participants. Thus only the remained four phases of the Nelson-Le Gall's model were addressed in the following context. Based on the results of the analysis task carried out in section 4.3, the linking relation between the Help-seeking processes and types of help-seeking approaches is summarized in details in Table 5.1.

The linking provides an important insight into the understanding that the help-seeking approaches identified in this study. The help-seeking approaches mainly focus on two help-seeking processes, namely Identification (identification of potential helpers) and Employment (employment of strategies to elicit help). Among the fifteen help-seeking approaches, seven approaches link to the process of Identification and eight approaches link to the process of Employment.

Table 5.1 Linking Help-seeking Approaches to the Help-seeking process

Influence category of Learning styles	Help-seeking Approaches	Linking to the help-seeking process
Processing Dimension -Engagement in selecting and using help features	Interacting with different types of help features	*Decision to seek help* ***Identification of potential helpers*** ***Employment of strategies to elicit help***
	Choosing straightforward help features	***Identification of potential helpers***
	Preferring interactive help features	***Identification of potential helpers***
	Restricting trying help features	*Decision to seek help*
	Adopting help features after thoughtful planning	***Employment of strategies to elicit help***
Input Dimension -Interaction with both formats and content of help features	Selecting visual help features	***Identification of potential helpers***
	Selecting syntactic & semantic help content in visual formats	***Identification of potential helpers***
	Preferring verbal help features	***Identification of potential helpers***
	Examining detailed verbal description	***Employment of strategies to elicit help***
Perceiving Dimension -Engagement in analyzing help content, structure, and design	Selecting help features with concrete information	***Identification of potential helpers***
	Avoiding exploring unfamiliar help features	***Employment of strategies to elicit help***
	Judging the logical design of help features	***Employment of strategies to elicit help***
	Examining the structures of help features	***Employment of strategies to elicit help***
Understanding Dimension -Application of strategies to make sense of and understand DLs and their functions	Understanding help content in a sequential way	***Employment of strategies to elicit help*** *Reactions to help-seeking attempts*
	Interacting with different help features in order to make sense	***Employment of strategies to elicit help*** *Reactions to help-seeking attempts*

5.2.4. Influence of learning style on help-seeking behavior

Based on the discussion of 5.2.1 to 5.2.3, the Help-seeking behavior and influence of learning styles is schematically illustrated in Figure 5.1 so as to provide a better overview for the relation. The top part of this figure depicts that the learning style preferences

influence over users' use of "types of help features". The influence from the learning style on "help seeking approaches" is shown on the bottom part of Figure 5.1. The influence of learning styles on help-seeking behaviors is illustrated as mapping relations indicated by arrows. The dashed arrow from the Understanding dimension represents the lack of support from the quantitative data to qualitative results.

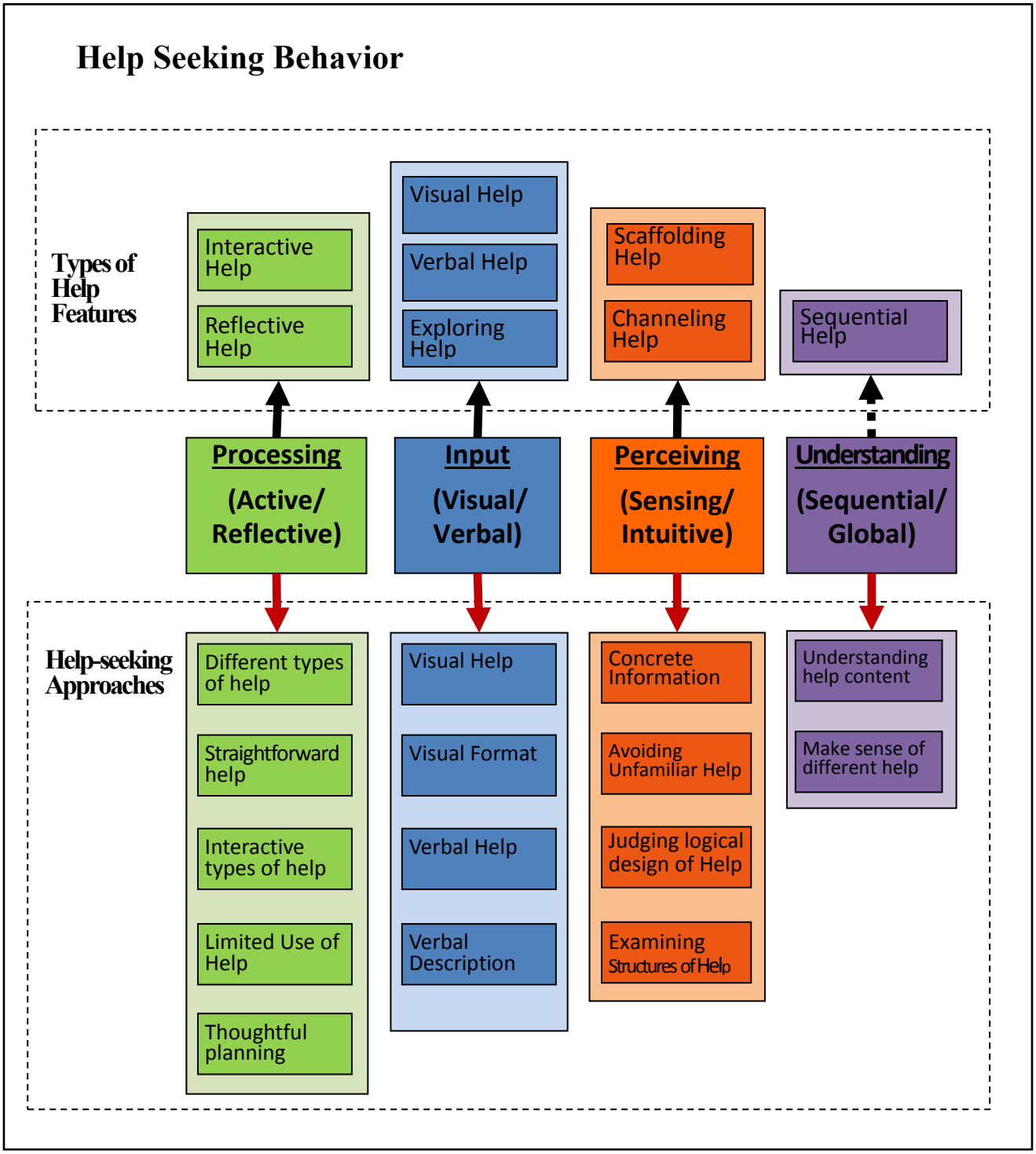

Figure 5.1 Influence of learning style on help-seeking behavior

5.3 Practical Implications

Based on the findings of this study, it is concluded that learning styles do affect participants' interactions with different help features of digital libraries, and the types of interactions can be identified accordingly. The characteristics of interactions provide practical implications for the design of digital libraries to assist users with different types of learning styles. In particular, the results suggest that digital libraries need to facilitate the help-seeking approaches by offering different types of help features, different formats of help, and different ways of organization and presentation of help content. In this work, the eight recognized learning styles are categorized into four dimensions, namely Process, Input, Perception, and Understanding. The major findings associated with each dimension are briefly summarized in the following paragraphs.

For the Processing dimension, Active and Reflective learners present their respective types of engagement in the interactions with help features. These two types of learners prefer different types of help features and different ways to approach help features. Active learners are particularly fond of trying various types of help features. Digital Libraries are required to offer simple and easy to get on hand features, like "FAQ" or "Google-like" design. In order to encourage more interaction, Digital Libraries are required to offer sufficient interactive help features, like "Online Chat" and "Ask a Librarian", which provides the opportunity for users to interact with a real human who provides real-time, dynamic, and relevant guidance for users. Implicit feedback has been used in IR research to infer user preference (Kelly & Teevan, 2003). Since Reflective users play a comparatively passive role in the interaction, it is relatively difficult to guide

Reflective learners to adopt more help features. Recommending and promoting new features to Reflective learners can be feasible to urge them to try new help features. Implicit feedback options (such as “Search History”, “Breadcrumbs”, “Try this”, etc.) are effective approaches to propose appropriate types of implicit help features to Reflective learners so as to help them participate more actively in the interaction. It is also recommended to provide a “Personalized note” functionality to help Reflective learners to record their own thoughts, understanding, or even mistakes along the way of search process. It is generally helpful to display each help feature with a clear label specifying its function and usage, because Reflective learners do not select help features for which the functionality is vague. Most important of all, the help features should be designed to reduce uncertainty, which means a good help feature contains a reasonably formatted structure.

For the Input dimension, Visual and Verbal learners also prefer help features with their respective formats. Visual content can be expressed with a syntactic (e.g., color, shape, texture and layout) or a semantic (e.g., objects, events, etc.) level of structure (Jorgensen, Jaimes, Benitez, & Chang, 2001). According to Jaimes & Chang (2000), “syntax refers to the way visual elements are arranged without considering the meaning of such arrangements. Semantic, on the other hand, deals with the meaning of those elements and of their arrangements.” It is demonstrated in several previous studies that humans mainly use semantic level attributes to describe, classify, search, and process images (Greisdorf & O'Connor, 2002; Jorgensen, 1995; Jorgensen, 1998). In general, Visual learners perceive and process both syntax and semantic levels of visual help features during the IR interactions. While the existing digital libraries emphasize

syntactic content for users, such as color and layout of interface design, specifying semantic levels of structure to users is also essential. Objects, people, and events are particularly needed to be highlighted and structured to assist users in identifying information and enhancing their domain knowledge as well. It should be noted that not all users like visual formats of help; it is thus important to offer both visual and verbal formats of help features. For example, Chen et al. (2005) recommended one possible solution which combines both verbal cue and visual cue concurrently in the same feature in order to accommodate different styles. Another way of accommodating both formats can be carried out by showing multiple options for the help features. Using "how to search?" as an example, this specific feature can be associated with two options: a visual display of how to search and a narrative presentation of how to search. Besides, visual versions can normally be presented in images or videos while verbal versions can be presented in a text or an audio format.

Regarding the Perceiving dimension, Intuitive and Sensing learners prefer different types of information for help. Intuitive learners learn how to utilize help features by analyzing the structure of the help design and matching between different help features. They want to know how exhaustive in scope, how comprehensive in depth, and varied types of format the DLs content would be. The function providing such overview prerequisite information is missing or inadequate in current digital library design. Digital libraries need to be transparent not only in content coverage, but also in design principles, so users can better understand the design structure of the system. Moreover, it is important to offer information regarding the similarities and differences between different types of help features, especially equivalent features in each system. On the contrary,

Sensing learners avoid using unfamiliar help features and like to follow concrete examples in help features. When solving problems, they prefer to be well-prepared with already learnt procedures or pre-existing practical settings. As a result, it is recommended to design digital libraries with standard layouts (e.g. a Google-like design) with consistent help features that would help Sensing learners to build a base for adjusting and learning a new system. Digital libraries can provide users with more help features that contain tangible information, in particular more options for browsing, e.g., timeline, most viewed terms, etc. More search examples in different domains or material formats are definitely helpful to assist Sensing learners in their search processes.

For the Understanding dimension, Sequential and Global learners prefer different ways of help content organization and presentation. The design of help features for the digital library needs to offer help contents with step-by-step instructions and comprehensive overviews with context, to facilitate both types of learners in understanding a digital library's features; regardless individually or as a whole. Chen and her colleagues (2005) recommended offering successive options, which provide outlines and links of related contents to accommodate different styles in web directories. In order to support both types of learners in digital library environment, it is suggested that linear backward and forward paths options should be provided for Sequential learners to move freely from one item to another, and more directing links to related help content and logical outline of help content should be available for Global learners. More importantly, it is helpful to generate a sitemap for all the explicit and implicit help features so as to provide users with all the potential help features and to demonstrate the relationships among all the features.

In summary, this study was conducted in University of Wisconsin Milwaukee, an academic environment in mid-west area. From interacting with the two Digital Libraries, novice users from the academic institute were not able to find the answer immediately and encountered problematic situations. They adopted various help-seeking approaches to solve their problems at hand based on their learning preferences. This should suggest to digital librarians to incorporate different types of help-features into their DL platforms. Not all users are willing to take the risk trying out all the help-feature. The results may point the way toward the design and delivery of digital library services, such as a more engaging processing layouts, diversified input formats, as well as easy-to-perceive and easy-to-understand modes of help features. The key for the design of digital libraries is to totally support novice users with different types of learning styles.

5.4 Methodological Implications

According to Case, one way to conduct both valid and reliable research is to apply multiple research methods and multiple sources of data (Case, 2002). It is so true that many researchers share this point of view and advocate the use of triangulation (Silverman, 2005; Patton, 2002). However, the use of mixed method research is not a common practice in the literature of library and information science (Fidel, 2008). This study adopts mixed-method in data collection and analysis with the purpose to address the research problem more widely and more completely than employing only one method. The qualitative method was used first to explore novice users' help feature use in digital

library as well as the influence of learning styles during the information search process. It is then the quantitative measures that we can rely on to verify the exploratory findings.

The mixed approach of both qualitative and quantitative can be used in a complementary fashion to answer all the research questions. The main focus is to carefully look for the degree of convergence between the two approaches (Denzin, 1978; Denzin & Lincoln, 2005). This study tackled the difficult problem of uncovering help-seeking behaviors in a way that was as authentic as possible of novice users. The results therefore reflect the real help-seeking behaviors as it occurs in the real world. Using the qualitative methods outlined in this study, the researcher was able to uncover a wide spectrum of the participants' patterns of help-seeking approaches. The mixed methods used to deal with the many challenges presented by this study may provide a methodological guideline for others who are designing user-centered approaches to the investigation of thoughts and feelings related to help-seeking behavior.

It is also worth noting that there are several disadvantageous factors of the mixed-method approach. The two-phase approach, including the qualitative exploratory and quantitative verification, results in rich and informative data yet this type of study is time-consuming and labor-intensive in both data collection and analysis. Future researchers need to recognize this factor and plan ahead of time. In addition, it is difficult to specify and determine what data from the qualitative phase to be connected to the quantitative observation and how these data to be used to generate quantitative measurements.

5.5 Conclusions

This dissertation investigated users' help-seeking behavior in the context of digital libraries. This study assumed that a user engages in an IR process by applying different types of help features and help-seeking approaches based on their learning styles. Also, in an attempt to assess the influence of learning style, this study identifies users' help-seeking behavior in using different types of help features and adopting diversified help-seeking approaches. Moreover, this study examined how the four dimensions of learning styles would influence users' help-seeking approaches when they encounter problematic situations. This study empirically answered the research questions based on the analysis of multiple sources of search data, protocols, and inner thoughts collected from sixty participants. Finally, limitation of the study and suggestions for further research are described in the following sections.

5.5.1. Limitation of the Study

A number of important limitations need to be addressed regarding the present study. These limitations are: limited generalizability, unnatural setting, participants' limited ability to articulate, and other related limitations.

First, a limitation of this study can be seen in the restricted numbers of novice users participating in the study. The limited samples provide valuable information yet it is still insufficient to be generalized to a broader context. Specifically, the samples of this study were drawn from different majors out of a chosen college campus located in the Midwest region, therefore, results of the study can generalized back to the selected academic

environment. Although universities are one of the target user groups of digital libraries and the college students are most suitable as study participants, it might be interesting to confirm the results with non-college students. Users' searching behaviors were also shaped by the types of tasks given to them by the researcher as well. The subject areas of the selected tasks were more specific to American history and are not generalizable to other domains of knowledge.

The second limitation of this study is related to the uneven distribution of learning styles. Although sixty participants were recruited for the study, the researchers did not know in advance what the learning style of the incoming participants were. After the study, the learning style scores were calculated and based on the answers provided by participants. The distribution for the Input dimension is pretty skewed toward the Visual styles.

Thirdly, there is a limitation of the study caused by the simulated nature of experimental setting. The unnatural setting can possibly influences the way participants normally search for information (Oh & Wildemuth, 2009). The computer labs settings are known to be sometimes problematic. Due to the time constrain of the study experiment, participants were allowed to search for a limited period of time, around 10 minutes, for each task. If participants were still searching for the task and the ten minutes ran up, the researcher had to stop participants and proceeded to the next task. This situation potentially influences the observation of participants' help-seeking behavior and caused the low number of frequency in the use of Reflective Help Features and Verbal Help Features, thus the two help features were not included in the quantitative testing.

Likewise, it also affects the observation of help features use of Global participants. Their behaviors of using specific help features were not observed in the experiment setting.

As the experimental observation may be somewhat obtrusive, participants were easily distracted by the intention of the researcher or aspects of the experiment setting. Additionally, participants might not show exactly the same help-seeking interaction in this study as in real-life authentic tasks. The searching tasks were carefully selected to simulate real-life situations and all participants cooperated and completed the tasks. It is believed that the research findings may contain minor bias yet it reasonably reflects users' realistic behavior.

Next, although verbal protocol analysis can truthfully record what participants are thinking during their information-retrieval process, particularly their thoughts related to help seeking, participants might have difficulty articulating their cognitive processes. Xie and Cool (2009) pointed out that not every participant in their study provided the detailed information related to what defined help seeking situations and what led to these situations. Other researchers were concerned with the problem that the verbal protocol might significantly influence performance and change behavior (Oh & Wildemuth, 2009).

Finally, there was also some subjectivity of the data collected from interview and self-report data. The subjectivity may be caused by factors such as the possible distorted responses due to personal bias, anger, anxiety, politics, and simple lack of awareness (Oh & Wildemuth, 2009). Interviews can be greatly affected by the emotional state of the interviewee at the time of the interview. Interview or self-report data can also be subjected to recall error, reactivity of the interviewee to the interviewer, and self-serving

responses. Besides, the participants themselves may also bias the performance due to social desirability or self-representation. Thus, they tend to present themselves being intelligent and well-adjusted or make unnecessary inferences.

5.5.2. Suggestions for Future Research

First, the four different dimensions of the ILS learning styles were explored to evaluate their influence over novice users' help-seeking behavior in this study. It is recommended for future research to focus on one primary dimension of learning style at a time in order to investigate the impact of learning style dimension more in-depth. In addition to the frequency, the time, and the number of types of help feature used, the measurements of effectiveness and users' satisfaction can also be included in future research.

Secondly, learning styles were explored to evaluate their influence over novice users' help-seeking behavior. It is recommended that further research can consider examining more cognitive factors. In the qualitative phase of this study, the learning styles were identified to have influence on novice users' help-seeking approaches. Other cognitive factors, such as motivational belief, self-efficacy, meta-cognitive knowledge, and self-regulated learning need to be explored. However, due to the limited scale of time and resources of this study, the concurrent investigation on multiple cognitive factors would not be feasible. Future work can investigate other cognitive factors with focuses on their potential cognitive influence on help-seeking behaviors.

Since digital libraries serve a wide range of diverse users via the internet, an expanded number of participants with equally represented learning style are needed to draw more generalized conclusions. Future research can be designed to have diversified real users and real tasks with prolonged time of observation so as to obtain more realistic data collected from better-specified measurable instruments (e.g. clickable data, eye tracking device, or wearable real-time device) that represent real help-seeking behaviors as in a natural context.

Finally, different methodologies can potentially be adopted for future research. The mixed-method approach is an innovative way to investigate the help-seeking behavior. Both qualitative the quantitative methodologies were adopted in this study to answer the research questions. Future research could follow the mixed-method approach to assess each learning style dimension using different designs. More importantly, better-specified measurements with new technology can be applied to help digital libraries and other IR systems to recognize users' need. These measurements include eye movements, body movements, facial expressions, gestures, and click-through data. Through the use of such technology, it can potentially offer more implicit help features in supporting users with different types of learning styles.

There is an obvious need for more research in the fields of individual differences and adaptation of IR environments. The purpose of such activity is to gain a better understanding of how individual differences affect the interaction of learning to use a new IR system. With such understanding, it will lead to a new IR environment that better suits the learning need and preference of each novice user. It is also hoped that the

various findings of this research could be practically transformed to useful knowledge in related fields.

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Appendix A: Informed Consent Form

UNIVERSITY OF WISCONSIN – MILWAUKEE
CONSENT TO PARTICIPATE IN RESEARCH

Informed Consent Form for Novice Users (IRB#: 12.353 04/30/2012)

1. General Information

Study title: The Study of Users' Interactions with Digital Libraries Focusing on User Engagement, System Support, and Help-Seeking

Person in Charge of Study (Principal Investigator):

Hong (Iris) Xie, Ph.D.
Professor
School of Information Studies
University of Wisconsin-Milwaukee
(414)229-6835 (phone)
(414)229-6699 (fax)

2. Study Description

I understand that I have been asked to participate in a research study of investigating the process of users' interactions with digital libraries. I understand that my participation is completely voluntary, and I do not have to participate if I do not want to.

I understand that my participation will take about one and a half hour to complete. I understand the study will be taken place in the research lab of School of Information Studies at University of Wisconsin-Milwaukee.

3. Study Procedures

I understand that my participation will involve the following activities:
After the initial contact, the student PI will email me a consent form which includes information explaining the purpose, procedures, benefits and risks of the study. Once I agree to participate in the study, I will come to a specified site and submit the form to the researcher in person. Then, the researcher will send a pre-questionnaire to me through email and collect background information in relation to using digital libraries. After the

researcher receives my pre-questionnaire, I will be asked to come to NWQ building of UWM for the experiment.

The data will be collected from the following means for users:

1.1) I will fill out a questionnaire which consists of my perceptions and attitudes toward digital libraries (10-15 minutes).

1.2) I am going to perform searches in digital libraries based on generic tasks assigned to me. I understand that the searches will be logged and videotaped for later analysis (60 minutes).

1.3) I will be asked to "think aloud" about what I am doing and why they are doing that way during my searches. What I say will be recorded on videotape (same as 1.2).

1.4) I will be observed during the search process, and my behaviors as a help system user will be recorded by software (same as 1.2).

1.5) After all the searches are done, I will fill in the post questionnaire which consists of my perceptions of the system features in the digital libraries and receive a interview for elaborating the answers I provided (15-20 minutes).

This visit will take about one and a half hour.

4. Risks and Minimizing Risks

- I understand that there is no serious risk occurring for subjects in participation in the research. I understand there is a risk that I may experience embarrassment or anxiety due to being videotaped and observed while performing searches. I understand that my image might appear on the video file, although the video file will be mainly made to capture monitor screen. I understand that my voice will be recorded on the video file as I think aloud in the search process. I understand that I will ask the student primary researcher questions and be observed during the searches while I work with him/her in one room. I also understand the researchers will try to minimize the risk by only revealing my participant number and not to discuss the study with others. However, the researchers cannot ensure that breaches of confidentiality will not occur.

- I understand the confidentiality of my responses will be protected at all times when the data are collected and analyzed, and when the results are reported in a published paper. No names will be attached to the questionnaires, search log files, and video files. All data will be stored with a coded subject identification number. Coded data will be made available for use in the analysis by the researchers. All the information

collected for this study and the identifying information of the participants will be destroyed after the study is complete.

5. Benefits

- I understand that once the study is completed, I will be given $30 for my participation in the study. I also understand that the long term benefit of the study will be the design of better digital libraries that will help users effectively retrieve information based on the results of the study.

6. Study Costs

I will not be responsible for any of the costs from taking part in this research study.

7. Confidentiality

All information collected about me during the course of this study will be kept confidential to the extent permitted by law. The researchers may decide to present findings to others, or publish our results in scientific journals or at scientific conferences. Only the PI and co-investigators will have access to the information. However, the Institutional Review Board at UW-Milwaukee or appropriate federal agencies like the Office for Human Research Protections may review my records.

- The collected data will be confidential and only revealing each participant's number.
- All data, including name and associated demographic data, collected from participants will be stored and kept in locked area by the principal investigators at the School of Information Studies. The video files will also be stored on a password protected computer by the principal investigators at the School of Information Studies. All data will be stored with a coded subject identification number. Coded data will be made available for use in the analysis by the principal investigators.
- All the information collected for this study and the identifying information of the individuals will be destroyed after the study is complete.

8. Alternatives

There are no known alternatives available to me other than not taking part in this study.

9. Voluntary Participation and Withdrawal

My participation in this study is entirely voluntary. I may choose not to take part in this study. If I decide to take part, I can change my mind later and withdraw from the study. I am free to not answer any questions or withdraw at any time. My decision will not change any present or future relationships with the University of Wisconsin Milwaukee. If am a current student taking class with the principal investigator, my refusal to take part in the study will not affect my grade or class standing. If I withdraw from the study, all information collected will be destroyed.

10. Questions

Who do I contact for questions about this study?
For more information about the study or the study procedures or treatments, or to withdraw from the study, contact:

PI: Hong (Iris) Xie, Ph.D.
Professor
School of Information Studies
University of Wisconsin-Milwaukee
(414)229-6835 (phone)

SPI: Chunsheng Huang/Soohyung Joo
PhD student
School of Information Studies
University of Wisconsin-Milwaukee
(414)229-3492 (phone)
huang22@uwm.edu

Who do I contact for questions about my rights or complaints towards my treatment as a research subject?
The Institutional Review Board may ask my name, but all complaints are kept in confidence.

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

11. Signatures

Research Subject's Consent to Participate in Research:
To voluntarily agree to take part in this study, you must sign on the line below. If you choose to take part in this study, you may withdraw at any time. You are not giving up any of your legal rights by signing this form. Your signature below indicates that you

have read or had read to you this entire consent form, including the risks and benefits, and have had all of your questions answered, and that you are 18 years of age or older.

_____
Printed Name of Subject/ Legally Authorized Representative

_____ _____
Signature of Subject/Legally Authorized Representative Date

Research Subject's Consent to Audio/Video/Photo Recording:

It is okay to audiotape/videotape me while I am in this study and use my audiotaped/videotaped data in the research.

Please initial: ____Yes ____No

Principal Investigator (or Designee)

I have given this research subject information on the study that is accurate and sufficient for the subject to fully understand the nature, risks and benefits of the study.

Chunsheng Huang/ Soohyung Joo SPI .
Printed Name of Person Obtaining Consent Study Role

_____ _____
Signature of Person Obtaining Consent Date

Appendix B: Pre-Questionnaire

Filling out this questionnaire indicates that I am at least eighteen old and I am giving my informed consent to be a participant in this study.

Age

18-21 21-29 30- 39 40-49 50-59 >59

Gender

Female Male

Native Language

English non-English

Ethnicity

African American Asian Caucasian Hispanic Native American Other

Educational Background (Major)

Undergraduate Program: _____ Graduate Program: _____

How do you rate your information search skill on the Web:

- □ Little knowledge or skills (just learning how to search information on the Web, need lots of help)
- □ Beginner (I need some help to search something on the Web)
- □ Intermediate (Fluent with using commercial search engines like Google and Yahoo.)
- □ Advanced (Fluent with using advanced search functions)
- □ Expert (Good at using advanced search functions, use complex Boolean operators, understand back-end information retrieval mechanisms)

Please rate the **frequency** with which you use the following by circling the appropriate number.(1=never use, 2=rarely use, 3=occasionally use, 4=often use, 5=use daily)

Type of Systems	**Never Use**				**Use Daily**
Web pages	1	2	3	4	5
Web search engines (e.g. Google, Yahoo)	1	2	3	4	5
Library of Congress Digital Collections	1	2	3	4	5
Other digital library please specify: _____	1	2	3	4	5

Type of Systems	**Never Use**				**Use Daily**
Online databases (e.g. EBSCO, ProQuest)	1	2	3	4	5
Library catalog (e.g. Panther Cat)	1	2	3	4	5
UWM Library Digital Collections	1	2	3	4	5
Other digital library please specify: _____	1	2	3	4	5

Overall perception of help functions

What do you typically do if you encounter any problems in using an information searching system?

1. try again 2. try different approach 3. consult system Help 4. ask another person
5. change systems 6. give up 7. Other _____(please specify)

To what extent do you think help functions of an information searching system are important? Please check one from the following.

1. not at all 2. a little 3. some 4. some more 5. Extremely

Why do you think that help functions are important or not important?

To what extent do you use help functions of a searching system? Please check one from the following.

1. never use 2. rarely use 3. occasionally use 4. often use 5. use every time

Why do you use or not use help functions of a searching system? (just put your reasons, you don't need to write complete sentences.)

How do you learn to use a new searching system when you use it for the first time?

1. trial and error 2. consult system Help (e.g. FAQ, search tips, etc.) 3. ask another person
4. Other _____ (please specify)

Thank you for completing the questionnaire. After finishing this questionnaire, please email to me at sjoo@uwm.edu /huang22@uwm.edu or bring it with you on the experiment day.

Thanks again for your participation.

Appendix C: Index of Learning Styles

For each of the 44 questions below, please select either "a" or "b" to indicate your answer. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
   (a) try it out.
   (b) think it through.

2. I would rather be considered
   (a) realistic.
   (b) innovative.

3. When I think about what I did yesterday, I am most likely to get
   (a) a picture.
   (b) words.

4. I tend to
   (a) understand details of a subject but may be fuzzy about its overall structure.
   (b) understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to
   (a) talk about it.
   (b) think about it.

6. If I were a teacher, I would rather teach a course
   (a) that deals with facts and real life situations.
   (b) that deals with ideas and theories.

7. I prefer to get new information in
   (a) pictures, diagrams, graphs, or maps.
   (b) written directions or verbal information.

8. Once I understand
   (a) all the parts, I understand the whole thing.
   (b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to
   (a) jump in and contribute ideas.
   (b) sit back and listen.

10. I find it easier
   (a) to learn facts.
   (b) to learn concepts.

11. In a book with lots of pictures and charts, I am likely to
   (a) look over the pictures and charts carefully.
   (b) focus on the written text.

12. When I solve math problems
   (a) I usually work my way to the solutions one step at a time.
   (b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
   (a) I have usually gotten to know many of the students.
   (b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
    (a) something that teaches me new facts or tells me how to do something.
    (b) something that gives me new ideas to think about.

15. I like teachers
    (a) who put a lot of diagrams on the board.
    (b) who spend a lot of time explaining.

16. When I'm analyzing a story or a novel
    (a) I think of the incidents and try to put them together to figure out the themes.
    (b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to
    (a) start working on the solution immediately.
    (b) try to fully understand the problem first.

18. I prefer the idea of
    (a) certainty.
    (b) theory.

19. I remember best
    (a) what I see.
    (b) what I hear.

20. It is more important to me that an instructor
    (a) lay out the material in clear sequential steps.
    (b) give me an overall picture and relate the material to other subjects.

21. I prefer to study
    (a) in a study group.
    (b) alone.

22. I am more likely to be considered
    (a) careful about the details of my work.
    (b) creative about how to do my work.

23. When I get directions to a new place, I prefer
    (a) a map.
    (b) written instructions.

24. I learn
    (a) at a fairly regular pace. If I study hard, I'll "get it."
    (b) in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first
    (a) try things out.
    (b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to
    (a) clearly say what they mean.
    (b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
    (a) the picture.
    (b) what the instructor said about it.

28. When considering a body of information, I am more likely to

(a) focus on details and miss the big picture.
(b) try to understand the big picture before getting into the details.

29. I more easily remember
(a) something I have done.
(b) something I have thought a lot about.

30. When I have to perform a task, I prefer to
(a) master one way of doing it.
(b) come up with new ways of doing it.

31. When someone is showing me data, I prefer
(a) charts or graphs.
(b) text summarizing the results.

32. When writing a paper, I am more likely to
(a) work on (think about or write) the beginning of the paper and progress forward.
(b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to
(a) have "group brainstorming" where everyone contributes ideas.
(b) brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone
(a) sensible.
(b) imaginative.

35. When I meet people at a party, I am more likely to remember
(a) what they looked like.
(b) what they said about themselves.

36. When I am learning a new subject, I prefer to
(a) stay focused on that subject, learning as much about it as I can.
(b) try to make connections between that subject and related subjects.

37. I am more likely to be considered
(a) outgoing.
(b) reserved.

38. I prefer courses that emphasize
(a) concrete material (facts, data).
(b) abstract material (concepts, theories).

39. For entertainment, I would rather
(a) watch television.
(b) read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
(a) somewhat helpful to me.
(b) very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,
(a) appeals to me.
(b) does not appeal to me.

42. When I am doing long calculations,
(a) I tend to repeat all my steps and check my work carefully.

(b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been
(a) easily and fairly accurately.
(b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
(a) think of the steps in the solution process.
(b) think of possible consequences or applications of the solution in a wide range of areas.

Appendix D: Post-Interview Questions

1. What do you think the ease of use of getting started in these digital libraries?

2. How do you feel about getting started in these digital libraries?

3. What is your opinion about the Helpfulness of Help Functions (Help-FAQ, Help-Search Help, Help-How to view, etc.) in these digital libraries? Probe: Do the Help Functions assist you when you get started in these digital libraries? Why?

4. What is your opinion about the Helpfulness of Implicit Help Functions (any functions that help you use this digital library, e.g. FAQ, About, Advanced search, featured collections, gallery view, etc) Probe: Do the Implicit Help Functions assist you when you get started in these digital libraries? Why?

5. What new features that you would like to see in these digital libraries to help you get started?

6. Cognitive learning preference is the tendency that an individual may have for processing information in a particular way when carrying out a learning activity. What do you think of that cognitive learning preference may have effects people's reaction toward how they get started in searching digital libraries?

7. Please briefly describe your overall reaction to how these digital libraries help you get started. Based on your personal experiences, please justify your reactions.

8. Do you have any other comments about these digital libraries?

Appendix E: Help Features and Topics

Help features	Help topics
Finding Aids	■ Search by Keyword ■ Browse by Collection ▫ By Date ▫ By LC Location ▫ By Name ▫ By Name/Title ▫ By Subject ■ Search/Browse Help ▫ Keyword Search ▫ Limiting Keyword Searches ▫ Browse ▫ Contents List Navigation ▫ Printing and Downloading ▫ Access and Use Restrictions ▫ HTML Metatags ▫ Technical Information ■ About Finding Aids
Bibliographies and Guides	These guides provide comprehensive overviews of unique Library resources.
Virtual Reference Shelf	Selected Online Resources for Research are also listed for DL users. Examples like links to Acronym Finder, Fast Facts Almanacs, and Encyclopedias.
Ask a Librarian	■ Chat ■ Email ■ Inquiries/comments form ■ Frequently Asked Questions (FAQ)
How to View	■ Sound Recordings ■ Documents (Text and Page Images) ■ Maps ■ Prints and Photographs ■ Video

Appendix F: Levels of Collections Visited Where Participants Seek Help

General Collection	UWMDC	LOCDC
Main Collections, Special Collections, & Sub-Collections	1. Collections of the Archives 1.1 The March On Milwaukee Civil Rights History Project 1.2 Greetings from Milwaukee 1.3 Milwaukee Neighborhoods: Photos & Maps 1885 -1992 1.4 UWM Photos Collection	1. American Memory 1.1 Coca-Cola Advertising 1951-1999 1.2 The Stern Collection of Lincolniana 1.3 Gottscho- Schleisner Collection 1.4 Baseball and Jackie Robinson 1.4.1 Timeline: Baseball, the Color Line, and Jackie Robinson 1.4.2 Early Baseball Pictures 1.4.3 Related Resources 1.5 Today in History 1.6 The Thomas Jefferson Papers 1.7 The Last Days of a President: Films of McKinley and the Pan-American Exposition, 1901 1.8 Film Chronology of Roosevelt and His Times
	2. Collections of the American Geographical Society Library 2.1 Cities Around the World 2.2 Digital Sanborn Maps of Milwaukee 1894 and 1910 2.3 Transportation Around the World	2. America's Story from America's Library 2.1 Jump Back in Time 2.1.1 Modern Era (1946 - present) 2.1.2 Play Ball! 2.2 Joint America at Play 3. Chronicling America: America's historic newspaper The McKinley Assassination 4. THOMAS : Bills, Resolutions 5. Prints & Photographs Reading Room The Prints and Photographs Online The Assassination of Abraham Lincoln
		6. Chronicling America: Historic American Newspapers Topics in Chronicling America

General Collection	UWMDC	LOCDC
		7. Web Guide Presidents of the United States James Garfield: A Resource Guide John F. Kennedy: A Resource Guide 8. American Treasures Memory Gallery Walt Whitman and the Civil War Captain! My Captain! Artifacts of Assassination Reasons Gallery: A Civil Society McKinley's Inaugurations, 1897& 1901 Imagination Gallery B: Leisure Arts Breaking The Color Line A Letter from Jackie Robinson The Jackie Robinson Story

CURRICULUM VITAE

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EDUCATION

Doctoral Candidate — September 2009 ~ August 2014
School of Information Studies,
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Master of Education in Curriculum and Instruction — May 1995
College of Education,
University of Texas at Austin, Austin, TX

Master of Science in Information Science — December 1992
School of Library and Information Sciences,
University of Pittsburgh, Pittsburgh, PA

Bachelor of Arts in Library Science — June 1989
College of Liberal Arts,
National Taiwan University, Taipei, Taiwan

RELATED PROFESSIONAL EXPERIENCE

2003–Present **Section Chief**, Division of Circulation, National Chung Hsing University (NCHU) Library, Taichung, Taiwan

- working as the executive head of administration group to consolidate eighty academic library members in Taiwan and apply for grant from the Ministry of Education for the Taiwan Academic E-Books Consortium
- organizing and composing the research grant proposal for National Science Council
- executing the consolidation projects of monograph and serials from university branch libraries to new NCHU library

1999 – 2003 Serial Librarian, Division of Serial, NCHU Library, Taichung, Taiwan

- managing electronic journals, designing searching web pages and planning and evaluating the collection development of paper-based journals.
- planning and executing the"Western Core Journals Project"and maintaining supportive resources for the research, teaching and learning in the university

TEACHING & RESEARCH EXPERIENCE

2009-2012	Project Assistant, School of Information Studies, University of Wisconsin-Milwaukee, Milwaukee, USA
2011-2012	Teaching Assistant, INFOST 571 - Information Access and Retrieval, School of Information Studies, University of Wisconsin-Milwaukee, Milwaukee, USA
2003–2009	Lecturer, Department of Humanities, National Open University, Taiwan courses instructed include Reference Resources and Services, Library and Information Use, Information Services, Information Organization, Library Instruction and Computer Literacy
2002	Lecturer, Electronic Collection Management Studies Program in 2002, National Library Association, TAIWAN course instructed The Selection and Evaluation of Electronic Resources
1997-1999	Lecturer, National Taiwan College of Physical Education, Taichung, TAIWAN courses instructed include Information Organization, Library Instruction and Computer Literacy

PUBLICATIONS

Huang, C. & Chou, H. (accepted). Assessment of Core Journal Collections on its Support to Faculty Research – A case study at the National Chung Hsing University Library. University Library Journal.

Huang, C., Joo, S. and Xie, I. (2012). Effects of learning styles on the application of search tactics: A preliminary result. Proceedings of the American Society for Information Science and Technology, 49: 1–4. doi: 10.1002/meet.14504901336

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Huang, C. (2003). The usage statistics of electronic journals and databases: the experience of National Chung Hsing University Library, http://www.stpi.org.tw/fdb/tr/2003/920305nchu01.doc.

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PRESENTATIONS (selected)

Huang, C. & Chou, H. (2013). A citation analysis of 2012 NCHU library core journal use. Conference on Digital Library services, September 27, 2013, Taichung, Taiwan.

Huang, C. (2012). Help-seeking interactions in digital libraries: Influence of learning styles. 14th International Conference on Asia-Pacific Digital Libraries, Graduate Student Consortium, ICADL 2012, Taipei, Taiwan.

Huang, C. (2012). Users' Features of Image Similarity. Poster presentation at the 2012 Student Research Poster Day of School of Information Studies, University of Wisconsin Milwaukee. April 2012.

Jeong, W. & Huang, C. Locating information science: Changes in Ph.D. dissertations During the past four decades. Poster presentation at the 3nd Annual SLIS-SOIS Research Forum, Madison, WI, USA. April 2012.

Chen, L. P., Huang, C., & Chang, Y. H. Digital archives of Taiwan agricultural history during the Japanese colonial period. Poster presentation at the ACM/IEEE Joint Conference on Digital Libraries (JCDL), Ottawa, Canada. June 2011.

Huang, C. Identifying Digital Libraries Author Publication Pattern using Visualization Clustering Analysis. Work in Progress presentation at the Connections: The Great Lakes Information Science Conference, Milwaukee, WI, USA. May 2011.

Joo, S. & Huang, C. System analysis of digital libraries: A practical manual for digital collection development projects. Poster presentation at the 2nd Annual SLIS-SOIS Research Forum, Milwaukee, WI, USA. April 2011.

Huang, C. (2010). Survey Study of International Activities and Relations of National Libraries. Presentation at the 2010 Student Research Symposium of School of Information Studies, University of Wisconsin Milwaukee. November 2010.

Lor, P. & Huang, C. (2010). IFLA NOIR SIG 2010 Survey of International Activities and Relations, Presentation at the IFLA National Organizations and International Relations Special Interest Group (NOIR SIG), Gothenburg, Sweden.

Huang, C. (2009). Digital Archive of Taiwan Agricultural History During Japanese Colonial Period: Phase I. School of Information Studies 2009 Student Research Symposium, Oct. 17, 2009. University of Wisconsin Milwaukee, Golda Meir Library.

HONORS

- Chancellor's Graduate Scholarship Award, University of Wisconsin Milwaukee (2009 – 2013)
- SOIS Dean’s Fellowship, University of Wisconsin Milwaukee (2009 – 2012)
- SOIS Doctoral Research Award Grant Opportunity (2012 – 2013)
- Graduate School Travel Awards, Graduate School, University of Wisconsin-Milwaukee (2011)
- Merits of Civil Servant for the coordination of the Annual Meeting of University Librarians in Taiwan (2008)
- Outstanding Civil Servant Award, National Chung Hsing University (2003-2004)
- National Higher Civil Service Examinations of Taiwan, in the Specialization of Library Management, obtain qualifications of appointment as a professional librarian (1989)