NEXT GENERATION CATALOGUES: AN ANALYSIS OF USER SEARCH STRATEGIES AND BEHAVIOR

BY

FREDRICK KIWUWA LUGYA

DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Library and Information Science
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2017

Urbana, Illinois

Doctoral Committee:

Associate Professor Kathryn La Barre, Chair and Director
Assistant Professor Nicole A. Cooke
Dr. Jennifer Emanuel Taylor, University of Illinois Chicago
Associate Professor Carol Tilley

ABSTRACT

The movement from online catalogues to search and discovery systems has not addressed the goals of true resource discoverability. While catalogue user studies have focused on user search and discovery processes and experiences, and construction and manipulation of search queries, little insight is given to how searchers interact with search features of next generation catalogues. Better understanding of user experiences can help guide informed decisions when selecting and implementing new systems. In this study, fourteen graduate students completed a set of information seeking tasks using UIUC's VuFind installation. Observations of these interactions elicited insight into both search feature use and user understanding of the function of features. Participants used the basic search option for most searches. This is because users understand that basic search draws from a deep index that always gives results regardless of search terms; and because it is convenient, appearing at every level of the search, thus reducing effort and shortening search time. Participants rarely used advanced search but selected it as a secondary alternative, especially when searching for local library or print collections. Participants understand an online catalogue as a list of library holdings that provides access to local print collections; and offers options for refining voluminous result sets. Participants frequently used author, title, subject, keywords; and citation, search within, print, save, e-mailing, fulltext download that offered clear alternatives to searching and search reformulation respectively. Such features are familiar to users from past search experiences and puts them in control of the system. Participants understand the function of VuFind features based on their perception and preference that: VuFind will give relevant and current information because of the large collection size at UIUC; because of their prior experiences with quick, minimal effort search reformulation strategies; and VuFind’s large result sets, presented in systematic and logical order. The evidence confirms that information tasks guide and shape the way searchers select and use system

features. Participant search processes change during and after using a specific system. Alternatives to improve the design of more robust search features are proposed.

ACKNOWLEDGEMENTS

This dissertation represents not only my work at the laptop; it is a milestone in more than three years of graduate school and specifically with the advisorship from Prof Kathryn La Barre. Undertaking this doctorate has been truthfully life-changing journey and I owe it all to the Almighty God for granting me life, the wisdom, and strength to undertake this task to completion.

First, my sincere thanks to the members of my committee - your unending valuable and consistent guidance and encouragement. My heartfelt thanks to Dr. Kathryn La Barre, Chair and Director of this research - I am grateful for your generosity, love and unconditional support. From the beginning to the end, you never abandoned me. Thanks for your patience. Dr. Nicole A. Cooke did not only introduce me to Use and Users of information research but grounded my theoretical conceptualization - my sincere gratitude to you. Dr. Jennifer Emanuel Taylor - a person with an amicable disposition - always clarified my doubts - helped me conceptualize my research design and methods, and making sense from the data. A special thank you to Dr. Carol Tilley - your thoughtful and guiding questions that shaped my literature review. Dr. Noah Lenstra for being kind enough to proof-read this work; I acknowledge the meticulous work by Ms. Cunningham Paige Danielle - not only edited and formatted this work provided valuable and timely feedback.

This dissertation would not have come to successful completion without the help I received from Dr. Terry L. Weech, Prof. Michael Twidale, Prof Linda Smith, Ms. Ames Penny Jo, all staff of School of Information Science, my PhD Cohort, and University Library Scholarly Commons staff; and the financial assistance from the Elsesser Fellowship and all funding received towards my education. Your support was greatly appreciated.

I am indebted to family and friends who supported me in their numerous ways. Special thanks to my Mum, wife, children, brothers and sisters.

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION 1
CHAPTER 2 LITERATURE REVIEW 13
CHAPTER 3 RESEARCH DESIGN AND METHODS 43
CHAPTER 4 FINDINGS 75
CHAPTER 5 DISCUSSION 117
REFERENCES 131
APPENDIX A: DATA COLLECTION INSTRUMENTS 141
APPENDIX B: RESEARCH STUDY CONSENT FORM 148

CHAPTER 1

INTRODUCTION

1.1 Introduction

> "*In principle, evaluation should be a significant check of a system's capacity to deliver what is required of it*." (Twidale, Randall, & Bentley, 1994, p. 441)

To get the attention of library users libraries are providing Web applications that offer centralized access to widely sourced library content. Next generation catalogues like VuFind offer such access and have many features and functionality similar to commercial search tools like Amazon, Google Scholar, and Facebook but from the user's point of view these tools perform similar functions to each other. Current access tools provided by libraries do a poor job of creating effective access. By working to gain better insight into how users interact with the features of next generation catalogues and how they respond to using these systems, libraries can overcome user confusion and frustration. Taking a qualitative approach, this dissertation research explored empirically how graduate students interact with the VuFind installation at University of Illinois at Urbana-Champaign (UIUC). Particular attention was paid to the systems features a group of graduate students use in their information seeking tasks. This research echoes Mitev's assertion that any decision to improve system design should be "*accompanied by an evaluation of its use and success or failure with the users*" (1989, p. 169). There is rich literature focusing on the search and discovery process (Johnston, Salaz, & O'Connell, 2013; Majors, 2012; Moore & Greene, 2012; Skinner, 2012), how to construct a search query (Bauer & Peterson-Hart, 2012; Borgman, 1986b; Pirmann, 2012), and how to narrow results to a usable number in relationship to users' backgrounds, age, academic level (Bauer & Peterson-Hart, 2012; Kules & Capra, 2012; Preater, 2010), subject interest, and experience with computers and type of library (academic, public, school and special) (Ahmad, Mushtaq, & Imran, 2012; Gallaway & Hines, 2012; Madhusudhan & Aggarwal, 2011; Ruzegea, 2012). However,

these studies provide little guidance on how graduate students interact with a VuFind installation (Miksa, 2012). The results from this research can be used to improve upon VuFind but also to improve other systems by better understanding graduate student's needs and how they search for information.

1.2 Statement of the Problem

> "*The ultimate goal of any discovery service, bar none, is to place content in the hands of the user or, more specifically, to discover, present, and deliver relevant content in a convenient manner to today's researcher.*" (Vaughan, 2011, p. 48-49)

As libraries struggle for the attention of library users, many of whom rely heavily on Web applications for their research, providing a one-stop centralized access to widely sourced library content is increasingly important in ensuring the library's long-term continued usefulness to patrons. Responding to the needs of the users, libraries put forward Google-like discovery technology, which offers a "centralized search model", and better tools to leverage the rich metadata trapped in the MARC record to enhance collection browsing. While the tool studied in this research, the VuFind installation at University of Illinois at Urbana-Champaign (UIUC) is limited in functionality compared to known discovery systems, centralized search technology seeks to offer access to a greater diversity of sources such as local library catalogues, institutional repositories, archival databases, and open and commercial electronic journal databases than those represented within the traditional online public access catalog, with features and functionality - like visually appealing and intuitively functional interface, expanded and augmented entry points, faceted navigation and searching, deep indexing, enhanced searching, etc , similar to commercial products like Amazon, Google, and Facebook (Moore & Greene, 2012, p. 146). There are currently many next-generation catalogue (NGC) products in the market, for example VuFind from Villanova University, Primo from Ex Libris, Summon from Serials Solutions, EBSCO Discovery Service from EBSCO, and WorldCat Local from OCLC. These products have many features in common and from the user's point of view, they perform similar functions (Cai, Dou, & Jiang, 2011). However, unlike all the other next generation catalogues, VuFind is open source and has no central index. The similarity in features and

functionality makes implementing a discovery tool a big decision, not only because of the large investment involved, but also due to significant impact on library systems and services as well as changing and varied user expectations, search strategies, and user behavior. Thus one critical problem facing libraries today is the need to gain better insight into how users interact with systems, and how they respond to using these systems. This research seeks to understand how graduate students use the VuFind installation at UIUC, i.e. discovery, presentation, and delivery of relevant content in a convenient manner for today's researcher.

There is a lack of consensus as to what functionality NGC should have (Markey, 2007a, 2007b) to support knowing what there is to find (discovery), getting to it (search) and actually getting it (location) (Dempsey, 2006). NGC should support user's expectations regarding their search behavior and provide more user-friendly interfaces than the traditional library catalogue.

Studying the features of the VuFind installation at UIUC that graduate students use to complete specific types of information tasks; and how they actually understand the function of VuFind's features is a positive step towards increasing our understanding of discoverability of library resources for library users. NGC have surpassed the traditional catalogue in terms of interface features, user-friendliness, and information retrieval in terms of recall and precision, but the movement towards a system that searches the majority of the library's resources has not yet addressed all of the aspirations of true discoverability (Moore & Green, 2012, p. 158). For example, Moore & Green (2012) observed that for expert users a single search is unable to provide the level of specificity needed for a particular subject specialty; while novice users hold a generally negative view of NGC because they have failed to support their searching needs, like not providing enough instruction on how to construct a search query or narrowing search results to a usable number; or not making it obvious how to construct a search query. Thus, more research is needed to understand users' search strategies and behavior in order to resolve the issues NGC are not addressing, as well as to identify and to take advantage of the areas in which catalogues can best support library users. There is rich literature focusing on the search and discovery process (Johnston, Salaz, & O'Connell, 2013; Majors, 2012; Moore & Greene, 2012; Skinner, 2012), how to construct a search query

(Bauer & Peterson-Hart, 2012; Borgman, 1986b; Pirmann, 2012), and how to narrow results to a usable number in relationship to users' backgrounds, age, academic level (Bauer & Peterson-Hart, 2012; Kules & Capra, 2012; Preater, 2010), subject interest, and experience with computers and types of libraries (academic, public, school and special) (Ahmad, Mushtaq & Imran, 2012; Gallaway & Hines, 2012; Madhusudhan & Aggarwal, 2011; Ruzegea, 2012). However, these studies provide little insight into regarding how graduate students understand and utilize features of NGC such as VuFind; and how tasks and practices influence their preference for these search features.

This study provides a close examination of how graduate students understand and use search features of online catalogues. The research focuses specifically on the system features of VuFind at UIUC that are directly used in support of searching activities. The VuFind installation at UIUC is a unique installation of VuFind because it limits searchers' options by only including some of the functionalities offered by next-generation catalogues and not available in the Voyager Classic Catalogue [*detailed descriptions of the VuFind Installation at UIUC are in Section 2.2.1*]. To achieve this goal, the study focuses on: a) the features of VuFind at UIUC that graduate students use to complete specific types of information tasks; and b) discovering how graduate students understand these features.

1.3 Purpose/Rationale/Motivation

Chickering and Yang (2014) observed that search technology has evolved far beyond federated searching. The concept of a Next Generation Catalogue spawned a generation of discovery tools that bring almost Google-like power to library searching. The problem facing libraries now is the intelligent selection of a tool that fits their context, as well as structuring a process to adopt and refine that tool to meet the objectives of the library. Taking a qualitative approach, the purpose of this research was to conduct exploratory empirical research into how graduate students interact with the VuFind installation at UIUC. Particular attention was paid to the systems features a group of graduate students use in their information seeking tasks.

1.4 Research Questions

This research is twofold: a) to improve our understanding of users' search strategies and behavior; and b) to provide insight into which catalogue features graduate students use, and the extent to which they understand these features. The key questions guiding this research include:

1.4.1 RQ1: What features of VuFind do graduate students use to complete specific types of information tasks?

RQ1 aims to identify which search features of VuFind graduate students use to complete specific types of information tasks. This includes identifying the most and least used features, with particular focus on search and browsing approaches, access points, interface and bibliographic displays, output and external links, search limits, and user assistance. This is important because it will help to show how users' choice of search features change during the searching episode and from their preconceived approaches before using the system. The observed information tasks are categorized into four tasks: bibliographic strategy [*where the participants searched for a known item*], analytical strategy [*where the participants expressed their need in topical terms*], search by analogy [*where participants formulated their needs through a known and appreciated item like a book*], and empirical strategy [*where the participants presented their needs in topical terms and associated it with a known set of documents*]. These tasks are detailed in Chapters 3 and 4.

1.4.2 RQ2: How do graduate students understand the function of VuFind's features?

RQ2 focuses on discovering how graduate students understand the function of VuFind's features. This includes not only what users perceive as the system features available for use in a given task are and what purpose they serve, but also how these understandings are arrived at and how they are interpreted in different contexts.

1.5 Definitions

To avoid the terminology problem often resulting from ambiguous usage of terms in information behavior studies, and particularly library and information science fields (Dervin, 1983; Dervin & Nilan,

1986; Wilson, 1999), this section defines how key terms and concepts will be used in this dissertation. The terms are arranged alphabetically.

Access points: Access points are fields of the bibliographic record that are indexed and searched, i.e. query specifications such as keyword, author, title, and subject, which define how the component term(s) of the query are to be interpreted or related for matching purposes (Carter & Levine-Clark 2013, p. 4; Hildreth, 1989a, 1989b).

A Control: A control (or access points control) is a communication tool between a user and an application that conveys a particular action or intention to the application through user interaction, and which can be used to manipulate content, provide user input, navigate within the application, or execute other pre-defined actions, e.g. the search box, access points, external links (APIs), and search limits. Interface controls allow users to interact with the application, manipulate or edit application content, and convey user intent to the application in a straightforward way (Apple Developer, 2016).

Analytical strategy: Analytical strategy (or analytical search strategy) refers to the practical techniques that a searcher engages into while searching by expressing their search needs into topical terms (Hawkins & Wagers, 1982, 1990; Pejtersen, 1984, p. 168).

Bibliographic display: Bibliographic display is the layout of the structure of the bibliographic record mapped from the MARC fields to locally defined labels and presented in a predefined order (Wool, 1996. Next generation catalogues offer multiple display formats, e.g. short & long display; MARC & user structured formats, and library terminology & language.

Bibliographic strategy: Bibliographic strategy refers to the practical techniques that a searcher engages into while searching for a known item. This strategy takes into account information retrieval through identification and collocation of resources, access to collections and management needs (Hawkins & Wagers, 1982, 1990; Pejtersen, 1984, p. 168).

Browsing: Browsing is a cognitive and behavioral expression of exploratory behavior; as an activity, browsing engages a series of glimpses[1], each of which exposes the browser to objects of potential interest (Bates, 2007). Browsing in online catalogues can take many forms, such as, display of ordered lists of terms, descriptors, and bibliographical records; Web-based, hypertext, and faceted navigation; field-directed (Author, Title, Subject, etc.) browsing; FRBRization; and sorting and relevancy rankings.

Context: [*For the purpose of this research*] Context elicits different behavior and is defined to include information tasks given to participants, interface components of a VuFind installation and other systems, advanced and basic search options, and experience with searching library tools.

Contextual Assistance: [*For the purpose of this research*] Contextual assistance is a general term for guided assistance that includes all forms of help available to the users of online catalogues, like online help, procedural help, and/ or tutorial information.

Critical Incident Technique: The Critical Incident Technique (or CIT) is a set of procedures used for collecting direct observations of human behavior that have critical significance and meet methodically defined criteria. These observations are kept track of as incidents, which are then used to solve practical problems and develop broad psychological principles (Flanagan, 1954; Johnson & Fauske, 2000; Serenko, 2006; Wang, Hsieh, & Huan, 2000).

Empirical strategy: Empirical strategies (or empirical search strategies) are practical techniques that a searcher engages into by converting their needs into topical terms that are associated with a known set of documents (Hawkins & Wagers, 1982, 1990; Pejtersen, 1984, p. 168).

Interface: The interface (or user interface) is the menu, layout, and controls represented as text and/or images that allow a user to interact with the contents of the online catalogues (Carter & Levine-Clark 2013, p. 264).

[1] While browsing through search results users of search tools like next generation catalogues momentarily or partially view search results without necessarily spending enough time to make full scale analysis - a process referred to as glimpse

Output and external links: [*For the purpose of this research*] Output and external links refers to the format, field, and order in which search results are displayed on the interface of online catalogues. Currently, next generation catalogues offer the following outputs: systematic ordering, relevance ordering, and multiple formats.

Search by analogy: Search by analogy is a search strategy that involves the practical techniques that a searcher engages into by formulating their needs through a known and appreciated item like a book (Hawkins & Wagers, 1982, 1990; Pejtersen, 1984, p. 168), a process described by David Ellis (1987, 1989) as "chaining".

Search features: [*For the purpose of this research*] Search features are features found on the systems' interface that are directly used by searchers at their discretion to support their searching activities.

Search limits: [*For the purpose of this research*] Search limits refers to search features that allow searchers to narrow a search by author, subject, title, call number or other specialized system limits like: publication date, version, language, formats, and media.

Search: Search is a process of either entering into the search box of a database or search engine search statements or, keywords or making a search query with words relating to an information source's author, editor, title, subject heading or keyword (American Library Association [ALA], 2013, p. 6; Carter & Levine-Clark, 2013, p. 225).

Task analysis: Task analysis is a method used to analyze how a task is accomplished, including a detailed description of both manual and mental activities, task and element durations, task frequency, task allocation, task complexity, environmental conditions, necessary clothing and equipment, and any other unique factors involved in or required for one or more people to perform a given task (Embrey, 2000; Kirwan & Ainsworth, 1992, p. 1).

1.6 Significance of Study

Researching how graduate students understand, select, and utilize search features in VuFind may ignite more robust conversations about how libraries and system designers can implement more useful online search systems. The qualitative approach taken by this research study ensured that proper attention is paid to understanding graduate student's awareness, selection, and utilization of search features. By improving our understanding of user search strategies, this study aims to capture important insights into catalogue use that may guide future research to develop evaluative criteria for catalogue installations overseen by LIS professionals, researchers, and system designers (vendors). Evaluating catalogue installations is not the focus of this research, rather the aim is to understand how graduate students interact with a VuFind installation, in the hope that the data can influence future design for library catalogues and discovery systems.

The research was developed with two major objectives in mind: first it aims to improve our understanding of users' search strategies and behavior, by providing new insights into how users interact with catalogue systems. Second, this research will outline one possible approach to studying how graduate students search for information using VuFind. Applying the proposed guidelines would involve demonstrating library systems to searchers and measuring the degree to which NGC functionality performs as desired or will be seen to be desirable by graduate students.

1.7 Limitations and Assumptions

1.7.1 Limitations: Use of one exemplar – VuFind at UIUC.

VuFind at UIUC, the search tool used in this research, does not fully implement all possible VuFind components, or even the full array of those found in all the other next-generation catalogues. This installation of VuFind is uniquely configured. The goal of VuFind at Illinois is to provide some functionality that is unavailable in the Voyager Classic Catalogue. This means that UIUC's VuFind is one particular installation of VuFind. A fully implemented next-generation catalogue is one that offers all its features to the searcher and keeps updating the system with new features developed. By the time of this

research the features implemented in VuFind included: search with faceted results, live record status and location, "more like this" resource suggestions, save resources to organized lists, browse for resources, author biographies, persistent URLs, Zotero compatibility, internationalization, and access to personal data, open search, OAI, Solr. However, course reserves searching, call number searching, publisher searching, limiting items by library, and direct export to Refworks are features not available in UIUC's VuFind.

In addition to VuFind, the University of Illinois uses Voyager Classic Catalogue. Voyager Classic Catalogue is an integrated library management system developed by Ex Libris, but managed Consortium of Academic and Research Libraries in Illinois for seventy-one of its member libraries, including the University of Illinois Library. The catalogue's implementation at UIUC includes the following components: acquisitions/ serials, cataloging, circulation/ call slip/ universal borrowing, media booking, classic online catalogue.

To address this weakness, during the search process participants were permitted to conduct searches outside the VuFind catalogue in order to complete their tasks. This allowed the research process to explore UIUC's VuFind functionality, but also the functionality of other alternative search tools provided through the UIUC library portal. VuFind was selected as the tool for this research process because it has undergone stringent user testing prior to implementation (Emanuel, 2011), thus this work is a follow up to that work. The VuFind software is widely marketed, used, and praised for its functionality and user friendliness (Emanuel, 2011). At Illinois, VuFind is provided as the default access to the library catalogue on the UIUC library Web page (at the time of this research) and is now fully adopted as the default catalogue for searching and requesting items from other I-Share Libraries by the Consortium of Academic and Research Libraries in Illinois (CARLI) (Emanuel, 2011, p. 44).

1.7.2 Limitation: Sample Size.

Another serious limitation of this study stems from the small sample size. This means that the results of this research are not generalizable. The aim of this research is to provide information about a small group of graduate students at a large research university in the Midwest. Through the use of

snowball sampling the researcher assumed that the participants fitting the sampling criteria were aware of others with similar searching experience. While sampling ensured subjects represented a variety of disciplinary interests, the study makes no conclusions based on the subject specialty or expertise of the participants.

1.7.3 Assumptions: Learning about user behavior can help guide evaluation strategies.

One key assumption of this research is that learning about users can help guide future work in evaluation. This study defines evaluation as an assessment of the degree to which online catalogues' functionality performs as desired or is seen to be desirable by users. Before we learn about evaluation of next generation catalogues it is important to reflect on user experiences and perceptions that are inherently tacit in nature. Thus, this research seeks to explore tacit knowledge, which can only be established by looking at how searchers look for information resources and the difficulties they face as they seek information. Learning about user tasks can include a number of user actions, such as: the process of entering search keywords or search statements into the search box or making a known item search query with words relating to an information source's author, editor, title, subject heading, or keyword; performing relevance tasks on the results; navigating through the search menu, interface and results layout, and access points controls; making sense of the search results; and browsing and linking through the pages. Searching takes different forms: keyword searching, field directed searching, the use of Boolean operators and truncation symbols, and limiting a search to specific fields; and is supported by different approaches: querying and browsing. Observing how graduate students select VuFind features to help them find information can inform system implementation decisions about which features and functions are most useful, and identify any gaps that may call for additional features.

1.8 Conclusion

Chapter 1 presents the core issues pertinent to this research. First, it introduces the main goal: improving our understanding of users' search strategies and behavior, specifically how graduate students

interact with a VuFind installation. Because this is an exploratory study, the results can be used to improve upon VuFind but also may inform future work to improve other systems. The literature review in Chapter 2 will explore the events shaping online catalogue research based on Hildreth and Borgman's works. Effort is made to describe search features found in next-generation catalogues, the current trends and developments of the catalogue user studies and its generations, and Illinois's VuFind installation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The last decade of catalogue research is characterized by advancement in technology resulting in powerful and functionally rich but simple interfaces (Breeding, 2010, p. 8; Twidale, Randall, & Bentley, 1994, p. 449) and implementation and integration of these technologies into the library's core public access systems for most information resources (Borgman, 1996a, p. 501; Emanuel 2011, p. 44). This has marked a period which foregrounds self-service and convenience as the single most important factors for information use (Mi & Weng, 2008, p. 5; Tenopir, 2003, p. 45). The need to design intuitive system interfaces that contribute to ease of use has been a subject of discussion for several decades. For example, "the Golden Period, 1961 - 1985" (Cochrane, 1985, p. 379) of information retrieval and library automation was marked by research on: increased searching power to perform operations; the human factor, i.e. user satisfaction and user-system interaction; searching power; and system functionality, performance, and development. The reasons for non-use of online library access systems also attracted attention (Borgman, 1986a, 1996; Cochrane, 1985; Hildreth, 1995a, 1985b; Markey, 1983, 1984; Yee, 1991). Despite improvements in design and functionality, and extensive use of technological devices, there is a widening gap between users and non-users of library catalogues (Borgman, 1996). In the bid to bridge the gap, this dissertation research explores what search features of VuFind are utilized by graduate students to complete specific types of information tasks and how students understand the function of the features implemented in UIUC's instantiation of VuFind. Concern has been expressed, however, that conclusions drawn from catalogue use studies are contradictory and unclear (Miksa, 2012, p. 25). Other issues with catalogue user studies are that their primary focus is librarians' own experiences and interests and too grounded in librarians' own senses of their own catalogue use skills, and that conclusions are drawn without use of deductive logic and supporting anecdotal evidence (Miksa, 2012, p. 25). The study of user search strategies and behavior that this dissertation is undertaking will address these concerns.

2.2 Overview: The Online Library Catalogue

In one form or another, from a mental list in the mind of the librarian, to book catalogues, card indexes, online public access catalogues and later next-generation discovery and access catalogues (Butterfield, 2010, p. 3992), the catalogue continues to guide library users through collections. Next-generation catalogues (NGC) are understood to be the technology that is replacing the online public access catalogue (OPAC). The OPAC replaced the card catalogue, which replaced the book catalogue. Each of these changes was marked by more efficient means of bibliographical record retrieval, the tendency to implement new technologies by librarians and system designers, as well as increased user convenience and satisfaction (Butterfield, 2010). With more items catalogued in separate registries, or via links and portal systems, what is clear is that NGC will be a connecting force between all of these registries and the OPACs.

2.2.1 Generations of online catalogues.

From its beginning to the present, the library catalogue has undergone developments resulting in rapid changes to its interface and functionality. These changes referred to as "catalogue generations" (Hildreth, 1985, p. 39) are identified as first, second, and third generations. These generations are described by their features whose evolution has been generally progressive and incremental. Each generation incorporates the features of the generation of the catalogue before it, but with new enhancements. Further analysis of over 30 online catalogues from lib-web-cats [*lib-web-cats is a directory of library websites and catalogues worldwide created and managed by Breeding*] (Breeding, 2016), and a review of the literature, shows that second generation catalogues are characterized by text-based, automated circulation systems, which include patron access, and known item and subject searches, with opportunities for interactive search refinement (post-coordinated searching). Boolean search capabilities are not easy to learn and use, as they are complex interface mechanisms that require training for effective searching and extensive help facilities to assist first time and infrequent users (Breeding, 2010, p. 8; Hildreth, 1985, pp. 40-41; Poo & Khoo, 2010, p. 3955). On the other hand, next generation

catalogues are characterized by a natural, personal, and simple to use interface whose features are enhanced with new functions (Breeding, 2010).

2.2.1.1 Evolution of catalogues.

Earlier studies by and those built on Charles R. Hildreth's[2] and Christine J. Borgman's[3] work made efforts to identify catalogue generations (Hildreth, 1984, 1988, 1989a, 1989b, 1991a) and feature evolution (Hildreth, 1984, 1987a, 1987b, 1990, 1995b), and support the need for catalogue use studies (1991a, 1995b, 2001a, & 2001b), but little has been done to extend their work. The works of Hildreth and Borgman are of significance to the evolution of catalogues and to the present research because they are evidence-based, influential, and widely cited; they address overlapping core issues such as novelty, and the studies are longitudinal. Through teaching, research, and consulting, Palmer School of Library and Information Science Associate Professor, Professor Emeritus Dr. Charles R. Hildreth participated in the advancement of library catalogue research since the 1980s to date. From his doctoral research dissertation, "*An evaluation of structured navigation for subject searching in online catalogues* (1993)", onwards, Hildreth provided critical reviews of second-generation online catalogues (1985, 1987a, 1987b, 1991a, 1991b). His research included detailed and in-depth debate analysis of search features and shortcomings of second generation catalogues (La Barre, 2012, p. 3), and provided both an extended discourse on user interface design (Hildreth, 1985, 1990) and a comparative analysis of online catalogues (Hildreth, 1991b, 2001a, 2001b). He emphasized the critical point of interaction between human and computer systems, especially in library systems. Adopting a user-oriented perspective, Hildreth's crowning achievement was the detail with which he described obstacles to second generation catalogues. He also presented an extremely useful evaluative framework for the comparison of existing systems and the design of future ones. This dissertation also builds on Hildreth’s alternative design models in support of exploratory information seeking (La Barre, 2012, p. 3).

[2] Charles R. Hildreth's scholarly works, education and honors, and work experience is available from, http://myweb.cwpost.liu.edu/childret/crh-cv.htm

[3] Christine L. Borgman's scholarly research output is available from, https://scholar.google.com/citations?user=e1y6CcQAAAAJ&hl=en

Unlike Hildreth, whose work provided search and interface alternatives, Christine L. Borgman presented the frustrations and difficulties involved with the use of library catalogues (La Barre, 2012, p. 3). Borgman, a renowned scholar and researcher on the design, development, and use of information retrieval systems, asserted that the difficulties in using library catalogues was a result of users' lack of conceptual, semantic, and technical knowledge in executing searches (Borgman, Hirsch & Hiller, 1996, p. 493; Borgman, 1996). Given the complexity of the information retrieval systems and the limited capabilities of users (Borgman, 1989), Borgman (1995) urged designing intuitive systems that require minimal instruction. While Borgman does not explicitly recommend specific approaches to evaluate systems, her emphasis on understanding user search behavior, specifically how and when to use system features, informed this study. By understanding how and when system features are used, Borgman notes that systems designers should be able to design intuitive catalogues. The present research takes several steps towards establishing a suitable and empirical standard of next-generation catalogue performance, and aims to provide the foundation for future research that will tend to lead towards this end.

The first generation catalogues, in the 1960s and 1970s, were primarily an online way of accessing the card catalogue with the same entry points as a printed catalogue. Second generation catalogues provided keyword and post-coordinate Boolean searching [*the specification of combinations of keywords using Boolean operators (AND, OR & NOT) within the online catalogue's systems functionality*]. The third or next generation catalogue that emerged in the early 1980s, following experimental systems like Okapi and Cheshire II, incorporated advanced search and matching techniques (Walter, 1989). Discovery systems do not rely on exact match (Boolean) searches, but use partial-match techniques (probabilistic and vector-based). Through his extensive study of library catalogues in the 1980s, Hildreth reported that each of the generations is not bound by a fixed span of years, but is defined by search features and an underlying, singular philosophical approach to searching a database of bibliographic records.

2.2.1.2 First generation.

The first generation catalogues, common in the 1960s and 1970s, were mainly designed based on how users access the card catalogue with the same entry points as a printed catalogue. This was based on the expectation that most users were interested in known-item searches. Hildreth (1995a, 1993) identifies two models that informed and motivated the design of the first online catalogues. The first model reflected attempts to emulate the familiar card catalogue in its new online form, while the second adopted a model familiar to online database searchers of commercial search services [***see Section 2.1.1.3 Second Generation***]. In the first generation, online access to catalogue records was restricted to entry via author or title data. Searching was initiated by derived-key input or by exact word or phrase-matching, as with heading searches in the manual card catalogue. Only short bibliographic records were displayed in a format that resembled the catalogue card. No subject access via either keywords or controlled vocabulary was provided, and searching was constrained by a two to three-step linear process. Refining and improving a search in progress, based on an evaluation of intermediate results, was not possible. Without full records, subject access, authority-based searching with cross references, and meaningful browsing facilities, Hildreth (1995a) observed that first-generation online catalogues were understandably criticized as inferior to traditional, non-automated library catalogues.

2.2.1.3 Second generation.

Second generation catalogues, which began appearing in the mid-1980s, represent a qualitative leap of progress over first generation online catalogues; and with their multiple access points, search approaches, and user-friendly display formats, represent the marriage of Hildreth's (1995a) two access models of first generation catalogues. Developers of second generation catalogues were challenged by combining the ease-of-use (or at least, familiarity) of the card catalogue with the powerful search capabilities available to trained online database searchers. Second generation catalogues become powerful, end-user, computer-based interactive retrieval systems that provide greatly enhanced access to the bibliographic citations, which represent the materials in one or more library collections. The early

model of the online catalogue which was designed based on the card catalogue no longer represents the way how users search next generation catalogues and Web applications. Second generation catalogues provided: more access points, more browsing options, multiple catalogue arrangements in a single source, very precise search results through the careful use of Boolean search capabilities, remote access, material status and availability information, access to the resources of other libraries either through a shared database or system-to-system linkages, increased utilization of library resources, and greater user enjoyment and satisfaction with the search process and search results. Search features which define second generation catalogues include: card catalogue like alphabetical searching, subject access via library-assigned headings, keyword access, Boolean searching, index term browsing, shelf list review/scan, full standard bibliographic records, multiple display formats, two or more dialogue modes, interactive search refinement/modification, search results display/print manipulation, help functions, context sensitivity, informative error messages, and action and "How To" option prompts (Hildreth, 1995a).

Improved card catalogue-like "main entry" searching and browsing-by-heading capabilities have been joined with the conventional information retrieval keyword and Boolean searching approaches. Much of the power and flexibility familiar to librarians and subject specialists which enables the "post-coordinating" of search concepts and terminology was brought to the online catalogue searcher. Many second generation catalogues support the ability to restrict searches to specified record fields, to perform character-masking and/or right-hand truncation, and to limit the results by date, language, place of publication, etc. While the improvements in second generation catalogues benefited librarians and subject specialists familiar with the new features, the new functionality came at a price in terms of reduced usability for untrained users (Borgman, 1995; Hildreth, 1995a,). Further the authors observed that second generation catalogues have undergone user interface improvements which has made them more usable for the untrained user, and new graphical user interface (GUI) techniques like windows and point-and-click buttons hold the promise of rendering the search process both more intuitive and more direct.

2.2.1.4 Next generation or third generation catalogues.

Referred to as third-generation catalogues, next-generation catalogues, or next-next-generation catalogues, next generation catalogues are mostly characterized by a single search box, advanced query tools, faceted search capabilities, enhanced visual displays, and reliance on social technologies such as tagging, which encourage user participation (Breeding, 2010, p. 11; La Barre, 2012, p. 1). NGC can be viewed as the latest manifestation in library catalogue history to strive for centralization of access to collections (Barton & Mak, 2012, p. 84). The centralization of access is the effective provision of a single portal for the discovery of library resources, a single search environment that a user can engage to search across all the information available at a library. The necessity for centralized access is a result of the fragmentation of library resources into separate information silos: the local and union catalogues, digital libraries, academic course-management systems, aggregated databases of journal articles, and institutional repositories.

A comparison of the search features across the second generation catalogues and NGC shows that the boundary lines between generations are somewhat unclear and overlapping and that the evolution of any particular online catalogue system spans more than one generation [*see* ***Table 1.1*** *illustration*]. Andrew Nagy, in his 2011 *Library Technology Report* issue noted that the scope and functionality of NGC is much greater than a catalogue. It is not a federated search, but has a central index from which to return results; it provides faceted navigation, filters and integrates outside sources, and uses open platforms, open source license software, and open content. NGC emerged to better elucidate the idea of an interface separate from the integrated library system with the features and functionality of a discovery layer, as well as with the ability to incorporate more than what was traditionally available through a library's catalog, including institutional repositories and digital libraries (Moore & Greene, 2012, p. 146). Third generation systems are defined primarily by their advanced interface search functionality, including: functional search and retrieval enhancements (e.g., closest-match retrieval and hypertext, exploratory browsing and searching); MARC-PLUS augmented catalogue records (subject descriptors, headings from tables of contents, classification vocabulary, etc.); integration of local Non-MARC and

Pseudo-MARC bibliographic records (non-standard records, subject pathfinders, abstracts, book reviews, and research guides); advanced relational database syndetic structure (pre-defining customized sub-catalogs and subject-based linkages, trails and pathways); additional self-service convenience functions (self-charging, online ILL or reference service requests, etc.); locally created and mounted information and referral files; remotely published, locally mounted and accessible information databases; gateway access to external bibliographic or information networks and databases (online reference databases, other OPACs, electronic union catalogs, and research networks, etc.). As described in **Table 2.1, Section 2.7,** third generation catalogues are optimized for library users allowing ordering, ranking, and sorting of search results based on facets, FRBRization, search term recommendation, and personalization within a visually enriched display, and connections to external applications.

In his summary on the events shaping the development of next generation catalogues, Hildreth (1995a) observed the confusion in the literature as to whether the emerging online catalogue (next generation catalogue) is the “enhanced: functionality and usability”; “expanded: indexing, data records, collection coverage; i.e., a "full-collection" access tool”; or “extended: through linkages, networks, and gateways to additional library collections, information systems and resources” online catalogue. He observed that some writers view these terms as synonymous and use them interchangeably, but often there is a lack of clarity or consistency in their use to explain related but different developments. For example, Hildreth (1995a) who identified three complementary ‘expansion’ paths along which online library systems proceed: a) more indexes to more sets of collections and more online reference databases; b) the gradual inclusion of more full text of journal articles, and possibly, books; and c) greater connectivity from online library systems to other systems, including other library systems, commercial services, bibliographic utilities, local networks, CD-ROM servers, and other information providers in the community. Extended third generation catalogues typically provide value-added access beyond the conventional online catalog by providing expanded entry points, augmented information resources, access to locally mounted and/or remote periodical index databases, and gateway functions to local, regional, and national telecommunication networks.

2.3 Study Exemplar: VuFind

VuFind is a library resource portal designed and developed for libraries at Villanova University by Andrew Nagy (software developer) and Chris Barr (interface designer). The goal of VuFind is to enable library users to search and browse through the library's resources by layering on top of integrated library systems and replacing the public catalogue interface to include: catalogue records, digital library items, institutional repositories, institutional bibliographies, and other library collections and resources. VuFind's focus is on “discovery” and narrowing down search results with facets, allowing for a customizable user interface, and its single search box can be integrated into local library websites. VuFind is open source; its functionality, some of which is similar to next-generation catalogues, includes a simple, single-box search interface; an available advanced search option; a relevancy-ranked default display; facets that help to narrow results; cover images; functions to place holds/requests in ILS; social networking functions; the ability to export to RefWorks and/or EndNote; persistent, bookmarkable URLs; and the ability to search multiple, local databases. Several libraries have implemented VuFind either as their primary catalogue interface or as an optional alternative and require their own programmers to implement VuFind (Emmanuel, 2011; Johnston, Salaz, & O’Connell, 2013).

VuFind is completely modular, i.e. it allows implementation of just the basic system or any/or all of the components. Since it is open source, it can be modified or allows adding modules to best fit library and user needs. A wide range of configurable options allow extensive customization without changing any code. VuFind runs on Apache Solr a platform created by Yonik Seeley at CNET Networks as an in-house project to add search capability for the company website in 2004. Solr is a highly scalable open source enterprise search platform that provides distributed search and index replication. Its major features include full-text search, hit highlighting, faceted search, dynamic clustering, database integration, and rich document (e.g., Word, PDF) handling (Shahi, 2015). Using Apache Solr’s, extensive performance and scalability offerings allows for VuFind to respond to search queries in milliseconds time and provides the ability for the processing to be distributed if an administrator needs to spread the load of the catalogue

over many servers or into a server farm environment (Shahi, 2015). VuFind is offered for free through the GPL open source license, meaning participating libraries can modify the software and share their successes with the community. VuFind functionality allows for the following functions: (Breeding, 2010; and Emanuel, 2011; Github.io[4], 2016) [*some of this functionality is also found in next-generation catalogues*]:

- Search with Faceted Results: The search system allows for the user to search from a basic search box and then to be able to narrow down the results by clicking on the various facets of the results.
- Live Record Status and Location with Ajax Querying: The search results page is able to display the live status of a record by querying the catalogue at that exact moment.
- "More Like This" Resource Suggestions: When viewing a record, the user will be offered suggestions of resources that are similar to the current resource.
- Save Resources to Organized Lists: The user has the ability to save the resources from both the search results page and from the record view page to their own customizable lists. The lists can be retrieved at any time and will always be there for the user. This helps to eliminate the need for desktop based citation management software that tends to be too difficult for basic users. This makes it simple for all users.
- Browse for Resources: The user has the ability to browse the catalogue allowing them to explore what the library has rather than only being able to see a very narrow spectrum of results.
- Author Biographies: The user can learn more about the author with contextual information and see all of the books written by that author held in the library's collections.

[4] Github.io is a web portal that provides updated information on VuFind, including information on VuFind systems, features, downloads, installation and user documentation, events and support, https://vufind-org.github.io/vufind/features.html, accessed May 12, 2016.

- Persistent URLs: The user can bookmark queries or records to allow permanent access to a page they were once on.
- Zotero Compatibility: Users can save and tag any records with Zotero or any other COinS based application so they can store their records in one place.
- Internationalization: The interface has translations available in Brazilian Portuguese, Chinese, Dutch, English, French, German, Japanese, Spanish and more; this allows to create personalized translation with ease and the user interface is much easier to customize.
- Access to Personal Data - Open Search, Open Archives Initiative (OAI), Solr: VuFind has many Application Programming Interfaces (APIs) available to interact with the search, data and many other features. It allows syndicating record data with other institutions via an OAI server; searching using VuFind's algorithms via OpenSearch; and interacting with Solr, VuFind's backend search and index engine to give complete access to personalized indexed data.

2.3.1 VuFind installation at UIUC.

VuFind at UIUC does not implement all of the VuFind's components, rather it provides some functionality that is unavailable in the Voyager Classic Catalogue. The four main improvements in the VuFind interface and functionality are relevance-ranked results, browsing capabilities, subject heading access, and faceted search and browse all supported with Solr. VuFind harvests data from the local OPAC (Voyager), I-Share catalogue, the IDEALS institutional repository, archival databases like Illinois Harvest and Hathi Trust, and data from the University's link resolver (SFX).

VuFind is the default catalogue for the University of Illinois (by the time of doing this research), although some users still search the classic catalogue because certain types of searches needed to be done in the Classic Catalogue, including search by call number and publisher name. However, the specific VuFind interface at the University of Illinois was developed by the Consortium of Academic and

Research Libraries in Illinois (CARLI) and is now also the default catalogue for searching and requesting items from other I-Share Libraries.

Vufind at UIUC offers basic searching, narrowing results, and advanced search options. VuFind de-concatenates Library of Congress Subject Headings, making each element of a subject heading a hyperlink to a search [*for example the concatenation of "snow" and "ball" is "snowball" while the de-concatenation of "snowball" is "snow" and "ball*"], and sorts search results based on criteria such as format, location, subject, author, language, and call number. Facets allow users to narrow large sets of search results to smaller more defined sets.

Using UIUC VuFind offers searchers are able to: search a single, simple search box; refine search by subject, title, topic, language, format, and more; search either the Illinois library catalogue or all I-Share libraries at once, including item status and location information; request UIUC and I-Share items; create usernames and passwords; link to their personal library accounts to save, organize and retrieve records from any computer (using created log-in information); text call numbers to their phones; save and tag records using reference management applications like Zotero; follow one-click links to reviews, including author reviews; use social networking tools, such as leaving comments and tagging; and find previews in Google Book Search. A user with a valid account is able to save items that they wish to revisit (add favorites); add descriptive terms to an items (tags); add comments about an item (comments); e-mail a record to themselves (e-mail this); view items checked out, requested, etc. (Your Account); and request an item to pick at a specific location (Request) (Bauer, 2008; Denton & Coysh, 2011; Emanuel, 2011; Ho, Kelley & Garrison, 2009). VuFind also has spell checking, "similar items" recommendation, similar item display based on title, tagging, commenting, user stored favorite lists, and sending search results via text message or email. Searching course reserves, call number and publisher name searching, limiting searched items by department library, and directly exporting to Refworks are currently unavailable in UIUC's VuFind. Given its capabilities and user-friendly interface, usage statistics between 2012 and 2014 show UIUC's VuFind to be the most preferred search system at the University of Illinois at Urbana-Champaign.

2.4 Online Catalogue User Studies

The study of users' information needs has a long history (Bawden, 2006; Wilson, 1981, 1994) characterized by the development of conceptual models to aid in the understanding of various aspects of human information behavior, with increasing sophistication and a plethora of variants and modifications (Bawden, 2006, p. 673). A large body of literature exists on online catalogues user and use studies (Majors, 2012). Most online catalogue user studies have focused on understanding the users' conceptual knowledge of the information retrieval process, their semantic knowledge of how to implement a query, and the need for technical skills required of the users to formulate a search statement in the language and syntax required by the system (Borgman, 1996b). Majors (2012) and Madhusudhan and Aggarwal (2011) provide an excellent review of the literature on a wide range of formal and informal user studies on next-generation catalogues. Using structured checklists designed based on previous literature, many other commentators have made comparisons to identify patterns between search features of vendor supplied online catalogues (Long, 2000; Moore, & Greene, 2012; Madhusudhan & Aggarwal, 2011; Tam, Cox & Bussey, 2009; Willson & Given, 2010); others have provided cues on the influence of the user's mental-models for the use and non-use of catalogues (Bauer & Peterson-Hart, 2012; Borgman, 1996; Preater, 2010); and others show the relationship between catalogue use that vary widely in background, age, academic level, subject interests, experience with computers and type of library (academic, public, school and special) (Ahmad, Mushtaq & Imran, 2012; Gallaway & Hines, 2012; Kules & Capra, 2012; Moore & Greene, 2012; Ruzegea, 2012). Online catalogue user studies draw many conclusions about the behavior and preferences of library users, and most of the time the literature has showed that these conclusions are contradictory or unclear (Borgman, 1996; Markey, 1984; Miksa, 2012). Miska observes that "user and use issues appear to have been addressed primarily through the various lenses of librarians' own experience and interests in libraries and their own sense of catalogue use skills, without a small use of deductive logic and anecdotal evidence to support their conclusions" (2012, p. 25).

The main objective of the literature review was to identify from past studies the features discussed, desirable feature identified, and methodology used. In summary, the analysis of faceted search interface of next-generation catalogues received the most attention. The features that keep appearing across the literature as desirable include: author, title, availability, location, format, subject, publication year, call number range, and geographical region (Bauer & Peterson-Hart, 2012; Kules & Capra, 2012; Niu & Hemminger, 2011; Ramdeen & Hemminger, 2012; Zavalina 2012). The features that appear as desired for classic traditional catalogues are categorized as: searching features, search limits and strategies, access points, bibliographic display, general customization, output/services/facilities/external links, user assistance features, page layout and text, labels and tags, and session filters (Preater, 2010; Ramdeen & Hemminger, 2012; Sauperl & Saye, 2009). There are similarities and differences among the features desired from next-generation catalogues and classic traditional library catalogues. The most desirable features of next generation catalogues noted by the current literature include: searching features - simple search box; access points - author, title, keyword anywhere, and subject; search limits and strategies - Boolean search (AND, OR, & NOT); bibliographic display - provision for bibliographic displays (short or/ and long display), author, title, call number, location, and table of contents; output - sorting by (author, title, relevance, classification, date of publication, format, ranks output by popularity, and subject heading); printing & e-mail; interlibrary loan; and user assistance and help.

A review of user studies literature on online catalogues and analysis of over 30 online catalogues from lib-web-cats, a directory of library web sites and catalogues worldwide, shows that second generation catalogues are characterized by text-based, automated circulation systems that includes patron access, known-item and subject searching with opportunities for interactive search refinement (post-coordinated searching), powerful Boolean search capabilities that are not easy to learn and use, complex interface mechanisms that require mastery for effective searching, and extensive help facilities to assist first time and infrequent users (Breeding, 2010, p. 8; Hildreth, 1985, pp. 40-41; Poo & Khoo, 2010; and). On the other hand, next generation catalogues are characterized by a natural, personal, and simple to use interface whose features are enhanced and new functions added (Breeding, 2010). Next generation

catalogues can be optimized for a library user audience, allowing ordering, and ranking and sorting of search results based on facets, FRBRization, search term recommendation, and personalization within a visually enriched display and connections to external applications.

2.5 Search Features

Search features are system features found on the systems' interface that are offered to searchers in support of their searching activities (Breeding, 2010, p. 11). The analysis of the literature review of this study groups search features into eight different categories: search, browsing, access points, interface, bibliographic display, output and external links, search limits, and user assistance. A detailed discussion of the scope of each of the eight search features and their relation to next-generation catalogues is useful to this research. The eight search features are discussed in the proceeding sections.

2.5.1 Overview: Search.

Search is a process of entering into the search box of a database or search engine search statements, keywords or making a search query with words relating to an information source's author, editor, title, subject heading or keyword (American Library Association [ALA], 2013, p. 6; Carter & Levine-Clark, 2013, p. 225). Next generation catalogues support numerous search options divided into basic and advanced search. The basic search constitutes a search by the traditional categories, while the advanced search is primarily keyword-driven and uses Boolean logic operators (AND, OR & NOT) that perform exact matching and require the search query to be specified as a Boolean expression (Poo & Khoo, 2010, p. 3953). Searching in next generation catalogues can take different approaches, because they are multiple ways within which a user can search. For example, a typical search may include the choice of keyword searching (e.g., searching for individual words in the title and subject fields) or field searching with automatic truncation (e.g., searching for a whole title or author name), the use of Boolean operators to combine two or more terms, the use of a truncation symbol, and limiting a search to specific fields (Skinner, 2012).

2.5.2 Approaches to Search.

From a historical standpoint, two fundamentally different search approaches are supported in online catalogues: querying and browsing (Hildreth, 1989, p. 11).

i) Querying: A query consists of a term(s) (e.g. character, number, word, or a phrase) and a query formulation or specification which defines how the component term(s) of the query are to be interpreted or related for matching purposes (Hildreth, 1989a). Query specifications are access points, e.g. keyword, author, title, subject, etc. (**Fig. 2.1**). Regardless of the manner in which the matching criteria are specified, query searching utilizes an exact matching (either phrase or keyword) function on the system. According to Hildreth (1991b), query searching is an appropriate, useful search option when the aim of the search is specific; the searcher knows precisely what is needed; and the request is expressed in the language of the database.

ii) Browsing: Browsing is a cognitive and behavioral expression of exploratory behavior. Commentators like Bates (1976, 1986, 1990, 2002, 2007), Bell (1991), Foster (2004), Foster & Ford (2003), Herner (1970), Kwasnik (1992), O'Connor (1993), Rice, McCreadie, and Chang (2001) and Toms (2000) argue that browsing, as an activity, engages a series of glimpses, each of which exposes the browser to objects of potential interest. Depending on interest, the browser may or may not examine more closely one or more of the (physical or represented) objects, which thus, depending on interest, may or may not lead the browser to (physically or conceptually) acquire the object. Browsing in online catalogues can take many forms, for example, display of ordered lists of terms, descriptors, and bibliographical records; Web-based, hypertext, and faceted navigation; field-directed (Author, Subject, etc.) browsing; FRBRization; and sorting and relevancy rankings. Browse searching is the most useful and preferred approach when the search aim is not specific (e.g. discipline, topic, type of publication, level of treatment, or perspective), the desired results are not known in advance, or the correct terms for representing the user's query are not known at outset (Markey, 1989). Both query searching and browsing

approaches assume that the user knows what they want and can describe it in the language of the OPAC being searched.

Traditionally, the process of searching follows a sequence of steps: the user must define his or her information need based on the problem to be solved; formulate and execute an initial search strategy; evaluate the initial results; and reformulate the search strategy as the search progresses (Belkin & Vickery, 1985, p. 114). There are two basic types of search performed by the users: specific item and subject searching. The distinction between these two types of searching is not clear because a single search often involves both types of searching (Poo & Khoo, 2010, p. 3954). However, these differ in respect to the criteria for judging search success and failure (Mitev & Walter, 1986). For example, a known-item search ends up as a keyword search when a specific item search fails to locate the desired item(s). In this case the search will return results that are related to the known-item search but not the exact search as expected.

2.5.2.1 Known item and subject searching.

Known-item (also known as “specific item) searching happens when the user is trying to search for a particular item whose details are known and/or the searcher has some information about, for example the author or words of the title. Known-item searching in NGC can be thought to be similar in many ways to the process of searching facts and concepts in a "factual database" like the encyclopedia (Bates, 1979, p. 209; Wildemuth, De Bliek, & Friedman, 1993, p. 533). The target of a search in a factual database is often a highly circumscribed set of subject areas, facts and concepts; whereas the target of a search in known-item searching is a more specific set of citations relevant to a query. Field directed search options might have important implications for the user’s success in locating the relevant items, the terms selected during the process of searching, and the efficiency with which the search can be performed.

Known-item searches succeed when the query terms are morphologically similar. They fail when cataloguers input incorrect citation information e.g. wrong initials, typos/misspellings, wrong titles, singular/plural, and word reversals, or the item is not in the collection (Yee, 1991, p. 17). Information

retrieval studies, and specifically catalogue research, consider success and failure of a catalogue in terms of whether or not an item was in the catalogue and, if it was, whether or not the user managed to find it (Hancock-Beaulieu, 1989; Mitev & Walter, 1986). Such a measure is geared to the assessment of the catalogue as a finding tool for known-item searches.

There is a general consensus in the literature that anywhere from 66% to 93% of users are successful in known-item searches with card catalogues, while the success rate with known-item searching in online catalogues ranges below 40.5% (Hunter, 1991, p. 399; Mischo, Schlembach, & Norman, 2009, p. 431). Based on patron responses in a 1983 survey of users' attitudes and behavior, conducted at twenty-two libraries, Matthews, Lawrence, and Ferguson (1983, p. 146) report that, 41% of the searches were known-item searches, and 59% of the searches were subject searches. Of the known-item search option, the title search option is more used than the author option, a fact confirmed by the transaction log study of Mischo, Schlembach, & Norman (2009, p. 431).

Keyword searching is when users input terms that the system uses to do a full text search to retrieve any item(s) on a particular topic or subject of interest. Studies of online catalogue searching show that: a) when a user doesn't know the elements that constitute a known item search they search with keywords; and b) keyword searches represent the simplest type of search and appear to have become the basis for subject searches (Hancock-Beaulieu, 1989, p. 30; Hunter, 1991, p. 396; Yee, 1991, pp. 11-12).

Poo and Khoo (2010, p. 3954) report on a nationwide survey of U.S. libraries in the early 1980s by Mathews, Lawrence, and Ferguson (1983) who found that about 59% of online catalogue use involves subject searches. Recent studies by Cherry (1992), Connaway, Budd, and Kochtanek (1995), Hunter (1991), Mischo, Schlembach, and Norman (2009, p. 431), and Wallace (1993), use catalogue transaction logs to report subject searching ranging between 35% to 60%. Poo and Khoo (2010, p. 3960) conclude that it is possible that the actual proportion of subject searching is even greater than reported because some of the keyword title searches actually represent subject searching. Across academic levels, studies by Connaway, Johnson, and Searing (1997) and Millsap and Ferl (1993) on OPAC use found that

undergraduate students tend to do subject searching, whereas graduate students and faculty tend to search by author or title, and do subject searching only when working outside their own fields.

The review of the literature by Yee (1991) found that the common failure for both known-item and subject searching comes when the item searched for is not in the collection, or contains nothing relevant. Accordingly, measuring retrieval effectiveness in online catalogues would be rendered very problematic because the system doesn't keep the user aware if the item exists or not. Additionally, not only are there problems in making relevance judgments on surrogate documents, the interactive nature of the search process, which allows reformulating the query, makes it very difficult to see how recall can be applied (Borgman, Hirsh, Walter, & Gallagher, 1995). Results from the analysis of catalogue transaction logs reported by Hunter (1991, p. 395) and Larson (1991) at North Carolina State University agreed with John Toile's 1983 landmark transaction log study that subject searching is the most often used, but least successful search. Larson (1991, p. 198) noted that subject or topical searches account for up to 59% of searching, and 43% of searchers report difficulty in formulating a subject search. More than two decades later, similar search behavior still exists among library users (Mischo, Schlembach, & Norman, 2009, p. 431).

In order to get a response in subject searching, the user has not only to specify their needs, but also to specify them in a way that matches the system, i.e. the user has to know what they want. In so doing, the user may find a book on a subject but it may not be what is really required or may only partially satisfy the user's search needs. In this case, retrieval effectiveness is based on the concept of relevance and the measures of recall and precision (Hancock-Beaulieu, 1989, p. 28; Larson, 1991, p. 213; Wildemuth, De Bliek, & Friedman, 1993, p. 534).

Subject searching succeeds when a substantial proportion of the retrieved items are about the subject described by the query. Degree of success is measured in terms of precision and recall -- the two most well-known traditional measures of effectiveness (Su, 1994, p. 207) -- generally used to evaluate differences in search performance (Wildemuth, De Bliek, & Friedman, 1993, p. 533). Precision is defined as the proportion of the retrieved documents relevant to the query; and recall is the proportion of the

relevant documents retrieved by a particular query (Wildemuth, De Bliek, & Friedman, 1993, p. 533; Su, 1994, p. 208). Failure in subject searching may be caused by: inappropriate terminology resulting from poor subject knowledge; misconceptions of the way subject content is described; inadequate subject descriptions; or catalogue collections containing nothing relevant (Hancock-Beaulieu, 1989, p. 31; Larson, 1991, pp. 207-10; Slone, 2000, p. 760; Wildemuth, De Bliek, & Friedman, 1993, p. 534). For example, Hancock-Beaulieu (1989) notes that in online catalogues, subject access is limited by the structure of the MARC record and how it is indexed and searched. Subject searching is dependent on titles and subject headings, which provide few searchable terms compared with the abstracts and subject descriptors of information retrieval systems (Blecic, et al, 1998, p. 43; Larson, 1991, p. 208).

Researchers like Hancock-Beaulieu, (1989), Hildreth (1989a), Larson (1991), and Mitev and Walter (1986) emphasize that the combination of pre-coordinate indexing of subject headings and the post-coordinate indexing of keywords can cause much confusion for the users when the number of non-relevant documents exceeds the number of relevant documents retrieved. That is, precision is not significantly correlated with the user's judgment of success. Users appear to be more concerned with absolute recall than with precision. This review of the literature on keyword, known item, and subject searching shows that no format of searching is most successful in retrieving the needed records from the library catalogue. Do the search options meet the needs of a wide spectrum of users?

2.5.2.2 Search using bibliographic fields.

The online catalogue indexes and searches bibliographic record fields. This permits a user to specify queries such as keyword, author, title, and subject that define how the component term(s) of the query are to be interpreted or related for matching purposes (Carter & Levine-Clark 2013, p. 4; Hildreth, 1991). Next generation catalogues provide bibliographic details as - expanded and augmented entry points. Other indexed fields may include user contributed content and social features such as reviews, rankings, and tags. These fields support querying, browsing, known-item and subject searching, and keyword searching as discussed above. For example, a user searching for a known item will enter in either keyword, author, title, or subject. Based on the query entered the searcher will select a

corresponding field of the bibliographic record to direct the system to search within the indexed terms of that field. If the title details are entered, the searcher will select the "Title" field on the access points to direct the system to search title entries indexed. Bibliographic display is the layout of the structure of the bibliographic record mapped from the MARC fields to locally defined labels and presented in a predefined order (Wool, 1996) – next generation catalogues have multiple display formats – short and long display. Thus, bibliographic display is measured against visual design.

Visual design refers to the page layout at each step during the search process and to how visual design facilitates the use of the catalogue. Tague suggests that "at any point in time, the system should recognize the user's state of knowledge about its language and provides appropriate displays" (1989, p. 38). In doing so, the system gradually teaches the user its language, and the user becomes very knowledgeable and efficient. In an adaptable visual interface, appropriate systems feedback represents the system's understanding of the user's natural language input, without necessarily the user learning how the system is translating the user's input.

2.5.2.3 Refining search using facets

Search limits or filters refer to search features that allow searchers to narrow a search by author, subject, title, call number, or other specialized system limits like: publication date, version, language, and formats and media. Within NGC, facets represent search limits. A facet is "a generic term used to denote any component of a compound subject, also its ranked forms, terms and numbers" (Ranganathan, 1967, p. 88, as cited in La Barre, 2006, p. ix). Facet research has been fundamental in NGC research, specifically browsing and navigation, relevance ranking, interface design, bibliographic display, output, and search limits. Hjørland, (2013) notes that the strengths of the faceted approach lie in its logical principles and the structure it provides to knowledge organization systems. His primary objection is that facets seem to be based on the problematic assumption that relations between concepts are a priori and not established by the development of models, theories and laws (Hjørland, 2013, p. 545).

Facets as used in faceted search systems are filters that allow users to navigate information along multiple paths corresponding to different orderings of the facets. In this case, the hierarchy of categories

is unfixed and changing, that is, once information is categorized using multiple facets, it can also be retrieved using multiple facets. The facet-analytic paradigm is probably the most distinct approach to knowledge organization within LIS, and in many ways it has dominated the modern classification theory (Hjørland, 2013, p. 345). The basic idea of faceted classification goes – according to Schulte-Albert (1974, as cited in Hjørland, 2013, p. 346) – more than 300 years back. Within LIS, facet research has been fundamental in online catalogue research, specifically browsing and navigation, relevance ranking, interface design, bibliographic display, output, and search limits.

Historically, facet theory was mainly developed by S. R. Ranganathan and the British Classification Research Group, but it is mostly based on principles of logical division developed more than two millennia ago. Colon Classification (CC) and Bliss 2 (BC2) are among the most important systems developed on this theoretical basis, but it has also influenced the development of other systems, such as the Dewey Decimal Classification (DDC), and it is also applied in many websites (Hjørland, 2013, p. 346; La Barre, 2006). In relation to documents and users, facets represent the categories, properties, attributes, characteristics, relations, functions, or concepts that are central to the set of documents or entities being organized and which are of particular interest to the user group for whom a particular resource is being created (Fagan, 2010, p. 58; La Barre, 2007, p. 82). Hjørland (2013) notes that the strength of facets approach is its logical principles and the way it provides structure in knowledge organization systems (KOS). However, its shortcomings are the lack of empirical basis, and speculative ordering of knowledge without basis in the development or influence of theories and socio-historical studies. Facets are used in faceted search systems to allow users to navigate information along multiple paths corresponding to different orderings of the facets. In this case, the hierarchy of categories is unfixed and changing, that is, once information is categorized using multiple facets, it can also be retrieved using multiple facets. This research will look at facets as browsing and navigational features of the NGC. Specifically, how facets are selected and used by graduate students in their tasks as implemented in VuFind at UIUC is studied.

2.5.3 Interface considerations.

The components of the user interface include the menu, layout, and controls represented as text and/or images that allow a user to interact with the contents of the online catalogues (Carter & Levine-Clark, 2013, p. 264). An online catalogue that is responsive to user needs is one that focuses on discovering and responding to users' queries as they evolve through the search process and helps the user explicitly formulate a statement of their needs. Sometimes humans and not machines function as interface, for example a librarian that stands or mediates between user and knowledge resources in the information system, thus providing the "interface" between the two components. In the absence of the librarian, the user deals directly with the interface of the information system. For the user to benefit from the knowledge resources, the NGC interface must act "intelligently," in the sense that it will accomplish the same functions (simulate the functional behavior) that a good human intermediary (librarian) would in the same situation (specific user, context and problem, and specific knowledge resource) (Brooks, Daniels, & Belkin, 1985, p. 191). In order for the discovery system to be responsive to the user's needs/queries, the user must be able to state their needs more specifically than when one talks to a librarian at the reference desk. Whatever query is specified must be rigorously accurate and all assumptions must be expressly stated.

In this case, what would a responsive catalogue interface do? Research by Brooks, Daniels, and Belkin, (1985) suggests that the interface should determine the users' goals, which might be short or long term, e.g. a user intends to begin or finish writing a thesis or a short term paper. Within this situation, the NGC should be able to perform the following functions, which previously required a librarian to mediate:

- The intermediary needs to know that users generally have certain types of goals or intentions.
- The interface should determine the status of the user, which could have infinite classification, for example, academic or non-academic. The catalogue will begin to formulate the hypothesis about the user's state of knowledge of the subject, their prior reference and catalogue use experiences. In order to be able to determine the user status, the intermediary must be aware of

the potential range of categories according to which users can be classified, and this will vary according to the particular library in which the NGC is employed.

- NGC should be able to determine the background of the user, for example field of employment and place of residence, which could be directly related to their current information problem, thus beginning to formulate hypotheses regarding the user's state of knowledge.
- Determining the user's familiarity with information retrieval system would help the system to generate appropriate explanations so that the user can participate usefully in the negotiation.

In 1988 Yee (1991) reviewed 310 publications spanning a period over four decades (1945-1987) on online catalogue users' needs and interface design effectiveness. In this review, Yee reports user problems that have continued to affect the catalogue responsiveness to users' needs as: difficulty matching subject with natural language terms; trouble interpreting output formats and manipulating search results; systems failing to differentiate between keyword and phrase search, e.g. use of non-distinctive or stop words; failure to interpret the cause and meaning of errors: e.g. errors due to typos, misspellings, incomplete or incorrect citations or items missing from collections; limited knowledge of controlled vocabulary and free text search; problems with word-spellings: e.g. abbreviations and initials, spacing and hyphenated words; navigational and search procedures challenges; user unawareness of search functionalities; and difficulties with Boolean logic. Many of the difficulties reported by Yee and other commentators are related to the problem of matching user queries to system controlled indexed terms. Many of these problems are still common among second generation catalogues; however, the features and functions of NGC aim to provide solutions to most of these challenges (Breeding, 2010).

2.5.3.1 Contextual assistance.

Contextual assistance, also referred to as context-sensitive help, is a type of online help or support obtained by searchers or users of a software at a specific point in the state of the software, providing help for the situation that is associated with that state (Grossman and Fitzmaurice, 2010). Context-sensitive help, as opposed to general online help or online manuals, doesn't need to be accessible for reading as a

whole. Each topic is supposed to describe extensively one state, situation, or features of the software. Contextual assistance is a general term for guided assistance that includes all forms of help available to the users of online catalogues, like online help, procedural help, and/or tutorial information. User assistance refers to the help messages, personalization, and customized settings and logins and registrations offered by online catalogues. User feedback is key to catalogue user assistance. Hildreth defines feedback as "monitoring user activity on an online catalogue and giving real-time feedback to the user during the actual search session to assist in the formulation of the query or interpretation of the search results" (1984, p. 41). This kind of back and forth user-system negotiation forms part of the system-user feedback process and is still very much system oriented. Next generation catalogues offer directory-based help messages, search/display "how to" options, search term recommendations, auto-complete, "more like this" recommended related resources, and RSS feeds (Grossman and Fitzmaurice, 2010). Interaction through feedback is a two-way process, influencing user behavior to suit what is best for the system, while the user feeds back to the system so that the system performs in a way that is best for the user (Hancock-Beaulieu, 1989). If the user wants something slightly different or related, the system interface should provide the necessary links interactively (Grossman and Fitzmaurice, 2010).

2.5.4 Output and contextual links.

Output and external links refers to the format, field and order in which search results are displayed on the interface of online catalogues. Within NGC output is the external links referred to as application programming interface (APIs). APIs are a set of routines, protocols, and tools connecting with the external applications. Currently NGC offer the following outputs: systematic ordering, relevance ordering, and multiple formats. In catalogues, cross-references represent a way of jumping out of the sequence, and over to related areas within the interface (Breeding, 2010, p. 26; Hildreth, 1989b, p. 10). Cross-referencing leads to an increase in recall (the ratio of the number of relevant records retrieved relative to the total number of relevant records in the catalogue) without decrease in precision (the proportion of relevant records in the retrieved set) (Walter, 1989, p. 96). Cross-referencing techniques may include synonym approximation and relationships between words and phrases, such as subject

headings, keywords, and author names. Cross-references are implicit, and users are not made aware of them (Walter, 1989, p. 97). Like in some second generation catalogues, NGC offer hypertext operations, and connections with external applications such as Application Programming Interfaces (APIs), as a set of routines, protocols, and tools connecting with the external applications (Breeding, 2010, p. 20), which permit navigation within and throughout the NGC interface in many different directions. Furthermore, highly navigable interfaces decrease error rates and learning time, while increasing performance and user satisfaction. APIs are about networks of linkages between related terms and items throughout the catalogue interface, as well as discovery pathways and trails (Hjerppe, 1989, p. 181).

2.6 Relevance

Relevance is the interpretive connection that is made between the observed pattern and the context of the observation; it takes into account the context of the message; and is equated to aboutness and topicality (Case, 2012, p. 105; Park, 1993, p. 319). Barry and Schamber (1998 p. 234) and Park (1993, p. 320) observed that users' relevance evaluations depend on their individual perceptions of their problem situations and the information environment as a whole, and that their perceptions encompass many factors beyond information content. For a document to be useful it must have a bearing on a user's particular situation (pertinence); thus, pertinence is assessed subjectively by the user. Barry and Schamber, (1998, pp. 223-33) provide a detailed analysis of criterion categories to relevance judgments that includes information need situations, user environments, and types of information. In information seeking, access, and discovery, relevance is manifested in a judgment of the quality of the relationship between a user's information problem and the information itself, or between representations of problems and information. Thus, relevance is: cognitive and subjective depending on users' knowledge and perceptions; situational, relating to users' information problems; complex and multidimensional, influenced by many factors; dynamic, constantly changing over time; and yet systematic, observable and measurable at a single point in time (Barry & Schamber, 1998, p. 221).

Unlike the Classical traditional catalogue where ranking of search results is based on the frequency and positions of terms in bibliographical records during keyword searches, advocates of the next generation catalogues shift away from a systems or mechanical term-matching view of relevance to a cognitive and dynamic process that involves all of the knowledge and perceptions that the user brings to the information problem situation. Moving in the direction of the current research, Taylor's User-Value-Added Approach reaffirms that relevancy is a cognitive and dynamic process affected by educational background, familiarity with the subject area, and the user's intuitive sense of analogy. Ranking results by relevance, clustering results and enabling faceted navigation would allow all users, despite their education level, experience with searching, and research topic, to drill quickly through the results and recognize the most relevant titles (Mercun, & Zumer, 2008, p. 247). Serendipity, federated search, recommendations on related materials, and enriched content are features that will add additional value to the online catalogue.

To improve relevancy in next generation catalogues, Blenkle, Ellis, and Haake (2015) suggest user contributed content such as ratings, reviews, comments, and tagging, as important indicators for use and which can be used in relevancy ranking. User contributed content is considered useful for catalogue users to take steps to construct sense in constantly changing searching situations (Dervin, 1983, 1999); and acknowledges that people see different things in messages and their reactions differ according to the system's feedback (Farradane, 1979). In response to indexing of user-contributed content, Farradane suggested and developed greater indexing procedures termed "relational indexing (RI)" based on analysis of thought processes drawn from cognitive psychology. The main purpose of relational indexing is to achieve greater exactitude, in the depth of indexing and the structuring, or interrelation of the words used, so that matching will be more exact (Farradane, 1979, p.16). The efficiency of retrieval in online catalogues depends entirely on the accuracy of the indexing process and consistency in choice of indexing words, and this accuracy also relys on the indexing of the question. Indexing of contributed content helps to deliver user-friendly results in significantly expanded indexes and can clearly improve library search for untrained users (Blenkle, Ellis, & Haake, 2015).

The number of times that an item has been checked out [*which Yang & Hofmann (2010) consider popularity*] can also increase the relevance of a title. Furthermore, relevance can be boosted in accordance with the number of items held by the library; in indexed bibliographic metadata, for instance, ranking could be provided for a certain target audience, based on whether an item is classified as an introduction to a subject (Christensen, 2013). Next-generation catalogues do better in relevancy ranking with increased precision, i.e. by sorting search results so that those documents which are most likely to be relevant to the search query are shown at the top and organized into different categories. In addition, circulation statistics should influence the relevancy results. More frequently circulated books indicate popularity and usefulness, so they should be ranked higher in the display. Items deemed important enough to have multiple copies should also receive higher relevancy ranking

The bibliographic record contains data elements that link it with associated and possibly relevant records (authors, call number, series title, and subject headings). These linkages are not exploited in second-generation online catalogues. A single, relevant bibliographic record may serve as the "jumping-off'' point for browsing a selected portion of the shelves, or it may be the point of departure for finding related materials. The user may wish to say, after viewing a bibliographic record, "I want more like this". The system could then use any of several methods to retrieve related records, including gathering all records in the database assigned one or more of the same subject headings or the same class number as the initial record. With a bit more design sophistication, the system could ask the user which data element in the displayed record (e.g., personal name, series title, specific subject heading, etc.) should be used as a gateway to related records (Yang & Hofmann, 2010).

2.7 Conclusion

The dissertation research reflects on user experiences and perceptions that have an inherently tacit dimension (Haynes, Purao, & Skattebo, 2009). The user's tacit knowledge, which this research explores, was established by observing graduate student interactions with a VuFind catalogue installation, and the difficulties they encountered. Measuring how users understand and use the search features of VuFind

involves a fuller understanding of what search features graduate students select, as well as involves the need to assess how user tasks influence the selection of system features. This research is not about evaluation of online catalogue technology, but rather the strategies searchers use to search for a known item, express a search need into subject terms, formulate a need through a known and appreciated item, and express a need associated with a known set of documents.

Chapter 2 Table

Table 2.1. Comparing Search Features of Second and Next Generation Catalogues

	Overlapping features	**Unique features**	
Category		**Second Generation Catalogues**	**Next generation catalogues**
Search	•Basic and Advanced search, •Boolean search (AND, OR, & NOT) (Nowkarizi, 2008)	•Search-term approximate – match routines (Nowkarizi, 2008)	•Enhanced searching (Functionality & Usability), •Metasearch functionality •Federated searching (Major, 2012; Skinner, 2012)
	•Field directed searching (Nowkarizi, 2008)	•Metadata-based indexing and searching (Moore & Greene, 2012)	•Deep indexing (Skinner, 2012) •Integration of free & full-text, and controlled vocabulary searching (Breeding, 2010)
Browsing	•Web-based, hypertext & backward and forward navigation	•Field-directed e.g. Author, Subject, etc. (Hildreth, 1995b)	•Faceted navigation •Search box on every page (Breeding, 2010)
Access points	•Multiple access – e.g. Keyword, Author, Title, & Subject (Moore & Greene, 2012)	•Standard item bibliographical details (Ramdeen & Hemminger, 2012; Ruzegea, 2012)	•Expanded and augmented entry points •User contributed content/Social features (e.g. Reviews, Rankings, & Tags) (Breeding, 2010)
Interface	•Text and image based (Kules & Capra, 2012)	•Functionally plain, & primitive appearance (Breeding, 2010)	•Visually appealing & intuitively functional •User centered design (Breeding, 2010)
Bibliographic display	•Multiple display formats: Short & Long; and MARC & User structured formats	•Library terminology & language (Ahmad, Mushtaq, & Imran, 2012; Majors, 2012)	•Visually Enriched content & user terminology (Skinner, 2012)
Output and external links	•Ordered results lists – sorting & relevancy ranking options •Multiple output formats •Interlibrary loan and circulation functionality supported	•Alphabetically ordered by author or title; & Chronologically systematic •Print, Save, E-mail, & Texting (Kules & Capra, 2012)	•Relevancy ranked results (Moore, & Greene, 2012) •FRBRization •Tag clouds (Breeding, 2010) •Favorites, Connections with external applications e.g. Application Programming Interfaces (APIs)
Search limits	•Search history, & strategy displayed	•Metadata-based limitation	•Faceted limitation – e.g. Format, etc (Breeding, 2010; Major, 2012; Skinner, 2012)
User assistance	•Help messages •Personalization & customized settings/ logins and registration (Major, 2012; Skinner, 2012)	•Directory-based help messages •Search/ display “how to” options (Breeding, 2010; Major, 2012; Skinner, 2012)	•Search term recommendations •Auto-complete •“More like this”: Recommended related resources •RSS Feeds (Major, 2012; Skinner, 2012)

CHAPTER 3

RESEARCH DESIGN AND METHODS

3.1 Introduction

The research design is intended to gather detailed and in-depth qualitative data to provide an initial stepping stone on a path to better understand a) the features of VuFind that graduate students use to complete specific types of information tasks; and b) how graduate students understand the function of VuFind's features. This exploratory empirical research seeks to provide insight into how graduate students interact with the VuFind installation at UIUC; particular attention is on the system features used by the sample population during a set of information seeking tasks. To explore the features of VuFind that graduate students use to complete specific types of information tasks, the research used a set of procedures - task analysis, user testing, and individual discussion - in a process referred to as critical incident technique. Audacity audio recording software was used to collect audio recordings during task analysis and individual interview/discussion; while Camtasia screen capture software was used to record screenshots and audio recordings during user testing. Scenario-based technique guided the development and description of the information tasks.

In summary, this chapter gives detailed discussion of the research design and methods including a discussion on: IRB, the study population and sample size, the data collection tools and methods, the information tasks, Camtasia, usability laboratory, the data collection instruments (interviews and individual discussion), data analysis, graduate students case study, the data collection approaches (tasks analysis, user testing and individual interview) and critical incident technique. The data collection process proceeds in three steps: First, graduate students described a search process based on a set of information tasks to be performed – task analysis; second, participants performed the information tasks on UIUC's VuFind as earlier described - user testing; and lastly undergone individual discussions to provide explanations for the participants' actions and behavior during task analysis and user testing. The data collection process began with recruitment of the participant. The complete process of analyzing the

findings revolved around identifying, defining, and creating relationships among the terms or words from the transcripts and thereafter making comparisons between the identified terms. The coding was guided by the search features outlined in **Table 2.1, Section 2.7** as will be discussed in later sections. The analysis revealed the features of VuFind and other search tools that graduate students used to complete specific types of information tasks. Further the research uncovered how graduate students understand the function of VuFind's features and their search behavior.

3.2 Statement of the Problem

One critical problem facing libraries today is gaining better insight into how users interact with systems, especially before and during using the systems and their thoughts after the search process. The question is how do graduate students use the VuFind installation at UIUC? There is a lack of consensus as to what function of NGC support searchers to complete specific types of information tasks; and how well they understand VuFind's features. Analyzing the data collected from participants' description of their searching episodes [*task* analysis] and data collected from user testing will provide evidence of the features graduate students use to complete specific information tasks. Comparing the data collected during task analysis, user testing, and individual interviews will help the researcher to understand how well graduate students understand VuFind's features. Therefore, three types of date will be collected: task analysis, user testing, and individual interview data.

3.3 Research Questions

In order to achieve the research goal of improving the understanding of users' search strategies and behavior, there is need to study how graduate students interact with the VuFind installation at UIUC with the hope that the data can influence future design for library online catalogues and discovery systems. The key questions guiding the research design include:

RQ1: What features of VuFind do graduate students use to complete specific types of information tasks?

Task analysis and user testing procedures were used to identify features of the VuFind installation and those of other Web applications that graduate students planned to use and did use to complete specific types of information tasks respectively. The main goal of RQ1 was to identify which search features of the VuFind installation at UIUC graduate students use to complete specific types of information tasks. This includes identifying the most and least used features with particular focus on search and browsing approaches, access points used, interface and bibliographic displays, output and external links, search limits, and user assistance.

RQ2: How well do graduate students understand VuFind features?

Comparison of task analysis and user testing data enhanced with individual discussion will guide the research to understand how well graduate students understand VuFind features. RQ2 was focused on discovering how well graduate students understand the function of VuFind's features. This includes not only what users perceive as the system features available for use in a given task are and what purpose they serve, but also how these understandings are arrived at and how they are interpreted in different contexts. The comparison of the data collected using the three data collection methods (task analysis, user testing, and individual interviews) were used to answer RQ2.

3.4 Research Design

This research is twofold: a) to improve our understanding of users' search strategies and behavior; and b) to provide insight into which catalogue features graduate students use, and the extent to which they understand these features. This section gives a detailed discussion of how the researcher planned to engage 14 graduate students at the University of Illinois at Urbana-Champaign in a user study, including how the participants were selected, the instrumentation plan, and the methods used for the development, implementation, and testing of next generation catalogues, i.e. user testing, think-aloud protocols, usability testing, focus groups, interviews, and user surveys, as well as task analysis used outside LIS to break users' goals into sub-tasks and actions.

3.4.1 IRB considerations.

The researcher obtained approval from the University of Illinois Institutional Review Board (IRB) to conduct research involving human subjects. The IRB office reviewed all the data collection instruments including the call for participation; data collection instruments - survey, task analysis and user testing briefings, and individual discussion; and research study consent form. The IRB committee further checked and approved plans for data storage, backup and security, access and sharing concerns, privacy of participants, and ethical conduct of the researchers. Before taking part in the study participants were briefed about the research and asked to consent before starting. Since this was a user study, there are no known risks of participating in this study, beyond those experienced in everyday, ordinary life.

3.4.1.1 Storage, backup, and security.

The data were stored on the researcher's laptop computer, which is secured with a login password known only to him. Only the researcher has access to the password, and therefore to the laptop computer. Data files, such as screen recordings, audio interviews, and transcripts from the task analyses and coding were kept on this computer. No identifiable data, such as names, addresses, or telephone numbers of the participants were recorded. An external backup drive was designated for this research project and kept in a locked cabinet in the researcher's house. Backed-up data on the personal external drive was uploaded and stored in a folder on the University of Illinois Box cloud storage system, and was accessible only by the researcher and by the research advisor using their campus active directory system login. The researcher was responsible for the data throughout the data life cycle.

3.4.1.2 Access and sharing.

The survey will ask the participants to provide their preferred form of contact, i.e. either their e-mail or telephone number. The main purpose is to send to them a reminder prior to the scheduled appointment. The e-mail and telephone contacts will be used strictly for reminding the participants about the scheduled meeting but not in any way to collect responses concerning the research or as part of the data analysis. The e-mail and telephone information will not be used in the analysis of the survey results.

To protect the participant's privacy, the researcher will expunge all the contact information on the survey immediately after the participant has reported for the study. This is because the participant's contact information is rendered irrelevant after they have reported. Upon finishing the survey analysis all the survey forms will be shredded and the shreds dissolved in water for one week before disposing them. Apart from e-mail or telephone number participants will not be required to provide any other biographical, professional, or any personally identifiable information. In doing so, their confidentiality was maintained. The data collected will only be accessible to the Advisor and the researcher, and will be strictly used for the purposes of writing this dissertation and any publications in future.

3.4.1.3 Ethics and privacy.

Apart from either telephone contact or e-mail information, no other biographical and professional data will be taken from the participants during the data collection process. In the analysis and reporting of the data, pseudonyms will be used for individual comments in the dissertation, and in any publications in the future. The University of Illinois Institutional Review Board (IRB) has approved the data collection methods, the storage of data, and these privacy checks. For all the participants, signed written consent forms will be obtained. Since this is a user study there are no known risks of participating in this study, beyond those experienced in everyday, ordinary life. It is hoped that system designers, LIS researchers, vendors, and all of academia will get to know, understand, and appreciate the guidelines for developing features of next generation catalogues, and then work towards improving and making the library catalogue stronger. Thus, the benefits of this research outweigh any known risks.

3.4.2 Population.

Users of the library catalogue can be categorized by age, academic level, library type, or specific job tasks such as library staff. The study population for this dissertation will be graduate students at the University of Illinois at Urbana-Champaign who will be selected based on their academic level (Long, 2004; Patton, 2002; Vogt, 2005). Although the researcher will not specifically aim to recruit a diverse sample of graduate students, conducting this research at the University of Illinois will allow the

researcher to tap into the diverse cultural background and academic experiences of the university community. University of Illinois at Urbana-Champaign will be selected as the study center and from which to select the study population because: a) the UIUC Library is the second largest academic library in the world with over 24M items, both print and electronic, all searchable in VuFind; b) the library catalogue receives over 1M visits every week thus it is highly possible to get participants with experience using the library catalogue from the selected population; and c) the library system has over 20 area studies libraries and this increases the possibility of recruiting academically diverse sample of participants (University of Illinois, 2016).

Library and information science researchers have used different categories of academic library users to study different phenomena of library use. The use of graduate students in user studies is not new, for example Liu and Yang (2004) studied the factors influencing graduate students' use of information sources in their distance education; Liao, Finn, and Lu (2007) compared the information seeking behavior of international graduate students and American graduate students at Virginia Tech; Liew, Foo, and Chennupati (2000) explored graduate students use and perception of electronic journals; Liu and Winn (2009) examined the information seeking behaviors of Chinese graduate students at the University of Windsor, Canada; Liu (2006) explored the extent to which graduate students in a metropolitan university setting use print and electronic resources; and Cothran (2011) quantitatively examined graduate students' acceptance and use of Google Scholar. This dissertation research will explore search strategies and behavior of graduate students at the University of Illinois at Urbana-Champaign because:

- Similar studies have used graduate students as a study population and the likelihood of succeeding with this population of library users is high for this dissertation;
- Unlike undergraduate study, graduate studies require students to engage in intensive research activities and therefore the possibility for them to have used library tools like VuFind and other Web applications is high. Therefore, graduate students would make a good study sample;

- Graduate students are expected to have a long history interacting and using Web applications and library tools like library catalogues thus having strong knowledge and skills using search tools;
- With a population of over 10,000 graduate students, the likelihood of getting a participant with preferred experience with online catalogues and Web application is high;
- The researcher assumed graduate students will have strong experience using library resources as well as familiar with other Web applications;
- The researcher is a graduate student at the University of Illinois at Urbana-Champaign and therefore can easily identify with participants through contact with friends;

3.4.3 Sample.

This research will snowball (Holstein & Gubrium, 1995; Patton, 2002) sample graduate students at the University of Illinois at Urbana-Champaign with at least one year of graduate coursework training. The snowball sampling technique is similar to the reputational sampling strategy, which is an approach for locating information-rich key informants, or critical cases (Holstein & Gubrium, 1995; Patton, 2002). By snowball sampling, the researcher will assume that the participants fitting the sampling criteria are aware of others with similar characteristics (Holstein & Gubrium, 1995; Patton, 2002). Thus the initial graduate students will generate leads for future contacts that will be screened using a survey (**Appendix A-1: *Participant Recruitment Survey***) for inclusion in the sample. When the list of graduate students identified and interviewed reach five, the researcher will start to construct a chain of probable future participants from the data supplied by cooperative participants (Holstein & Gubrium, 1995; Patton, 2002). Formal and informal communication linkages between interviewees and prospective participants will permit efficient identification of appropriate participants. Snowball sampling is limited by the bias inherent in the respondent selection process, which may cause any estimates derived from the sample to contain a systematic bias. This bias originates from the fact that participants with a high visibility, or those acquainted with more people have a greater probability of being selected than does as social isolate.

To eliminate this bias, the researcher will ensure that at least five participants from each of the four recruitment procedures (**Appendix A-5-6)** – by posting a notice board advert, e-mail via the GradLinks, graduate student e-mail list, talking to students reading from the library, and contacts through friends – will be selected. In this case if a participant is identified through GradLinks e-mail such participants will be requested to identify other participants within their own networks. A total of 14 graduate students (Johnston, Salaz, & O'Connell, 2013) with demonstrated catalogue and Web applications experiences – referred to as information-rich (Patton, 2002, p. 246) – will be located through recommendation from those with whom the researcher has established a relationship. While the researcher will be interested in students with demonstrated knowledge and skills in catalogue and Web applications, librarians, library and information science (LIS) students, or participants with any LIS training will be eliminated from this study because: to a larger extent librarians and LIS students are catalogue enthusiasts and search experts (Noble & O'Connor, 1986, p. 610); they are advocates of catalogue use; they are passionate about the catalogue as a work tool, and as a result might possess extremely positive or negative attitudes that would bias the research data (outliers). Nevertheless, this special group of users (librarian and LIS student practitioners) could be used as a control group. However, this kind of comparison is outside the scope of the study.

The number of participants used in user studies varies but overall the sample size is relatively small. For example, Nielsen (2000) and Nielsen and Landauer (1993) claim that 5 users are enough to catch 85% of the problems on practically all Web sites, and as the number of participants increased, the additional usability challenges discovered per participant decreased. The study has been accepted as an industry standard (Nielsen and Landauer, 1993; Tan, Liu, & Bishu, 2009, p. 622;). However, Spool and Schroeder (2001) in their user testing study on a Website with 49 participants reported that 5 users could only find 35% of the problems. Woolrych and Cockton (2002) reached similar conclusion. The level of expertise of the participants is a very important factor in the 5 users number (Nielsen and Mack, 1994; Tan, Lui & Bishu, 2009). In summary, considerable confusion exists in literature on the relative number of participants needed for a user testing experiment (Tan, Lui, & Bishu, 2009). It is a fact that the results

of the user testing are affected by the methods used, the number of participants, the scenarios used, and the expertise of the participants.

As reflected by the literature referenced earlier and as observed by Emanuel (2011, p. 46), the researcher will seek a diverse sample and will accept at least two participants from any seven subject specializations [*whichever seven came first*] to make a total of 14 participants. Unlike Emanuel, who accepted to use the first five participants from her three categories of participants to make a total of fifteen participants to achieve a diverse sample, in this research the researcher will aim to have a number greater than five because of Jakob Nielsen's statement that five users will find 85 percent of usability problems, notwithstanding that other authors have refuted this finding and proposed a number greater than five if participants are carefully selected. A sample size of 14 graduate students will be selected because: a) the likelihood of getting novel results after the 15th participant will be minimal; b) there is a high level of homogeneity in the population sample (Patton, 2002, p. 243); c) selection of participants is limited by the snowball sampling but the biases will be addressed as discussed in the latter paragraphs and the population sample is information-rich (p.243); d) there are no special interest groups that require intensive study; e) there are no multiple samples within the study group that would require equal treatment; f) three data collection methods will be used (task analysis, user testing, and individual discussion), g) availability of the participants, and h) budget and time resources as will permit (Holstein and Gubrium, 1995, p. 74; Patton, 2002, p. 246). The researcher will attempt diversity in academic discipline, age, and sex based on researcher's judgment (Patton, 2002, p. 244) but no conclusions will be made based on these three parameters.

3.4.4 Data collection and instrumentation.

The instrumentation plan is composed of a number of decisions made before beginning the study. These decisions are made to determine what data is needed to answer the two research questions (Blankenship, 2010). The key decisions made as part of the study's instrumentation plan include: how to gather the data, when to gather the data, where to gather the data, and how to analyze the data. Answering

these questions will guide the progress of the study to the ultimate goal of answering the research questions.

In order to select the right data for this study the research will need to define what data is needed to be gathered to improve our understanding of users' search strategies and behavior. Participants will be asked to complete specific types of information tasks using a search tool like VuFind. This will help to gather data to show the specific features of the VuFind installation which were used to complete specific types of information tasks. for examining how graduate students understand the function of VuFind's features, interview data is needed to fully understand the reasons in the decision-making process. By using the interview process, the researcher will engage graduate students into a two-way conversation in order to explore the reasons for their choices. This type of data will be very comprehensive in exploring the decision-making process, and it is more effective than looking at only one or two variables (Blankenship, 2010).

The next question is how the data will be collected. The literature shows that researchers in library and information science use a variety of different methods to study the broad scope of information behavior studies, including user testing, focus groups, and user surveys (Chambers, 2013, p. 4). Therefore, the researcher plans to gather qualitative data using a set of procedures – a survey, task analysis, user testing, and individual discussion (Hughes, Williamson, & Lloyd, 2007, p. 50; Serenko, 2006, p. 1086).

As will be described in the later subsections, data collection will start with participants responding to a survey. In the survey participants will self-rate their experience with using library catalogues and other Web applications. This process will take at most two minutes of the participant's time. The second part of the data collection is task analysis, i.e. participants will be asked to describe how they would go about searching for information materials to answer the four information tasks [***information tasks will be discussed in detail in section 3.3.11.1 Information Tasks***] using UIUC's VuFind or any system of their own – how they have done it in the past. This process will take between ten and fifteen minutes of the participant's time. In the second phase participants will be asked to perform

actual searches using UIUC's VuFind or any search tool of their own while thinking aloud for the same information tasks – user testing. This time the information tasks will be reordered to minimize any chances for the participants to memorize and duplicate their earlier description of the same tasks during task analysis. If allowed to memorize and duplicate these processes would compromise the validity and reliability of the data collected during user testing. User testing will take between twenty and thirty minutes of the participant's time. Lastly, the researcher will engage each participant in an individual discussion to explain how they understand the function of VuFind's features. The individual interview will take less than five minutes.

3.4.4.1 Survey.

The main purpose for the survey [***Appendix A: Data Collection Instruments, Appendix A-1: Participant Recruitment Survey***] is to guide the researcher in selecting participants (Evans, & Rooney, 2008, p. 125; Patton, 2002, p. 256). The survey will consist of a list of questions aimed at understanding the participant's technological skills and awareness of and knowledge about using next generation catalogues and other Web applications. The survey will ask participants to state their academic major or department. The goal is to get a more diverse sample i.e. a sample that is representative of the university's 15 colleges and instructional units, but this data will not be used in the analysis as was previously discussed in the population section. The researcher is interested in getting at most two participants from at least seven of the 15 subject specializations to make a total of fourteen participants. Then the survey will ask the participants to state their year of study. Two years of graduate school will be considered a minimum for one to have the required experience with searching library tools and other Web applications. This minimum experience is set by the researcher based on his own experience as a graduate student at the University of Illinois at Urbana-Champaign. Further, the researcher will assume that two years of graduate coursework exposed participants to rigorous research experience including using different search tools like the library catalogue. The survey will then ask participants to self-rate their experience with library catalogues and other Web applications, specifically their experience using computers generally, familiarity with library catalogues, frequency of using search engines and library catalogues, and their

familiarity with the VuFind installation at the University of Illinois at Urbana-Champaign or any similar search tool of their choice. Responses to these questions will help the researcher to understand the participant's experience with searching despite having of two years of graduate study. The last part of the survey will ask participants to provide their availability [*day and* time] by filling in a table and their preferred contact information so that the researcher can send them a reminder.

3.4.4.2 Task analysis.

Outside library and information science research, task analysis has been used to break apart behavioral aspects of complex tasks, such as planning, diagnosis, and decision-making (Annett & Stanton, 2000). In recent studies, task analysis has been used to break users' goals into sub-tasks and actions, presented in the visual form of a graphic chart (Prommann & Zhang, 2015). Furthermore, task analysis offers a practical model for goal execution, allowing designers to map user goals to a system's varying task levels, and evaluate the feasibility of those goals. In so doing, task analysis offers the structure with which to learn about tasks, and to highlight any unnecessary steps and potential errors that might occur during a task performance (Embrey, 2000; Stanton, 2006). The strength of task analysis lies in its dual approach to processes and detail; on the one hand, user interface elements are mapped at an extremely low and detailed level, while on the other hand, each of these interface elements gets mapped to user's high-level cognitive tasks (Crystal & Ellington, 2004; Prommann & Zhang, 2015; Stanton, 2006). This informs a rigorous design approach, where each detail accounts for the high-level user task it needs to support (Kirwan & Ainsworth, 1992; Liljegren, 2006, p. 247). Thus, task analysis as a methodology is supported by the specific techniques used in the present research to collect data, organize it, and then use it to make various judgments, specifically how well graduate students understand VuFind's features. The application of task analysis methods in the present research will provide a 'blueprint' of human involvement in searching, building a detailed picture of online catalogues from the human perspective. Such structured information will allow the level of analysis to ensure compatibility between system goals and human capabilities so that the user goals are achieved (Kirwan & Ainsworth, 1992, p. 1). The main goal of task analysis will be to elicit the participants to think about how they will

search for materials to answer each of the information tasks/scenarios. During task analysis each participant will be asked to describe the search features of VuFind or any other search tool of their choice (this could be one they normally use in their work) that they would use to complete specific types of information tasks. Emphasis will be on search and browsing approaches, access points used, interface and bibliographic displays, output and external links, search limits, and user assistance.

After a brief introduction, together with the participant, the researcher will read aloud the first scenario and will ask the participant to state the kind of information materials they expect or desire to get to answer the scenario. The researcher will be interested in whether if the participant will look for print or electronic information material; and if so where they will search for that material. Then the researcher will ask the participants to give a step-by-step process, stating the different search features that they will use to get or search for each or one of the materials identified. The goal is for the participant to describe step-by-step details in the form of a flowchart starting clearly from the first thing they will do to the last step when they will be satisfied with the results that answer the information task. Then the participant will be asked to give reasons why they think such search features would help them find the materials to use to answer the task at hand. The purpose of this process is to see if the participants actually understand the function of the search feature they are describing. Then the participants will be asked to state alternative search strategies they will take to get the preferred materials in case the steps earlier chosen to take did not return items of interest. The purpose of this step is to compare the participant's earlier description with their new course of action and determine if they really understood what they said earlier and the function for each search features. All this discussion will be recorded using the Audacity audio recorder and saved on to the computer. Immediately after the task analysis the participants will be taken to the computer to perform the requested tasks on the computer using UIUC's VuFind or any other system of their choice.

3.4.4.3 User testing.

User testing is perhaps one of the most popular usability testing technique used in the study of user search experiences (Tan, Liu, & Bishu, 2009). User testing provides valuable insight into usability

problems in both a "finished-ready-to-launch-interface" as well as an "iterative design-construction phase of an interface". User testing relies mainly on the experience and comments of the users and is usually conducted as a scenario-based environment. As a result, user testing would usually evaluate according to what exists, rather than to what is possible (Tan, Liu, & Bishu, 2009, p. 621), and works better when a cognitive walkthrough is done and certain system trials have been performed (Jeffries, Miller, Wharton & Uyeda, 1991). Different commentators have recommended user testing as the primary method in studying user experience. Researchers contend that user testing method will help to identify most of the usability errors (Lindgaard, 2006; Nielsen and Mack, 1994). Scholars further report that more severe problems are discovered through user testing (Jeffries et al, 1991; Tan, Liu, & Bishu, 2009).

The power of ‘‘*seeing is believing*’’ creates a bias for system developers towards user testing (Nielsen and Mack, 1994, p. 212; Tan, Liu, & Bishu, 2009), as user search strategies and behavior that are not detected by user testing are considered to be ‘‘false positive’’ strategies. Not all user strategies and behaviors are detected in user testing, and some of the missed behaviors can indeed have great impacts on system design. Nielsen and Mack (1994) argue that these user strategies may not have been detected because the user testing may have been too short a duration for some behaviors to be observed and some behavior may occur too infrequently to be observed by small groups of users that were tested. Users may also demonstrate the ability to perform the task in spite of the interface challenges (Doubleday, Ryan, Springett, & Sutcliffe, 1997). Further diversity of users of online catalogues across the globe prohibits user testing by all segments of global users (Tan, Liu, & Bishu, 2009). As a result, user behavior that were deemed to be "false positive" behavior may be the most important steps in studying actual system usage.

User testing will happen immediately after task analysis. The researcher will walk the participant to a computer connected to the internet with a browser open and running UIUC’s VuFind. Again, the researcher will brief the participant about the goals for the research, their rights, and the research processes including what is expected of them. The main goal of user testing will be to allow the participants to perform the tasks on the computer and obtain materials to answer each of the information

tasks/ scenarios [***information tasks will be discussed in detail in section 3.3.11.1 Information Tasks***]. The participants will be asked to think aloud as they perform the tasks. By verbalizing their thoughts, participants will allow the researcher to determine not just what they will be doing with their searching, but also why they will be doing it. While UIUC's VuFind will be the system running in the browser on the computer, the researcher will encourage participants to work with any other Web application or search tool of their choice. The tools can be those that they normally use in their work or that they use to complete specific types of information tasks. The participants will be informed that Camtasia screen and audio recording software was used to record their actions and audio for later analysis by the researcher. The researcher reviewed the contents of the consent form to ensure that the participants was aware of their rights and comfortable through the research process. While performing the information tasks emphasis was on how they interact with search and browsing features, access points used, interface and bibliographic displays, output and external links, search limits, and user assistance. This was important because it would help the researcher to know how searchers use the search features of UIUC's VuFind or library search tools and other Web applications like Google Scholar and Google Web when searching. This further will help to identify how users' choice of search features change during the searching episode and from their preconceived approaches before using the system.

After a brief introduction, together with the participant, the researcher will read aloud the first scenario and ask the participant to start the searching process and identify the kind of information materials they will desire to find answer the scenario. The researcher will be interested in the kind of information materials the user chooses, i.e. either print or electronic information material, and where they search for the material. The screen shots captured and the audio recordings will be saved on the computer for later analysis and will be immediately copied to the external hard-drive as a backup copy. During the searching episode the researcher will remind the participants to explain their actions. The main goal is to understand if and how the participants understood the meaning of the search features they will use. If the participant chooses not to start with UIUC's VuFind, then the researcher will ask if they can use another system of their choice other than VuFind. The purpose will still be to compare the participant's earlier

search processes with UIUC's VuFind and a system of their choice and determine if they really understood the function for each of the search features. Immediately after user testing the participant will be moved away from the computer to the table for the individual interviews as discussed in the section below.

3.4.4.4 Think-aloud protocols.

User testing required participants to perform information tasks while thinking-aloud (Johnston, Salaz, & O'Connell, 2013; Patton, 2002; Holstein, & Gubrium, 1995) as discussed in ***section 3.3.4.3 above***. The think aloud protocol is part of the user testing technique used to collect data. It is a testing method where the user is presented with a test system and given a set of tasks to perform. During task performance participants are asked to talk aloud about their processes. Thinking aloud involves having one participant at a time use the system for a given set of information tasks while being asked to "think out loud" (Nielsen, 1993, p. 18). By verbalizing their thoughts, participants allow the researcher to determine not just what they are doing with the test system, but also why they are doing it (Given, 2008; Hevey, 2010; Lavrakas, 2008; Mathison, 2005; Willis, 2005). Research experts agree that think-aloud aims to elicit the inner thoughts or cognitive processes that illuminate what is going on in a person's head during the performance of a task (Patton, 2002) or a set of specified tasks (Given, 2008; Hevey, 2010; Lavrakas, 2008; Mathison, 2005; Willis, 2005). This is the core aim of the data collection. Think-aloud works in such a way that while the participant engages in an activity, the researcher asks questions and probes to get the participant to talk about what they are thinking while performing the task/s. According to Stacy Wilson (2000, as cited in Patton, 2002) thinking-aloud is a reliable method because the verbal data and protocols generated do not depend on subject's short-term memory recall of the cognitive processes; rather it depends on long-term memory and strategies recorded when solving similar problems. Moreover wealth of qualitative data can be collected from a fairly small number of users; and the users' comments contain vivid and explicit quotes that are memorable and can inform decision making. However, wrong information can be given that is based on the participant's "theories" of what caused trouble and what would help (Nielsen, 1993). To avoid the researcher being trapped by the participants'

own rationalizations about their own behavior, attention was paid to the recorded data as a way of relating user's actions and explanations (Given, 2008; Hevey, 2010; Mathison, 2005; Willis, 2005).

3.4.4.5 Individual discussion.

The researcher will conduct individual conversations to elicit facts about the actions of the participants during task analysis and user testing (Holstein & Gubrium, 1995; Patton, 2002). Interviewing will be employed in this research as the act of finding out from the participants those things that the researcher cannot directly observe (Patton, 2002). Thus, interviewing will allow the researcher to enter into the participant's perspective. Interviewing can have ethical challenges and Patton (2002, p. 406) advises that "the interviewer needs to have an ethical framework for dealing with such issues". The IRB approval process addressed most, if not all of the ethical concerns in this research. It is believed that the quality of information obtained during an individual interview largely dependent on the researcher (Cooper, Reimann, and Cronin, 2007). The purpose of the individual interviews will be to further explore how participants understood the function of the search features of the system they used; and how users' choice of search features will change during the searching episode and from their preconceived approaches before using the VuFind installation.

Immediately after user testing the individual discussions will begin. The participants will be asked to go over two incidents: a) events that participants will consider extremely positive; and b) incidents that they will consider extremely negative. In this part of the study, the researcher will also ask participants to provide one positive and one negative critical incident covering events with respect to using UIUC's VuFind or any system of their choice that they have used during the search process. A positive incident is one when UIUC's VuFind or any other search tool help the participant to complete a task effectively, efficiently, or pleasantly. A negative incident is one when UIUC's VuFind catalogue fails or provides challenges that hinder the participant in the completion of their information task.

3.4.5 Usability Lab – research setup.

The University of Illinois at Urbana-Champaign Library has a usability laboratory, located in the University Library Scholarly Commons (1408 W. Gregory Dr., Urbana, IL 61801, Telephone 217-333-2290). The laboratory is equipped with desktop computers, connected to the university network. Computer access is provided through the campus Active Directory login system. For this project in addition to a personal laptop, two Scholarly Commons workstations were used. The Scholarly Commons will be reserved between October and November 2014 on the days that will be agreed upon with the participants. Since the Scholarly Commons computers have to be logged into using the campus Active Directory login the researcher is confident that participant's privacy and confidentiality will not be compromised. The researcher will log into the University's Active Directory using his personal credentials as opposed to asking the participants to login. Access to the Usability Laboratory will be limited by a Key kept by the library staff at the Scholarly Commons. The key will be checked out by the researcher for a full day and returned before 5:00pm. The computers in UIUC's Usability Laboratory will provide software such as Camtasia screen capture and audio software, Auducity audio recording software, Mozilla Firefox and Google Chrome browsers, Windows Media Player (WMA) for playing videos, and an internet connection through UIUC's network.

3.4.5.1 Camtasia and Audacity.

Camtasia, a screen recording software program, will be installed on the researcher's laptop and used to screen capture actions of the participants while using VuFind (Johnston, Salaz, & O'Connell, 2013). Camtasia was also installed on the Research Commons computers and will be used for a similar purpose as described in **Section 3.3.5 Usability Lab – Research Setup**. Camtasia is selected given its robustness, low cost, and popularity among UIUC library staff, hence guaranteeing technical support. For confidentiality purposes, any recordings made from the Scholarly Commons workstations using Camtasia were saved on an external drive and kept in a locked cabinet in the researcher's house and later analyzed from a personal laptop. Audacity, open source audio recording software installed on the researcher's

laptop, will be used in recording audio conversations in task analysis and individual interviews. Audacity is selected for this research because the researcher is familiar working with it and it is freely available for download and installation. Confidentiality is further reinforced by the fact that access to the Scholarly Commons workstations is by campus Active Directory login system. All the recorded data will be converted to Windows Media Player format (WMA) and stored on the researcher's external drive that will be kept in a locked cabinet in the researcher's house. Participants' actions will be recorded using the screen capture software Camtasia while navigating through the VuFind installation.

3.4.6 Triangulation.

To facilitate deeper understanding of users' search strategies and behavior this dissertation will use three data collection methods - task analysis, user testing, and individual interviews; to collect data from graduate students with different academic specializations, a process referred to as triangulation. Triangulation is the combination of two or more data sources, investigators, methodologic approaches, theoretical perspectives, or analytical methods within the same study (Denzin, 1970; Maxwell, & Loomis, 2003; Smith, & Kleine, 1986; Thurmond, 2001). These combinations result in data triangulation, investigator triangulation, methodological triangulation, theoretical triangulation, or analytical triangulation (Hussein, 2015). When more than one type of triangulation is used, for example, two or more data sources along with two or more investigators, the resulting complex triangulation is referred to as multiple triangulation (Thurmond, 2001).

This dissertation will use two types of triangulation: data sources triangulation and methodologic triangulation. Data sources triangulation varies based on the times the data were collected, the place, or setting and from whom the data were obtained (Denzin, 1970; Mitchell, 1986). Methodologic triangulation also known as multi-method, mixed-method, or methods triangulation, strives to decrease the deficiencies and biases that stem from any single method creating the potential for counter-balancing the flaws or the weaknesses of one method with the strengths of another (Barbour, 1998; Greene & Caracelli, 1997; Thurmond, 2001).

Methodologic triangulation can further be classified into two types — within-method triangulation and between- or across-method triangulation. Researchers using within-method triangulation use at least two data-collection procedures from the same design approach (Greene & Caracelli, 1997; Hussein, 2015). For quantitative approaches, the procedures could consist of administering survey questionnaires and using pre-existing information from a database. In qualitative approaches, non-participant observations could be combined with focus group interviews. Researchers using between- or across-method triangulation employ both qualitative and quantitative data collection methods in the same study (Denzin, 1970; Mitchell, 1986). An example is combining participant interviews and questionnaires in the same study (Denzin,1970), or using participant observation with analog or Likert-scale surveys. This dissertation will use task analysis, user testing, and individual interviews, which are all qualitative research methods and therefore within-method triangulation. Using within-method, methodologic triangulation and multiple data sources triangulation will increase confidence in research data by revealing unique findings from each of the three approaches thus providing a clearer understanding of the research problem. Through the use of task analysis, user testing and individual interviews as well as selecting graduate students with different specializations this research will discover areas of both convergence and divergence in the data collected. Triangulation will enhance the completeness and confirmation of data in research findings of this dissertation (Hussein, 2015).

3.4.7 Case study.

The unit of analysis is the most important element that is analyzed in a study (Patton, 2002; Long, 2004; Vogt, 2005). It is the 'what' or 'who' that is being studied. In social science research, typical units of analysis include individuals (most common), groups, social organizations and social artifacts. A particular unit of analysis from which data are gathered is called a case (Long, 2004; Vogt, 2005). A case describes an instance of an object of study (Dul & Hak, 2008, p. 4). On the other hand, a study prescribes a research project (practice- or theory-oriented research object). Thus, a case study is both a process of inquiry about the case and the product of that inquiry (Denzin & Lincoln, 2000). The case study method differentiates four types which rely on the specific purpose of the case study, for example explanatory, exploratory case

studies (Yin, 2014, pp. 238-241), descriptive case studies (Dul & Hak, 2008; Eisenhardt, 1989; Yin, 2014), test theory and theory-building case studies (Dul & Hak, 2008; Eisenhardt, 1989). In terms of theory building and testing a case study research process is one in which a specific situation is studied either to see if it gives rise to any general theories or to see if existing general theories are borne out by specific situations (Goddard & Melville, 2011).

Based on the above introduction, there are multiple definitions and understandings of the case study. This dissertation will define a case study as a systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest (Bromley, 1990, p. 302). The case study method can be applied in both quantitative and qualitative research. However, case study research is usually classified as a qualitative method by highlighting the in-depth understanding acquired predominantly by qualitative methods (Eisenhardt, 1989; Yin, 2014; Zucker, 2009). The primary focus of data collection is on what is happening to the individuals (case) in a setting and how individuals are affected by the setting. Case study research is not a sampling strategy, rather the purpose is to get an in-depth understanding and the complexity of at least one case, but the challenge is to select appropriate cases. Accordingly, Stake emphasizes balance and variety when choosing cases, as well as picking cases which are rich in content (Stake 1995). Stake's approach (1995) to the number of cases to be conducted is to not define a finite number. The number rather depends on the research question and its purpose. Eisenhardt (1989), however, suggests conducting more than four cases in order to derive generalizable findings. According to Yin (2014) even one case is enough to generate valid data, however, generally there is a positive correlation between investigated cases and validity. Thus, Yin advises to examine multiple cases (when available) because a multiple-case study can strengthen derived findings and does not lead to a direct replication compared to single-case studies. Consequently, having only one case study requires strong argumentation to encounter criticism convincingly.

By using a case study, this research stands to gain from in-depth explanations and descriptions in answering the research question, allowing the researcher to gain a holistic and real world perspective. The case study can be applied retrospectively and prospectively (Zucker, 2009; Stake, 1995). The dissertation

single case design was applied prospectively. Regarding a single-case design, reliability as well as the generalisation of the findings is subject to critique. Furthermore, criticism arises because of the deep involvement of the researcher in the study which may affect the results (Yin, 2014). This research considers the study of graduate students' search strategies and behavior as a kind of archetypal case study within human information behavior research. Specifically, understanding features of VuFind that graduate students use to complete specific types of information tasks and how they understand the function of VuFind's features provides unusually rich access to a significant real-world scenario. Yet there are recognizable contextual constraints impacting how users plan to use and actually utilize search features, for example a) varying skill levels of the participants replete with uncertain knowledge and multiple interpretations; b) users' entirely random and unpredictable information behavior, and c) how the tasks depicted in a scenario genuinely represent the phenomenon being explored.

3.4.8 Scenario-based technique.

Scenario-based techniques account for multiple user roles as well as a range of contextual influences (Kim, 2012, p. 300). Scenarios are "concrete and grounded units of analysis" (Haynes, Purao, & Skattebo, 2009, p. 334) that explicitly reflect users' experiences with online catalogues, i.e. a series of user activities of systems used in human–computer interaction (Kim, 2012: 300). Since the 1950s, researchers have developed different terms for scenarios, including vignette, case story, case simulation, hypothetical scenario, task scenario, and situation scenario, and used them interchangeably to describe the brief, concrete descriptions of realistic situations (Kerlinger, 1986, p. 457; and Kim, 2012, p. 301).

Scenarios require an identified actor represented as a prototypical role, a setting describing the context in which the scenario takes place, and the goals motivating the scenario (See **Appendix A-2 & A-3**). Scenario-based techniques are shown to be effective in a variety of applications including: human computer interaction, usability studies, visualization, comparison of systems, and designing systems (Haynes et al., 2009, p. 334; Kim, 2012, p. 301). A key advantage of using scenarios in this research is their scalability and flexibility to account for work practices distributed over space, people, and time (Haynes et al., 2009, p. 335). By using scenarios, this study focused not only on particular features of the

system, but also on the contextual interactions among the user, the task, and online catalogue features (Carroll, 2000; Kim, 2012, p. 301; Stiemerling & Cremers, 1998; Sutcliffe, 2002). The study was able to gauge how graduate students respond to four search situations, to observe their behavior, and to elicit their opinions, beliefs, and attitudes.

Scenarios further provide specific focal points for understanding behavior, and therefore have the potential for reducing the effort and expense associated with ethnographic and other more immersive methods. Moreover, scenarios provide a common, good language for designers, users, and evaluators, which are necessary to support both formative and summative studies (Carroll, 2000; Haynes et al., 2009). Scenarios offer efficiency in data collection, and improve the internal validity by standardizing the conditions under which the research will be carried out (Kim, 2012, p. 304). However, external validity is lowered, i.e. how much the situation depicted in a scenario genuinely represents the phenomenon being explored will be reduced. Ambiguity with scenarios results from the targets of the analysis, the types of tasks, and the content being analyzed. Scenarios are limited by the variety of situations in which they are used and the varying skill levels of the participants, who have uncertain knowledge and multiple interpretations of the task. To completely reduce ambiguity in scenarios is to eliminate options and overproceduralize a set of important decisions. This tension calls for defining the parameters of any performance and situation. For example, in task analysis before attending to a set of tasks, participants were briefed and guided through procedures without necessarily helping them to answer the tasks. A set of guiding statements will be prepared beforehand and read to the participants before attending to the tasks to ensure that they understand what the scenarios require them to do. While performing the tasks in one way or the other, the researcher anticipated the participants would overproceduralize a set of important decisions, then the researcher instructed the participant with guiding statements outlined in **Appendix A-2 and A-3**.

3.4.8.1 Information tasks.

Information tasks [*referred to as scenarios in this research*] will be given to each participant [*see section 3.4.2*]. The tasks will consist of a set of questions carefully worded and arranged with the

intention of taking each participant through the same sequence and asking each participant the same questions with essentially the same words (Given, 2008; Lavrakas, 2008; Lewis-Beck, Bryman & Liao, 2004; Patton, 2002; Vogt, 2005). Carefully worded and arranged scenarios will help to minimize variations in the questions posed to each participants (Lewis-Beck, Bryman & Liao, 2004; Patton, 2002); allowing them to answer the same questions while increasing comparability of responses and producing complete responses for each participant for each key research question. The responses will later be coded and aggregated to be able to make generalizations about the entire population. Additionally, this approach will facilitate organization and analysis of the data.

On the other side standardized information tasks have little flexibility in relating the tasks to particular individuals and circumstances because of the standardized wording of questions and this might constrain and limit naturalness and relevance of questions and answers to the participant's class assignments (Given, 2008; Lavrakas, 2008; Lewis-Beck, Bryman & Liao, 2004; Vogt, 2005). The current research will produce two sets of questions – one for the Social Science and Humanities, and another for Sciences. The information tasks will be categorized into four tasks: bibliographic strategy [*where the participants searched for a known item*], analytical strategy [*where the participants expressed their need in topical terms*], search by analogy [*where participants formulated their needs through a known and appreciated item like a book*] and empirical strategy [*where the participants presented their needs in topical terms and associated it with a known set of documents*].

3.4.9 Critical incident technique.

Critical incident technique was chosen as the reference paradigm within which to study and understand users' search strategies and behavior, with the goal of identifying the features of VuFind that graduate students use to complete specific types of information tasks and how well they understand these features. The Critical Incident Technique (or CIT) is a set of procedures used for collecting direct observations of human behavior that have critical significance and meet methodically defined criteria. These observations are kept track of as incidents, which are then used to solve practical problems and develop broad psychological principles (Flanagan, 1954; Johnson & Fauske, 2000; Serenko, 2006; Wang

et al., 2000). A critical incident can be described as one that makes a contribution – either positively or negatively – to an activity or phenomenon. Critical incidents can be gathered in various ways, but typically respondents are asked to tell a story about an experience they have had. CIT is a flexible method that usually relies on five major areas.

This research will use a set of procedures -- task analysis, user testing, and group discussion -- in a process referred to as critical incident technique (Flanagan, 1954) in order to collect direct observations of graduate students' use of next generation catalogues features, and to provide explanations for their actions and behavior (Hughes, 2007, p. 50; Serenko, 2006, p. 1086). Guided by the data from the task analysis interviews, and from the usability testing screen recordings from the users' VuFind searches, the researcher will engage the participants in individual discussions guided by the critical incident technique (Serenko, 2006, p. 1087). Participants will be questioned on two distinct areas: a) events that participants will consider exceedingly positive, and b) incidents that they will consider extremely negative. Drawing from previous investigations that utilized the critical incident technique (Johnson & Fauske, 2000; Serenko, 2006; Wang et al., 2000), participants will be asked to respond to questions detailed in **Appendix A-4.** The sample questions will focus on discovering how graduate students understand next generation catalogue features, including how these understandings are arrived at and how they are interpreted in different contexts. Do users interpret features according to their actual functionality and use? If so, do they do the right task while using these features, i.e. do they interpret the features according the task they were designed to perform? If they want to perform a search whose functionality is not provided, how and what do they do to fulfill that need? When do they decide to leave the catalog?

3.5 Methods

The problem facing libraries now is the intelligent selection of a tool that fits their context, and structuring a process to adopt and refine that tool to meet the objectives of the library. Taking a qualitative approach, the purpose of this research was to conduct exploratory empirical research into how graduate students interact with the VuFind instantiation at UIUC. Particular attention was paid to the

systems features a group of graduate students use in their information seeking tasks. This research considers graduate student's search strategies and behavior as a model case study within human information behavior research, including narratives that describe details of a user's interaction with a system as a focal point to improve our understanding of how users interact with next generation catalogues. In this case study, tasks analysis, user testing, and individual interviews are used as data collection methods.

3.5.1 Participant recruitment using a survey.

The original plan was to recruit a large pool of participants using the recruitment process discussed earlier. Each participant would fill out a survey to self-rate their experience with library catalogues and other Web applications. If the participant's responses to the survey met the researcher's criteria, then the participant would be allowed to take part in the research. However, this recruitment process did not attract any participants. While still waiting for participants to show interest, the researcher decided to contact friends to participate. This did not mean that participants who responded would be turned down, rather the researcher planned to follow them to take part in the research. The researcher ensured that friends contacted had at least two years of graduate study. It was then necessary for the friends to self-rate their experience with using the library catalogue and other Web applications. This was because while the researcher and participant knew each other well, the researcher did not know their experience with using library catalogues and other Web applications. Therefore, since the researcher wanted to make sure that all the participants met the criteria, all participants, whether those identified by the researcher or those identified by the friends, were asked to respond to the survey to measure their experience with library catalogues and Web applications. All the participants who were recruited by the researcher and those identified by the researcher's friends were recruited to take part in the research because they meet the criteria.

3.5.2 Analyzing data.

The qualitative data collected included transcripts from task analysis, user testing, and interviews. This data provides a unique opportunity to understand users search strategies and behavior. The transcripts documenting many of the formal and informal information seeking processes of graduate students provides an opportunity to observe information behavior from multiple perspectives. In the analysis of the data collected, the focus was on identifying the features of VuFind and other Web applications that graduate students use to complete specific types of information tasks, and ways they understand the function of these features. This included identifying the most and least used features, with particular focus on search and browsing approaches, access points used, interface and bibliographic displays, output and external links, search limits, and contextual assistance. Further, the analysis focused on what users perceive as the system features available for use in a given task, the purpose they serve, and how the reasons for their choices differ in different contexts. The interpretation of the results was based on the features used and how the participants understood the function of these features, i.e. central to this analysis was showing how graduate students understand the function of the features of VuFind and other Web applications. This highly qualitative data was hand coded by identifying terms from the transcripts, guided by the descriptions and definitions (Miller & Salkind, 2002; Patton, 2002) of the search features discussed in the literature review, illustrated and summarized in **Table 2.1,** and illustrated in **Figure 3.1**.

Particular attention was paid to how the participant described a processes, and how such processes relate to the search features -- search, browse, access points, interface, bibliographic display, output and external links, search limits, and user assistance as illustrated above. The coding also looked at how these features were related to each other. The key decisions taken by the researcher in analyzing and interpreting the research data were guided by the research questions in relation to the eight search features. The first step towards evaluation of the data was to identify terms from the task analysis transcripts, the user testing data, and the in-depth individual discussions. In the discussion potion, the identified terminology was further defined within the context of use by the participants and supported with diagrams, quotes from the transcripts, and quantitative data generated from the transcripts. During

the evaluation of the data and in the writing phase, the goal was to ensure that the terms represent the exact context of use, and the meaning that the participants attached to their actions.

Detailed data analysis did not start until all the data was collected, as described in the research design section. The analysis of the data started in November 2014 and continued through the dissertation writing phase. During this period the researcher focused on the terms identified and defined from the data to create cross-links with the search features. The interpretation of the analysis followed thereafter, guided by the scholarly and theoretical trends described, leading to the development of the guidelines for future studies.

3.5.3 Tasks/scenarios performed.

Participants were asked to describe and perform the tasks on either UIUC's VuFind installation or any system of their choice. The information tasks were referred to as scenarios and were of four categories:

a) The bibliographic strategy where the participant searched for a known item. Participants from social sciences and humanities disciplines were asked to describe how they will go about finding encyclopedia article with a title "Background checks" from the *Encyclopedia of Privacy*, [Two Volumes], Santa Barbara, CA: Greenwood, edited by William G. Staples. While those from the sciences were asked to find encyclopedia article with a title "Archimedes' theories" from the *Encyclopedia of Scientific Principles, Laws, and Theories*, [Two Volumes], Santa Barbara, CA.

b) The analytical strategy required participants to express their needs in topical terms. The participants from the humanities and social sciences were asked to find sources that give a general overview and background information on the beneficial aspects of steroids for sports; while those from the sciences were asked to find sources that give a general overview and background information on the ethical issues of stem cell research.

c) The search by analogy tasks required participants to formulate their needs through a known and appreciated item like a book, a process described by David Ellis (1987, 1989) as chaining. In this case, participants from the humanities and social sciences were asked to find a book,

magazine and journal article to answer one of the following questions: 1) What are the effects of global warming on the habitats of endangered animals? 2) What is the impact of race on fraternity recruitment? Participants from the sciences were asked to find a book, magazine and journal article to answer one of the following questions: 1) What are the trends in designing energy-efficient houses? 2) What are some alternative medicine approaches to treating arthritis in Africa?

d) The empirical strategy tasks required participants to present their needs in topical terms and associate them with a known set of documents. For this task each category of participants performed two questions. The humanities and social sciences students were asked to find a citation in MLA and APA styles for an item with the following details: Title: Driving records of persons arrested for illegal drug use, Main Author: Crancer, Alfred, Other Names:Quiring, Dennis L., Published:[Olympia]: State of Washington Dept. of Motor Vehicles, 1968. For science participants, the item details were: Title: Pounder's marine diesel engines and gas turbines, Main Author: Edited by Doug Woodyard, Published:Amsterdam, Elsevier/Butterworth-Heinemann, 2009, and Edition: 9th ed. The follow up question for humanities and social science students was:- Find English drama titles of the 17th century era written based on William Shakespeare's Romeo and Juliet. For science students the second task was: - Find English drama titles of the 17th century era written based on science fiction.

3.5.4 Task analysis.

For each of the four scenarios the participants were asked to describe how the system would respond to their search. For each task the participants were asked to state the kind of materials they expected and desired to get from the system, and how they would go about looking for those materials using UIUC's VuFind. Then the participants were asked to describe how they would go about finding alternatives without leaving UIUC's VuFind, i.e. how they would go about using different system features to find what they were looking for. The participants were then asked to give reasons for their choices, and their preferences attached to those choices, i.e. why they think the choices made will give them the best

resources. The participants were asked to describe their feelings about the process, if they would have used a different search system other than online catalogues, and what features they would use from that preferred system. The preferred system could be a search engine like Google, or a commercial application like Amazon. From searching both VuFind and either Google or Amazon, the participants were asked to discuss their experiences with the systems. Each of the participant's data was coded for comparison and analysis. This part of the study took approximately twenty minutes of the participant's time. For a total of fourteen participants, the researcher spent approximately five hours.

3.5.5 User testing.

After the task analysis discussion described above, a new, but similar, set of tasks, as described in the task analysis interview, were presented to the participants in a changed order without altering the language, sentence structure, or grammar (See **Appendix A-3)**. Changing the order was aimed at distorting any mental models that would have been formed while discussing the tasks in the task analysis interview. Using a computer connected to the Internet with an open browser running UIUC's VuFind, the participants were asked to perform searches to obtain information materials that they think would help in answering the tasks. Using Camtasia screen capture software, the actions of the participants were recorded on the computer for future analysis and comparison with data recorded from the task analysis interview. The main goal was to capture the participants' actions and how their behavior and selection of search features changed as a result of using the system. This process was designed to answer specific questions. What features of VuFind do searchers use? Does using the system alter the participant's original search plan? What features are preferred and why? Performing the tasks on UIUC's VuFind took approximately forty-five minutes of the participant's time. Since the second part took place immediately after the first part, at least one hour was needed to complete the first and second parts together. Thus, fourteen working days were needed to complete part one and two of the study if one participant per day attended. However, since this is a user study, the researcher was able to handle a maximum of two participants at a time for some days. The whole data collection exercise took 12 days.

3.5.6 Individual interviews.

Immediately following user study, the researcher engaged the participants in individual discussions. Participants were questioned on two distinct areas: a) events that participants considered exceedingly positive, and b) incidents that they considered extremely negative. Participants were asked to respond to questions detailed in **Appendix A-4.** The sample questions focused on discovering how graduate students understand next generation catalogue features, including how these understandings are arrived at and how they are interpreted in different contexts. Do users interpret features according to their actual functionality and use? If so, do they use the right features while performing these tasks (i.e. do they interpret the features according the task they were designed to perform)? If they want to perform a search whose functionality is not provided, how and what do they do to fulfill that need? When do they decide to leave the catalogue? Special attention was paid in to make the participants feel that their actions were valid and correct. Without disclosing the identity of the participants, screen recordings from user testing were replayed, and participants were asked to give explanations for their actions, a process referred to as member checking, informant feedback, or respondent validation (Creswell, 1994, p. 158; Harper & Cole, 2012, p. 510).

3.6 Conclusion

On completing the data collection, the following data were collected: 14 task analysis interview audio recordings from 14 participants, 14 user tests screen recordings converted to Windows Media Player format (WMA) and stored on the researcher's laptop and external drive as back up, and 14 individual interview audio recordings from 15 participants. The research design and methods were intended to gather detailed and in-depth qualitative data to guide the researcher's understanding of the features of the VuFind installation at Illinois that graduate students use and how they understand the functions of these features. This research is going a step ahead by not only using user testing and individual interviews as methods but also using task analysis to explore through comparison of the data

how graduate students understand the function of search features. The data collected using these methods is presented in Chapter Four.

Chapter 3 Table

Table 3.1. Coding the Qualitative Data

Data collection procedure	**Data/ Transcripts**	**Codes/ Search features – See Table 2.1**	**Comments – Guiding notes**
Task analysis	"… when I do searches with the [UIUC] systems I start with their largest search, which turns up the results page [listing] the article databases, the library collections and it goes all the way down to Google Web pages"	Search - Metasearch (largest search) Output – relevancy ranked results, ordered lists Output - FRBRization External links (APIs) – connection to other databases	"turns up the results page [listings] the article databases, the library collections" participant met UIUC's results dashboard
User testing	"… sometimes I will do a search within, like if I have author whose works I wanted to look for …"	Browse – (search box [*basic search*] for searching within Browse – faceted navigation Browse – search box on every page Search Limits – Faceted limitation [*search within using author*] Output – FRBRization and APIs (linked works in the results page)	UIUC's VuFind screenshots depicting the features discussed
Individual discussion	"... finding a citation was the easiest of all tasks ..." "… finding the encyclopedia article was so difficult … to find … I tried whatever I could ... even when I found the encyclopedia itself … I couldn't find the article …"	Empirical search strategy [*Searching for a known item was difficulty for this participant*] – Bibliographic search strategy	

Note: *The whole process of evaluation revolved around identifying, defining and creating a relationship among the terms, and thereafter ranking and making comparisons to establish empirically proved and tested observations* (Miller & Salkind, 2002; and Patton, 2002).

CHAPTER 4

FINDINGS

4.1 Introduction

This chapter presents the findings organized according to the search features identified from the data that participants used to complete specific types of information tasks. The first part of this chapter presents the survey results that guided the selection of the participants based on their computing background (knowledge and experience) with library catalogues and Web applications. The second part is the results of the task-based questions and interview discussion.

4.2 The Survey

This study engaged fourteen graduate students who were code named A to N whose data was transcribed for analysis and coding. The participants' responses to five survey questions were used as the benchmark for selecting information-rich participants and as a point of reference for analysis and coding. All the data from all the fourteen graduate students informed this study. Single participants came from community health (A), nutritional sciences (B), agricultural and consumer economics (C), food science (F), transport engineering (G), civil engineering (K), statistics (H), education – mathematics (I), languages – French (J), architecture (L), economics (M), and law (N), while two participants (D, E) were graduate students of human resource development. Five participants (A, B, E, F, and G) had two years of study in graduate school; four participant (C, J, L and N) had three years of study in graduate school; four participants (H, I, K, and M) had four years of study in graduate school; and one participant (D) had four and half years of study in graduate school. The average years of graduate study was 3.0, the median was 3.0, the mode was 2.0 years, while the range of years was 2.5 years. Eight of the participants (A, B, D, F, G, I, J, and L) self-rated as intermediate computer users while six (C, E, H, K, M, and N) self-rated as expert computer users. Ten of the participants (C, D, E, H, I, J, K, L, M, and N) indicated they were familiar with library catalogues; two participants (B and G) indicated were not familiar with library catalogues; and two participants (A and F) were uncertain about their familiarity with library catalogues.

Nine participants (A, B, C, D, F, H, J, L, and N) indicated that they often use search engines in their searching activities, while five participants (E, G, I, K, and M) indicated that they sometimes use search engines in their searching activities. Seven participants (A, F, H, I, K, L, and M) indicated that they sometimes use library catalogues in their work tasks, five (C, D, E, J, N) indicated that they often use library catalogues, participant B rarely uses library catalogues, and G never uses library catalogues. This shows that twelve of the participants that took part in this study had at least some experience with library catalogues. Four participants (D, I, J, and M) indicated that they were familiar with the VuFind library catalogue; participant H was uncertain; and nine participants (A, B, C, E, F, G, K, L, and N) indicated that they were not familiar with UIUC's VuFind library catalogue. It is important to note that not all of those that indicated they were not familiar with VuFind library catalogue have never actually used it, but a reason could be that they have never heard of that terminology. As a summary of the above observations, all fourteen participants were graduate students with over two years of graduate study and had experience using computers, search engines and library catalogues. While only four participants indicated familiarity with the VuFind library catalogue, twelve participants were familiar with library catalogues in general, thus the fourteen participants met the criteria outlined in the research sample. The details from the data analysis follow below.

4.3 Search Features Used to Complete Tasks

Important differences exist in the way participants understand and describe the function of the search features of VuFind and how they use them when searching for information resources. For each task participants orally described a step by step process of searching, stating the search features of interest in the results page and how to navigate from one page to another to get the call number, the physical location of the item, or the full text of the item. In the due course of searching participants expected to reformulate their search if they failed to get to the desired results. The data below presents results of the tasks each user was told to conduct.

4.3.1 Task analysis.

The first question asked participants to orally describe a step by step process of how they would go about searching for a known item in VuFind or any system of their choice. The known item search was categorized as a bibliographic search strategy.

4.3.1.1 Bibliographic search strategy.

The researcher told each subject to find information materials appropriate to answer one of two tasks based on their subject specialization. Those from humanities or social sciences chose to find an encyclopedia article with a title “Background checks” from the *Encyclopedia of Privacy*, [two volumes], Santa Barbara, CA: Greenwood, edited by William G. Staples; while those from the sciences were asked to find an encyclopedia article with a title “Archimedes’ theories” from the *Encyclopedia of Scientific Principles, Laws and Theories* [two volumes], Santa Barbara, CA: Greenwood, edited by Robert E. Krebs. Eight participants (A, B, C, F, G, H, K, L) chose to do the science task; while six participants (D, E, I, J, M, N) chose to do social science/humanities task.

All fourteen participants stated they would start their search by entering the details of the item in the search box (**Figure 1: Screenshot of the UIUC VuFind Simple Search Box**). Six participants (A, I, K, M, L, N) said they would search using UIUC's library website; two participants (D, J) said they would use UIUC's VuFind library catalogue; and six participants (E, C, F, G, H) said they would use the Google search engine; and participant B would use a search engine but never clearly stated the name of that search engine. Four participants (I, K, D, E) would search by putting in the encyclopedia title, for example participant E observed that searching by author would give many results if the author has multiple publications, while two participants (A, F) would search by the article title but not the encyclopedia title. Three participants (B, G, L) would enter in both the title of the encyclopedia and the author's name at the same time, while two participants (C, H) would enter the article title and author's name into the search box. Three participants (J, M, N) would enter in first the title of the encyclopedia and the editor's name to get the encyclopedia and thereafter browse the encyclopedia website to get to the

article. Participant M would start with the author's name for the simple reason that it is a shorter phrase than the title name. Participant M noted that "... because I have found too that if you type typos which is more likely to do for a really long phrase then you don't get the searches so I start with something that is gonna be you know easy to search, because why make it harder."

Participant M would use the advanced search functionality of the UIUC's library website by first entering the title of the encyclopedia, then author or editor, stating that "One thing that really frustrates me about library catalogues is when ... there is no results returned even when you're sure the books are in the library ..." Because of the frustration anticipated in using library catalogues, participant M would switch to the WorldCat search engine because of the feature "... that will tell you ... the libraries where ... to find the book ... I can use the WorldCat and it will tell me if University of Illinois ... Urbana Free Library, ... Champaign Public Library, ... [or] Parkland Library has it." Like participant M, participant D would use the advanced search option of UIUC's VuFind. But all the other participants (A, B, C, E, F, G, H, I, J, K, L, and N) would use the basic search option of the respective search tools selected to use as discussed above.

After typing in the details of the item four participants (A, K, L, I) would select access points like author or title to qualify the search and get more specific search results. All the participants said they would click the search button after typing in the search keywords. After searching with the encyclopedia title in UIUC's VuFind, participant D suggested they would add the author name and the article title to narrow down the search. When the results came all the participants anticipated getting some form of results in a list. The participants said they would look for the search keywords from the results to identify the searched item. Participant B would look for the author, the publication date/year, and the publication volume. Participants I and D said they would look for the link to the I-Share library. Participant I would do this in order to get the books that are not in the library; while D said would look for where to order the book if getting it at the UIUC library website failed.

Participant D would further look for ways to narrow down the search results because UIUC's library catalogue brings many search results. Participants D and L would switch to Google Scholar if the

results from UIUC's catalogue were meeting the needs of the question. Participant L would also look for other details of the item searched for, for example call number, author, article title, and volume. Participant A said if the results of the search are not satisfactory, they would switch and search using the advanced search option. Like participant A, participant G would repeat the search using the advanced search and searching with more keywords like title, author, name of publisher, and publication date at the same time. Apart from participant M, who opted to use the advanced search features of UIUC's VuFind, all the other participants opted for a Google web search or Google Scholar search if the search failed in the first instance. And if the catalogue failed participant M said would chat with the librarian or stop by one of the libraries and ask for assistance from the librarian. Participant M further observed that when searching for a known item as opposed to starting with a topic would probably use the WorldCat or the UIUC's VuFind catalogue.

4.3.1.2 Analytical search strategy.

The second question asked participants to orally give a step by step process of how they would go about searching using topical terms. Searching by expressing the information needs in topical terms was categorized as an analytical search strategy. Like in question one the researcher told each subject to find information materials appropriate to answer one of two tasks based on their subject specialization. Those from humanities or social sciences were asked to find sources that give general overview and background information on the beneficial aspects of steroids for sports; while those from the sciences were asked to find sources that give general overview and background information on the ethical issues of stem cell research. As in question one, eight participants (A, B, C, F, G, H, K, L) chose to do the science task, while six participants (D, E, I, J, M, N) chose to do the social science/humanities task. Participants picked keywords to use in searching from the question statement of their choice.

Despite the search tool or keywords selected by the participants, they all said they would first use the first quick search box (basic search) to perform topical searches. At the results page twelve participants (A, B, C, D, E, F, G, H, K, L, M, N) said they would look for scholarly articles. Participant M said that the topic provided is something that has gone on for quite some time and people have a lot of

emotional touch i.e. the topic has generated a lot of opposing views. For the same reason six participants (B, C, F, G, H, M) said that because they are interested in the articles would not use UIUC's VuFind or WorldCat, but would use UIUC's library website. Participant D said would use UIUC's VuFind. Five participants (A, E, K, L, N) stated would use Google Scholar to do their searching.

From the results page, participant M said would search within the results by using author name or adding more keywords. Participant M was interested in getting results displayed similar to UIUC's Library website dashboard. The UIUC's library website dashboard is a categorized results list based on data harvested from the different resources searched, such as VuFind, I-Share, Web of Science, or EBSCOHost (**Figure 2: Screenshot of the UIUC Library Dashboard**). Participant M planned to look at Web of Science first because of its features like saving sources to RefWorks and allowing for manipulating the search results, for instance by searching within a particular collection or publication using author words. Likewise, participant F would search within a particular document or journal to narrow down the search results. For this reason, participant M would enter in one or two keywords to allow for starting with broad search results and thereafter enter more keywords or an author's name to narrow down search results to a smaller and more manageable number. Other features that participant M liked in Web of Science included selecting and saving items in a temporary folder from a big search results, and downloading all selected and saved PDF articles, including all citations, by a single click.

Four participants (B, G, H, and M) preferred that the output is similar to UIUC's dashboard as opposed to VuFind's results list. Participant M emphasized that from this dashboard a single click on any category, for example EBSCOHost, VuFind or I-Share, would run the same search or the same search would be repeated in that database. This would allow the searcher not to go through the same process of typing in the keywords in the secondary resources. The four participants (B, G, H, and M) further noted that from the results list of any of the selected databases they will find an article or item that matches the topic terms after clicking on it, download the article, and look through the references to identify matching articles or resources.

To select the best article from the results list participant M preferred to use different strategies, for example, using Web of Science that would allow them to sort articles returned in the results list by the number of times the item is cited, saying "... if the article has been cited 50 times I can have that come right to the top and its obvious because it has been cited many times, then this is an important article, and maybe the article has some general information, some critical information, or important methodologies."

Three participants (E, K, and N) said they would talk to a professor or advisor with experience in the area of research to help with identifying prominent scholars on the topic. Participant N emphasized that looking for that particular scholar would help not only to find the scholar's work but also those involved in similar work, the conferences they participated in, the network of their colleagues, and themes driving their research. Participants E and K would search by putting the scholar's name in Google Scholar, while N noted that "the author's name is something you get in a kind of an experienced sort of way" without giving further details

Subject D would search with one or two keywords using VuFind's simple search box; then would identify the best candidate book from the search results and look for possible keywords from the subject words assigned to that book in the catalogue. D would further click on each of the subject words and review the search results for any possible matching items, and the search results obtained as a result of clicking the subject words in the online catalogue would give items that are more focused on the subject researched than a search using keywords.

After typing in the keywords into VuFind's simple search box, from the results list participant J would identify the call number of the most appropriate item selected, then search with the call number to start browsing the search results similar to the way one would browse the physical shelves. In line with call number searching, participants D and J noted that searching with call number is easy and there is low risk of typos, "... you just need to punch in the numbers and system would tell you which of the specialized libraries the book might be and the location of the book on the. So if you're in hurry that is a great feature." Participant D believed they could broaden their search by searching for a call number that was 399.5 versus 399.6." Broadening would be going from 399.65 to 399.6.

As stated earlier, five participants (A, E, K, L, and N) preferred to use Google Scholar or the Google search engine. As stated by participant K "... Google Scholar is really sensitive than any other search engine ... allow to add keywords at any stage in the search process such as author citations. The ability to copy and paste, and then search with a whole statement makes Google Scholar good to use." Participant L further noted that "... I don't have to go through journals or build another set of searches ... I can just simply repeat a similar search." Participant A added that Google Scholar's search within, cited by, related articles, and cites buttons/features are very powerful. Like participants A, E, K, L, and N, five participants (B, C, G, H, and M) talked positively about the sensitivity of Google Scholar. For example, participant G noted that ..."I might put a topic on stem cells and if I use Google Scholar or WorldCat I would get responses about stem cells but may be if I used the library I will get stem cells and plant stems ... and ... I feel like that sometimes the results returned are just not what I researched ..."

Further in the stem cell example participant K noted that "... well I wouldn't put just stem cell into Google Scholar [because] that would probably give me around 10,000 results which I never hope getting through. But what I do in Google Scholar is adding stem cells with ethics or stem cells with cancer so I will try to do a more sophisticated search because the database is big enough that I can ask it a sophisticated question and it can give me maybe some more. It will give me results for a more relevant search and may be instead of having 100 pages of results or may be 10 pages and 10 is the number that I can reasonably get around with."

4.3.1.3 Search by analogy strategy.

The third question asked participants to orally give a step by step process how they would go about searching using keywords to find a book to answer the task, and then use the book citation to find a magazine and journal that will be used to answer the same question. In this case the subjects searched for a book using topical terms selected from the task, and then they found an article and magazine not necessarily based on the book, but rather one whose subject content would answer the task. To be able to do this task, participants reformulated their search based on the identified book to find a magazine and journal to answer the same question. This search process was referred to as search by analogy.

The researcher asked each subject to choose one task based on their subject specialization. Those in the humanities or social sciences had two choices, either to pick '*what are the effects of global warming on the habitats of endangered animals?*' Or '*what is the impact if race on fraternity recruitment*?' Those in the sciences selected either '*what are the trends in designing energy-efficient houses?*' Or '*what are alternative medicines approaches to treating arthritis in Africa*?' As in question one, eight participants (A, B, C, F, G, H, K, and L) chose to do the science task, while six participants (D, E, I, J, M, and N) chose to do the social science/humanities task. Participants picked the keywords to use in searching based on their choice of question statement.

To find the initial book all the participants said they would use search words from the question statement that was given to them by the researcher. Six participants (A, B, C, G, H, and J) said would use UIUC's VuFind, one participant (L) would use UIUC's Library website, while four participants (D, F, K, and N) would use Google Scholar or the Google search engine. Two participants (E and M) would first use UIUC's VuFind to find the book, then use Google Scholar or the Google search engine to find the magazine because it is non-scholarly, but use UIUC's databases to find the journal because it is scholarly. Lastly, one participant (I) said would use Google Scholar or the Google search engine and then chat with a librarian.

Participant M, one of those who proposed to use UIUC's library website, said that the magazine is not a book, it is periodical and non-scholarly, so "... I might do the multiple databases search in the library's website but there is a section in the article databases called LexisNexis news [which contains] newspapers articles, so I might look there. I might also use Google Scholar, Google search engine, or Google News." Participant M further said that Google news is preferred because it is a news search engine and will return other news sources, for instance local news, stories, or local magazines.

Participant I would have "like ten Web pages open and one of them is a library search, ... a Google mini search, then Google Scholar ... I don't know how I think that way, but I like it because I can look at how the searches are returned." Participant I further mentioned that "I will keep [one tab open] and move on to another tab and then I will be able to get back to it. I do chat with librarians because it is

right there in the Web interface." Participant I enjoys interacting with librarians because they are excited about research in general, "… so if I come in excited about my idea the librarian will get excited with me and [will] help me find information."

To get the book, participant E would start from the library catalogue by putting in the keywords in the simple search box. The keywords would come from the question statement provided by the researcher. For the magazine, participant E noted that has never searched for magazine and therefore has no idea how to search for it or what search tools to use. To get the magazine participant E would use the Google search engine's simple search box by typing in the search keywords from the question statement provided by the research. In this part of the question participant I would repeat the same steps as in question two to get to the materials.

To get the book participant B said the keywords are "*arthritis*" and "*medicinal approaches*." First participant B would type in "*arthritis*" and then "*medicinal approaches*" in the library catalogue's simple search. Participant B noted that the output would lead to the topics that are covered, further noting that "... when I type in "*medicinal approaches*" [I will get results that will include] the treatment so I do not need to type treatment ... and if I would like to go to Africa then I can add the word "Africa" as part of the keywords." In the results list participant B would go ahead and identify the book. To identify the best book to answer the question, participant B said that "normally different books have like summaries for different chapters so [I] would read summaries of different chapters ... in these summaries I would look for keywords searched, like arthritis, medicinal approaches, alternative medicine approaches. Then I would try to make the whole question statement go into the summaries and try to see if the summaries feature the question statement keywords."

Like participant B, participant J would use a similar process, but noted avoiding searching with one keyword instead will use at least two keywords – "*alternative medicine*" then added "*arthritis*" – in order to avoid making the search broader. "Normally if you make it very broad it will give you all the irrelevant information that you might not need so it is always good that you identify your keywords. Using these keywords ("alternative medicine" then added "arthritis") would give me results and from that

[results list] I would add a third word of interest – “Africa” – in order to make the results smaller and I don't spend too much time looking through too many search results." Participant J emphasized looking for the presence of the keywords in the search results. For the magazine, like participants E and M, participants B and J said would look for them from health magazine publications that they would search for from the general search engines like Google search engine because magazines give general information.

Two participants, N and F, would put the question statement as it is given by the researcher in Google search engine's simple search box or use Google Scholar. Participant N believes that Google Scholar would give results containing some books, some magazines, and some journals. Participant I would use the Google search engine or Google Scholar results, then go back to the library and search for the book, magazine, and journal using the Easy Search box because "... the library catalogue will have all the titles or headings ... to use. I will use “*impact of race on fraternity recruitment*” on Google Scholar, so Google Scholar will help me find a book, magazine or journal reference or citation to use and search in the library catalogue." From the open tab running Google Scholar, participant I would put in the keywords to get general titles or what has been written on the topic or something related. Then noted “… when I see something related to the topic I would click on the link to see if the full text is available but if I fail to get it, then will proceed to the library catalogue. The next thing would be to copy and paste the item details to the library catalogue search box and click search, then go over the search results to identify a matching item.”

Participants D and K opted to search using Google Scholar's simple search box by typing in “*race and fraternity recruitment*” and “*impact, race, fraternity recruitment*” respectively. From the results page looked for books, magazines, and journal articles. The participants would pay attention to the match between searched words and those in the results list and the kind of the information materials - whether books, magazines or journals. For the journal articles, participant D observed that "I would prefer to limit the search to those published less than five years ... I will also look at those journals published out of African American studies, I will look at what the journals talk about the prominent scholars on race or

related topics. I will review the search results based on matching author with journal name." According to participant D, VuFind does well at giving details about who is contributing to the book, magazine or journal.

Participant L would use UIUC's library website. From the website "I will select access points options matching the kind of information materials wanted, for example select books when search for books, magazines when looking for magazines or Journal when looking for journal article. From the results list page participant L said would look for the matching search results."

Four participants (A, H, G, C) would go to the library catalogue then choose the option for books, then type in the keywords, for example *"global warming* and *indigenous animals"*. For example, participant A noted that "based on [the keywords], I hope that it will bring up books which I have access to. If I am looking for magazines I will also select magazines and then put in the keywords and if I am looking for a journal article, I will also click on it and also type in the keywords I chose."

4.3.1.4 Empirical search strategy.

The fourth question asked participants to orally give a step by step process for how they would go about citing an item in MLA and APA styles when provided with the details of the item. This was quite straight forward questions that required participants to use any search tool or citation tool of their choice to get the citation for the item provided in the question statement. For participants from the social sciences and humanities discipline were asked to find either the MLA or APA citation style of an item with the following details: Title: Driving records of persons arrested for illegal drug use; Main Author: Crancer, Alfred; Other Names: Quiring, Dennis L.; Published; [Olympia]: State of Washington Dept. of Motor Vehicles, 1968. For the participants from the sciences the item details were: Title: Pounder's marine diesel engines and gas turbines; Main Author: Edited by Doug Woodyard; Published: Amsterdam; Elsevier/Butterworth-Heinemann, 2009; and Edition: 9th ed.

Participant A would type in the title of the item into UIUC's library catalogue and press search. Once finding the item, participant A would click on the item and look for the 'cite' link found on the right side of the screen to get the citation. Then they would be able to get both MLA and APA citations.

Participant K said would do it manually, "… [while] I have attended RefWorks trainings [in the past] I haven't been practicing. The time I have [used] RefWorks was for [exporting] articles but it has been a nightmare experience. I have decided not to use it again. Even Endnote has not help me so I just decided to do it manually."

Participant L would go to Google Scholar and cite it from there, "... if I am using APA, the sixth edition ... I will go to Google Scholar, ... type in the book title in the search box. [From the results list] I will select which way the citation will be. From the library [catalogue] I can go to VuFind from there you have an option to cite the general book."

Participant D would use Endnote or RefWorks but neither of these has worked well in the past. The participant noted that "I cannot go in and use Endnote or RefWorks later ... I have to go and manually change it." Participant I would use Google Scholar or UIUC's library catalogue, "... I will go to Google Scholar to give me APA style and then I will come back to the library website where I can download them. Sometime when I was publishing a paper I had to use the Chicago Manual, I went to Google scholar and so when it popped up I remember came back to the University catalogue and I did the same and then I printed it out." Participant B has not used any citation features in search systems, saying "... I am not familiar with that features. I have used APA using my Word document." Participant E has used they Mendeley citation manager to make citations, but has not used the library catalogue. While participant J has used Purdue University's Library online writing lab website resources to do citations, six participants (C, F, G, H, M and N) said they have not used any citation features in VuFind or Google Scholar like other participants mentioned above.

4.3.2 User study.

Unlike in the previous section (task analysis) were participants were asked to orally describe how they would go about searching for information materials, in user study participants were watched and recorded performing searches on UIUC's VuFind installation or any system of their choice. The first question asked participants to search for a known item in VuFind catalogue or any system of their choice. The known item search question was categorized as a bibliographic search strategy.

4.3.2.1 Bibliographic search strategy.

The researcher told each participant to find information materials appropriate to answer one of the two tasks based on their subject specialization. Those from humanities or social sciences were asked to find encyclopedia article with a title "Background checks" from the *Encyclopedia of Privacy*, [two volumes], Santa Barbara, CA: Greenwood, edited by William G. Staples; while those from the sciences were asked find to encyclopedia article with a title "Archimedes' theories" from the *Encyclopedia of Scientific Principles, Laws and Theories* [two volumes], Santa Barbara, CA: Greenwood, edited by Robert E. Krebs. As illustrated in **Table 4.2**, eight participants (B, E, F, G, H, J, L, M, and N) chose to do a science task while five participants (A, C, D, I, and K) chose to do a social science/humanities task. Ten participants (A, B, C, D, F, G, I, K, M, and N) started their search using UIUC's VuFind, two participants (E, J) started their search using the Google search engine, and two participants (H, L) started with UIUC's library website. Of the ten participants who started their search with UIUC's VuFind, four participants (D, F, I, and M) switched to Google Scholar to complete their search, and one participant (L) who had used the UIUC Library website (**Figure 3: University of Illinois at Urbana-Champaign (UIUC) Library website**) also changed to UIUC's library website.

The participants exhibited totally different search behaviors, however they had some similarities in the choice of their keywords, search tools, search options (either using basic or advanced search options), and access points. For example, four participants (B, F, G, and N) entered "Archimedes theories" as keywords into VuFind's simple search box, while participant M selected the same keywords but in VuFind's advanced search option. After making a search in the VuFind catalogue using "Archimedes theories" these participants (B, F, G, M, and N) either switched to search with the encyclopedia title words or added the encyclopedia title words to their first search. On the other hand, five participants (A, C, D, I, and K) entered "background checks" as keywords. Of these, two participants (C and D) used the advanced search options while three (A, I, and K) used the simple search option. Eight participants (A, C, D, F, G, I, L, and M) also selected access points to qualify their search, for example participant L selected author options, while two participants (G and I) selected title options but also used

database type, and subject options respectively. Two participants (F and M) used author and title access points with participant M specifically entering last name, first name - in that order. Three participants (A, C, and D) selected different access points and used facets during searching. For example, participant A spent a lot of time navigating through the facets and after many trials finally selected the author option; participant C switched between the simple search box below the search results and the advanced search option link on the results page; and participant D selected item format and navigated through the facets limiters on the UIUC's VuFind catalogue, but failed to find the encyclopedia option. Of the fourteen participants, seven (B, E, F, H, K, N, and M) managed to find their respective encyclopedia article, while the other seven (A, D, G, I, J, and L) failed.

Given the disparity in searching behaviors, below is a detailed but condensed outline of how each of the participants performed on question one. The account for each participant is important because of the unique and distinctive approaches each participant used while searching for the materials.

Participant A entered into VuFind's simple search box the word "background", then checked through results, added "checks" to have "background checks" and clicked search. Participant A hovered over the facets but clicked none of them, then clicked on the sort options, scrolled back to the search box, added "encyclopedia" keyword and pressed enter. Two items showed up in the results page. The participant then went back to the search box, retyped "background checks" and pressed enter to search again. A scrolled multiple times and clicked through the different facet categories specifically looking for the title of the encyclopedia and the author/editor's name with without success. A then removed all the other keywords from the search box, typed in the editor's name "William G. Staples", selected author from the drop-down access points options and pressed enter, scrolled down the search results, and right-clicked on the title "Encyclopedia of privacy [electronic resource]". At the long bibliographic display for this item A looked through the different options, including location, availability, table of contents, then scrolled down to the search box below the search results, typed in "background checks", and pressed enter. A reviewed the search results but did not find any helpful, then clicked the browser go-back-button

and went back to the long bibliographic display of the *Encyclopedia of Privacy*. At this point the participant satisficing settled with these results.

Participant B started by typing “Archimedes theories, encyclopedia of science principles” in the simple search box of UIUC’s VuFind catalogue. With irrelevant results, the participant switched to search for “encyclopedia of scientific principles.” When asked why B removed the first keywords “Archimedes theories,” participant B replied that “Archimedes theories” is a narrowed subject and would retrieve the *Encyclopedia of Scientific Principles* in the results. After failing to get the desired results, participant B changed and typed in the “encyclopedia of scientific principles” in the search box and clicked the search button. From the results page participant B clicked on the title to go to the long bibliographic display but failed to continue to get the full text (**See Figure 5: Screenshot of the UIUC's VuFind Long Bibliographic Display**). Unlike the short bibliographic display (**See Figure 4: Screenshot of UIUC's VuFind Short Bibliographic Display**) with a link “Get it online”, the long bibliographic display had an “ABC-CLIO - Full text online” clickable link to the encyclopedia that the participant failed to see. The participant observed that much as it was the item needed, it wasn’t opening. When asked why the participant never clicked “Get it online”, replied "... when it is opened I expected the encyclopedia to be online but it is not online so since it's not online I might decide to leave this page and go elsewhere." While saying all this, participant B clicked on the link “ABC-CLIO - Full text online” which opened in another window. This opened the encyclopedia page but participant B never saw it opening from another window tab. Participant B did not appreciate links opening from other tabs and noted that this was a time wasting process.

From the UIUC’s VuFind's basic search interface participant C clicked “advanced search option,” then typed in the first search box “background checks”, checked through the facets but clicked none of them, scrolled up and clicked the “Find” button. C looked through the results, scrolled up and down, then changed to the VuFind catalogue front page and typed "encyclopedia of privacy” in the simple search box. From the results list C clicked “Encyclopedia of privacy [electronic resource]” to go to the long bibliographic display. Not satisfied with the details displayed, C clicked the browser go-back-button and

then clicked another title entry for “Encyclopedia of privacy.” This was a print title available in the stacks. Without spending time on this page, C clicked the advanced search option, in the first search box typed “encyclopedia of privacy” and in the second search box typed “background checks” which gave no results. At the no results page C clicked to go to the I-Share catalogue that displayed results after an automatic search with the same keywords. After a couple minutes on this page, C then changed to UIUC's VuFind advanced search, typed in “background checks”' in the first search box, then “Williams G. Staples,” and clicked search but no results showed up. Again C clicked I-Share but still failed to get to the encyclopedia article.

Participant D switched between the advanced search and simple search of UIUC’s VuFind catalogue, and finally settled on the advanced search. When asked why, the participant noted that the advanced search option allowed narrowing the search as they chose. In the first search box D typed in “background checks,” in the second search box typed in “encyclopedia of privacy,” then in the last search box typed in editor's name “Williams G. Staples.” Then D limited the search to books, and the English language option available in VuFind’s advanced search, then clicked search. With no search results participant D then changed the keywords to “background checks encyclopedia” and pressed enter. On achieving results, participant D was astonished and showed a sign of relief, then mentioned that they would check through the results page and the facets to see the variety of things the library has. The results were not that good so the participant decided to go back to the UIUC library website. D clicked the Illinois logo 'I' redirecting the window to UIUC home page, and then clicked the library link to open the UIUC library website. From the library website D selected “Articles” then typed in “background checks” and clicked the access points to select the encyclopedia option or anything close to that. Disappointingly the search results were not good. The participant selected “Multi Subject Resources” and then clicked “Go.” From the results page (UIUC's dashboard), the participant looked through the results, then clicked the “WorldCat” link from the results list. From WorldCat's interface, participant D scrolled down and up, without noticing anything relevant, then clicked the UIUC Library website home page link to open UIUC Library website. At the library website, the participant clicked the link “Encyclopedia” under "Reference

Tools" hoping to search for or browse for the encyclopedia. Disappointed by the page that opened, the participant noted being unable to search or browse for the encyclopedia, then said that despite not getting the encyclopedia "... at the back of my mind I am looking for an encyclopedia resource ..." D further noted "... the list is not in alphabetical order ... and I cannot search [due to no search box]. When frustrated with such, I seek the librarian assistance." After failing on the above fronts, participant D opened another tab and went straight to Google Scholar. The participant used Google Scholar because of its SFX technology that identifies materials owned by the library with a UIUC logo. After multiple searches participant D accepted failing to get the encyclopedia article.

Participant F started from UIUC's VuFind basic search and typed "Archimedes theories, encyclopedia of scientific principles" as keywords then clicked catalogue options, but selected none of them, then pressed enter. No results showed. F clicked on the access point, selected none. Again F clicked and selected author and typed in the author names, but did not search, instead changing to the title option and typing in the title name. F noted title words would be more specific, typed in "encyclopedia of scientific publications," and pressed enter. At the results list, F scrolled up and down reviewed the results, and mentioned looking for author, publisher and publication information. Then went back to the search box and added "laws and theories", selected title access point and local catalogue, then pressed enter. Still there were no results. F then went to Google search engine, then switched to Google Scholar and entered "Archimedes theory" and the author words "Robert E. Krebs" and pressed enter. At the results page F specifically reviewed the title, author names, and publication details. F finally clicked the ABC-CLIO EBooks databases link to open the encyclopedia and to the article.

Participant G typed in "Archimedes theories" in the UIUC's VuFind simple search box and then added the encyclopedia title "encyclopedia of scientific principles", but received no results. G then changed the keywords and searched for the encyclopedia article title "Archimedes principles," selected title options and selected the All I-Share catalogue option. From the results list participant G clicked none and changed the keywords again to "Archimedes theories encyclopedia" which brought one results that was not relevant. After these trials and failures participant G noted rarely using the VuFind catalogue,

then changed to Google search engine. At the Google search engine, G searched “Archimedes theories scientific principles Santa Barbara” and pressed enter. From the results list participant G scrolled through the results, added the word “encyclopedia” to the keywords and searched. This still gave poor results. When asked why they added all these keywords, participant G replied “… I have to search with all the keywords that are given in the question to make sure I get to the article.”

Participant I started with typing in “background checks” in the UIUC VuFind library catalogue's simple search box, then selected “title”, but immediately changed to “subject” from the drop-down access points list. From the results list participant, I observed that while the search keywords were highlighted the results were irrelevant. None of the author, title, publication dates and publishers matched the details of the searched item. Disappointed by the search results, participant I switched to the UIUC VuFind front page, typed in “William G. Staples” and clicked search, but the results were poor. I next typed in “encyclopedia of privacy” and selected keyword option from the access points, and reviewed the results for author name “Williams” without success.

Immediately participant I left the UIUC VuFind catalogue to use the I-Share catalogue which was also unhelpful, then switched to Google Scholar. In Google Scholar the participant typed “Williams G. Staples,” added “background checks,” and searched. Without getting any relevant results participant I said they would seek the assistance of a librarian by visiting the library or chat from the UIUC library website.

Participant K typed “background checks” in the simple search box of UIUC's VuFind, selected title from the access points, then clicked “Find”. Without selecting any item K scrolled up and down, then typed “encyclopedia of privacy” to add it to the already existing search words “background checks,” clicked search options, selected Title, then clicked “Go.” There were no results. K then scrolled back to the search box, removed “background checks” from the search words, then added “encyclopedia of privacy” and pressed enter. Then K scrolled through the results and clicked "Encyclopedia of privacy [electronic resource], then checked the publisher, publication date, and thereafter clicked to see the table of contents, location and availability, then clicked the link to the online resource/encyclopedia and successfully got the encyclopedia article.

Participant M used UIUC VuFind's advanced search and selected the advanced search option that matched the bibliographic details of the task. M then selected the author access point, typed “Krebs Robert” in the order last name, first name, then pressed enter. From the results page participant M selected the book item and noted starting from there to identify other similar books. At the results page participant M identified the text that matched the search keywords in the task, for example author name “Krebs” and item title “encyclopedia of scientific principles, laws and theories,” then the location and availability. K observed that the item was an electronic resource, but also noted they would use the “text me the call number” feature to get the call number if the item was a print item because it saved them from moving around with half a dozen index cards containing the call number as the case was in high school. Further, participant M noted that “I think this is [call number feature] one of my favorite things.” Participant M then browsed through the results page to the item searched. Participant M retrieved the electronic version of the encyclopedia article.

When asked why participant M never searched with the article title “Archimedes theories,” M reasoned that personal experience has taught them that search engines do not work that way for known item searches. For search options, that title search is the best search option for known item searches. When pressed further to explain this observation, participant M said "well I am suspicious! But seriously if we look here, Archimedes is not listed as the item title. *Encyclopedia of science* is the item title." While at the ABC-CLIO Greenwood e-book website, the gateway to the Encyclopedia, and pointing at the alphabets of the table of contents for the book, participant M noted that "... I suppose sometimes this information isn’t very complete you know because you might look at the table of contents and you might say these are the Bs, the Cs and yet here it gives you volume 1, A to K and volume 2, L to Z. And then you don't have the titles." After clicking on alphabet “A” the page opened with all the titles under A. Participant M noted the search results. However, M was disappointed with the word 'Archimedes' not appearing anywhere on the list. Then M suggested that one has to be really efficient and it helped if one is a little bit savvy about how to search these things.

Participant N started with UIUC's VuFind simple search, clicked access point options, selected searching with the “All libraries I-Share” option, then typed in “Archimedes theories + encyclopedia of scientific principles + background checks” and searched with no results. Participant N noted that they would look for the encyclopedia first and then search within the encyclopedia for the article. Within the search box of the I-Share catalogue participant N changed the search keywords to “encyclopedia of scientific principles, laws and theories” and pressed search. From the results list, N selected and clicked on the right title which opened in the long bibliographic display, and then clicked the online link to the encyclopedia's ABC-CLIO EBook databased and browsed to the article.

Instead of using UIUC's VuFind catalogue, participants E and J used the Google search engine, while participants H and L used UIUC's library website. Participant E opened the Google search engine in another tab, typed “encyclopedia of scientific principles, laws and theories” into the simple search box and clicked search. From the results page participant E clicked on the link to Amazon and wondered if the book could be bought. When asked why E started with Google search engine, participant E replied that search engines provide links to other sources like journal websites, however all the searches failed to give relevant results, then switched to UIUC’s VuFind. When asked why not use the author option, participant E replied that "I usually use author but rarely use title." To complete the task, participant E typed in the encyclopedia title words “encyclopedia of scientific principles, laws and theories”, and from the search results confirmed the details of the encyclopedia and mentioned that "... its [an] online resource" and clicked "Get it online." At the ABC-CLIO Greenwood eBook website, the gateway to the Encyclopedia the participant mentioned that "I will search “Archimedes theories.” After searching the encyclopedia article was retrieved from the search results. When the researcher asked the participant why they didn't use the library catalogue to search for the book in the first place, E replied "I usually don't start with the library catalogue. I start with Google."

Participant H started from UIUC's library website, looking for anything on the website that says encyclopedia. H could not see anything saying “encyclopedia”, and therefore decided to go to the search box and search for “encyclopedia.” In the UIUC's library website search box H typed in “encyclopedia of

scientific principles, laws and theories" and pressed enter. From the results list H noted not searching for encyclopedias before but could try the results list at the library website dashboard, and so clicked on the Voyager Classic library catalogue that opened in a different tab. From the results list H identified the second item with matching details, clicked on the title that opened the long bibliographic display, looked for the article title, and tabbed on "Full View," then "ABC-CLIO Full Text Online" without clicking it. Then H wondered how to get the full text pdf of the article. Finally, H clicked on the "ABC-CLIO Full Text Online" link that opened the ABC-CLIO EBook Collection to get the full text article.

Participant J searched the Google search engine with "Archimedes theory from encyclopedia." From the results list J clicked the second item on the list which opened *Britannica Academic* edition online with an "Archimedes Principle" article, and clicked on one of the links that is a reference to this same web page which changed nothing. J moved the curser and clicked on the different navigational tabs, then changed to the Google search engine with the same search keywords and went straight to the search results and clicked on the title with the Wikipedia article. Without success, participant J again opened the Google search engine and searched with the keywords "encyclopedia of scientific principles, laws and theories," then clicked on each of the links that appeared on the list, finally failing to get the encyclopedia and article.

Participant L started from UIUC's Library website and typed in "Archimedes theories," then clicked on the search option but selected none of them and clicked "Go." At the results list on the UIUC's library dashboard, the participant clicked the first link for EBSCOHost. From EBSCOHost's interface the participant looked through the article titles. Since there was nothing promising the participant decided to add the search keywords "Encyclopedia article" from the EBSCOHost's advanced search box. There were no results after searching. Then L clicked the browser's back button and went back to UIUC's library website. From this website, the participant typed "encyclopedia of scientific principles Archimedes theories" in the search box and pressed enter. From the UIUC's library website results page nothing was showing in any of the different database categories searched. Apart from WorldCat showing 27 results, EBooks 11title and Web Search engines 1230 titles, all the other database categories showed "No Search

Results." From the same interface participant L typed the editor's name “Robert E. Krebs” into the search box and selected the author option to qualify the search and pressed search, and from the results page (UIUC's dashboard) clicked an EBSCOHost link.

At this point participant L changed from EBSCOHost to using Google Scholar and this time clicked on the Google Scholar category, repeating the same search for the editor's names “Robert E. Kreb.” On this page participant L went ahead and added “Archimedes theories” in the search box on top of the editor's name that was originally searched by the system. This time L got no results. L clicked on Google Scholar's suggested option “Did you mean” and looked through the results, then immediately removed the name “Robert E. Kreb” and pressed enter. L looked through the results and finally gave up with the search. When asked what to do next, L noted "... if I need to find something for sure I will have to contact the librarian." This participant failed to get the encyclopedia article.

4.3.2.2 Analytical search strategy.

The second question asked participants to search using topical terms. Searching by expressing the information needs in topical terms was categorized as an analytical search strategy. Like in question one the researcher told each subject to find information materials appropriate to answer any one of the two tasks based on their subject specialization. Those from humanities or social sciences were asked to find sources that give a general overview and background information on the beneficial aspects of steroids for sports while those from the sciences were asked to find sources that give a general overview and background information on the ethical issues of stem cell research. Participants picked the keywords to use in searching out of the question statement of their choice. Eight participants (B, E, F, G, I, K, L, and M) chose to perform science tasks while six participants (A, C, D, H, J, and N) chose to perform humanities or social sciences tasks. Seven participants (A, B, C, D, G, H, and L) chose to start their search with UIUC’s VuFind catalogue, six participants (E, J, I, K, M, and N) chose to start with UIUC’s library website, while participant F used the Google search engine to look for book titles and later changed to UIUC’s VuFind catalogue to search for the books. Three participants (A, B, and M) used different access points options while searching, for example participant A used VuFind’s facet limiter

options, participant B sorted the search results by publication date, and participant M selected to search with “Everything” under the “Multi-Subject” option of the UIUC library website. All the fourteen participants succeeded in performing this task.

Of the seven participants (A, B, C, D, G, H, and L) that used the UIUC’s VuFind catalogue, participants A and B showed quite different search behavior from the rest of the participants. A detailed but reduced account of their (A and B) individual actions is presented. Participants C and D had similar search behavior, but differed from G, H and L. The detailed but condensed outline of how each of these participants performed on question two follows below.

In the UIUC's VuFind catalogue, participant A typed “steroids and sports” in the simple search box and pressed enter. On the results page A clicked to expand the “Format” search limits options, right clicked on “Books” option under “Format” and opened another tab. At that tab A looked through the results several times and without selecting any, then noted “… I am looking for articles or any electronic resource.” A then clicked the Advanced Search button and hovered over the search limit features - facets, but selected none. Then under the advanced search option, A typed “steroids” in the first search box and “sports” in the second search box. A got no results because steroids was wrongly typed but never noticed it. Then A moved back to UIUC's VuFind catalogue, and from the results page clicked on the title *Drugs, steroids, and sports* and said they would check out and use this resource for this question since it is available. Participant A noted they would check the relevance of the item against the subjects listed in the item's bibliographic records.

Participant B typed “ethical issues of stem cell research” in the UIUC VuFind catalogue’s simple search box and pressed enter. At the results page B selected “Newest First” under the sort options, then looked through the search results specifically for search words. Then B noted that none of the search results had the search words highlighted. B then clicked the title *Bioethics and the future of stem cell research* as one whose title contain the search words, then matched the publisher and publication date to confirm the relevancy and quality of the material to the topic.

As noted earlier, participants C and D has similar search behavior. In the VuFind catalogue simple search box participant C typed in “steroids for sports” and clicked search, while participant D searched with “benefits of steroids for sports” as a keyword. At the results page participant C and D reviewed the search results to match the searched keywords and the words in the results list. Participant D right-clicked on different items on the list to open them in different tabs, then noted that they were looking for materials whose content is technical because participant D believed that materials that are technical could give a better overview and background information on the topic researched, and would be more detailed. Then participant D selected the title *Steroids and doping in sports: a reference handbook* by David E. Newton as the most appropriate item for the question. Participant C noted that if the search failed, then would resort to searching Google search engine for more appropriate keywords. From the Google search engine, C typed in “background information on steroids for sports,” then from the results list C said they would select things from ESPN because "... I know that at ESPN they know the use of steroids in sports." Participant C also said that would select the title “A Background on steroids in sports - News Africa,” then “A brief history of how steroids destroyed America's sports.” On the other hand, participant D added quotation marks to the search keywords "benefits of steroids for sports" to make the search more specific, but the search results were zero. Then D removed the quotation marks, searched the database and obtained search results. From the search results, participant D noted that they would use search limits, especially for the subject area specialty to make the search more specific. Thereafter D would look for those items that are electronic and print but would prefer electronic versions. D identified candidate items to answer the question.

On the other hand, three participants (G, H, and L) started from the VuFind catalogue, but each of them entered different keywords from each other before pressing search. Participant G entered “stem cell research,” then added “ethics”; participant H entered “ethics stem cell research”; while participant L entered “stem cell research” and after searching and looking at the results added “ethics”. Each of these participants (G, H, L) selected those books they thought matched their personal judgment to answer the question and said would give a general overview and background information on the topic.

Participants M and E used UIUC's Library search website and searched under the "Everything" option. However, participant M's search behavior was quite detailed compared to participant E. Participant E searched UIUC's Library website with the keywords "stem cell research", then selected the Voyager Classic catalogue option from the UIUC's dashboard to get to the books.

Like participant E, participant M opened UIUC's Library website and clicked the "Everything" tab, and selected "Multi Subject Search" option from the list of database search options then typed in "stem cell research" as keywords. At the results page the participant liked the different categories in which the results were grouped. Participant M called this the "dashboard." The dashboard categorized the results into small grouped database that included the library catalogue, Google Scholar, Google Search engine, EBSCOHost database and all organized in a single list. Participant M noted that they usually used the dashboard as "… my home page …" From the dashboard participant M right-clicked to open any of the grouped categories to open in another tab. Participant M further noted that "… what I am seeing here is that it has more than half a million articles, that is almost a million, there is a lot stuff here, and I don't really wanna do that." To narrow the results, participant M typed the Boolean connector "AND" and added "ethics" to the search. The results reduced to 2000 articles from over half million, then M noted "... that is a number I can work with ... if I click on Web of Science, it might be different. I might look at these journals …" Participant M clicked on each of the database categories that opened in a different tab and analyzed the search results. M compared journal titles in journal databases and Google Scholar, article titles and authors, and summaries/abstracts. Participant M noted that the title "Regulatory authorities and orthopedic clinical trials and expanded mesenchymal stem cells" was the most probable title that addressed issues of specific treatments developed. M also noted that titles on stem cells and religion could be interesting when handling general topics of ethics and stem cells articles. M further observed that relevance judgment would be based on those articles that addressed science and nature because of the scientific nature of the question. About the scholarly quality of the articles, participant M noted that "… the scholarship is really high quality but the articles are written more like magazine articles, so within the scientific community it is the very high prestige journals that matter." M continued

on to note that "… so like you have arrived if you have published in *Science* and *Nature* … I might pick these two taking a stand against pseudoscience that might have something to do with ethics because stem cells are controversial … I might pick these two because of the names of the journals." Then M selected the articles to their marked list, and sorted the marked list based on their publications dates (newest publications first), number of times cited, and those that were related. For example, participant M observed that "… this [article] has been cited more than 500 times, so it's really important. I will pick those and then add them to my marked list. So when I am happy with these 200 pages, I go through all of them … from my marked list." Participant M further noted that "… after opening the full text from the publishers I can see from the UIUC Discovery button that I have full text – so I like it when the button shows. From this Website I can go right to RefWorks and I can download all the citations." The RefWorks button was important to participant M as they noted that "… even if I don't use the article I have now saved it, I can go back to it if I wanted. But if I decided you know it's really interesting and it's something I wanna read. If I wanted … I can even go back." Then participant M downloaded the article from the journal and magazine. To get the book, participant M used WorldCat. From a new tab, M opened WorldCat and in the search box typed "stem cells" and "ethics" as keywords. At the results page M noted that "… it looks like I-Share has 751 titles and UIUC has 250 titles. I generally like to start big and go small. So I will start with I-Share because I think it looks more like VuFind catalogue." From the results page at the I-Share catalogue, participant M noted that "… there are all different kinds of sources, books, journals and magazines."

Like participant M, participant J and N used UIUC's library website. For search box keywords, participant N typed "beneficial aspects" then "steroids for sports," while participant J typed in "steroids for sports," then "background information." Both participants noted the number of search results in each of the database categories, for example participant J noted that "… it looks like I-Share has 223 titles, Google Scholar has 43200, UIUC library catalogue has 143 titles, EBSCOHost has 2200 matches." Participant N observed that "if you look down … VuFind has 253 matches, EBSCOHost 43 titles and 10 titles from book chapters that I can be able to access now. This is interesting because as a researcher you

know there is a lot of chapters to start with and books. This tells me that if I wanted to do steroids for sports and clicked on this [for example EBSCOHost] I would get articles for this research." To get the magazines, both participant clicked on the Google Search engine category.

Participant F started with Google Scholar, entered in "ethical issues stem cell research" and searched. In the search results F noted that they would look for books, by following the item format label "Book" that appears on each of the item in the results list. Participant F noted that after identifying the book title from the list, they would search for that in the UIUC VuFind library catalogue as earlier done in question one. Participant F preferred not to repeat that process of searching for a book from VuFind.

Two participants (K and I) opened UIUC's library website and in the simple search box on the website typed in "ethical," then "stem cell research" and pressed enter. From the results noticed search results from each of the database categories, then K noted "I would prefer to use electronic resources but I can look at the book first," then right clicked on UIUC's VuFind and opened VuFind in another table, and identified different appropriate titles of books to look at by right-clicking to open in a new tab. Then I said they would prefer also online sources, before scrolling up and down the results, closely examining the search limits. Without seeing anything helpful K opened another tab with Google search engine, typed "define genetics" in Google search engine search box, and noted that was looking for alternative words to use in the search because the first words used in the catalogue were not helpful." K went back to VuFind and noted that there are no really good results that directly connected to what genetics means as defined from the other website (the website searched through Google search engine). Then from VuFind catalogue results I clicked on the book title *Stem cell research: the ethical issues/ edited by Lori* and said would borrow this book to start with and find other better sources. Then I looked at the location and availability because it is exactly what the subject wanted. Participant K right-clicked on the VuFind catalogue results from the UIUC Library dashboard, then identified three titles of books as those to start with.

4.3.2.3 Search by analogy.

The third question asked participants to search for a book using topical terms and then use the book citation to find a magazine and journal that would be used to answer the same question. In this case the subjects searched for a book using topical terms selected from the task, and then found a related article and magazine not necessarily based on the book, but rather one whose subject content would answer the task. To be able to do this task, participants reformulated their search based on the identified book to find a magazine and journal to answer the same question. This search process was referred to as search by analogy. The researcher asked each subject to choose one task based on their subject specialization. Those in the humanities or social sciences had two choices, either to pick '*what are the effects of global warming on the habitats of endangered animals?*' Or '*what is the impact if race on fraternity recruitment*?' Those in the sciences selected either '*what are the trends in designing energy-efficient houses?*' Or '*what are alternative medicines approaches to treating arthritis in Africa*?' Five participants (A, B, C, E, and N) chose to do the science question while nine participants (D, F, G, H, I, J, K, L, and M) chose to do the humanities question. Ten participants (A, B, C, D, E, F, G, H, I and L) completed the first part of the question that required looking for the book using UIUC's VuFind catalogue and thereafter switched to other search tools of their choice. For example, participant A used UIUC's VuFind simple search box to search for the book, then switched to the advanced search option of VuFind to get the magazine and journal. Participant C used UIUC's VuFind to search for the book, magazine, and journal. To search for the journal and magazine, participant D chose to use the UIUC library website, B and E used the Google search engine, N, G, H, and L used Google Scholar, and the rest of the participants (I, J, K, and M) used both Google scholar and UIUC's library website interchangeably.

From UIUC's VuFind participant A typed "global warming and endangered animals" in the search box and pressed enter. From the results page A right-clicked on the "Books" option under "Format" and opened another tab. Then A scrolled up and down, right-clicked on the first three items and chose to settle for the first four books. The four books were selected based on the keywords matched in the item's bibliographic record and the table of contents within the bibliographic record of this item.

Participant A was not comfortable with the way the table of contents was organized. To get the magazine, participant A first clicked on the VuFind advanced search and looked for options to search specifically for magazines or journals. A typed “global warming” in the first search box and in the second search box typed “endangered animals,” but got no results. Then A went back to the VuFind simple search box, typed in “endangered animals,” then searched. A browsed through the results list from page 1 to 2, then added the keyword “and habitat” and pressed enter. Finally, A said they will not be able to find magazine and had never done it before.

To find the book, participant B started from the VuFind catalogue, typed in “medicine approaches arthritis” as the keywords in the simple search box, then noted they preferred to use keywords than author names because keywords gave a variety of resources to compare with. B clicked search and at the results page looked for books whose subject was related to medicine or pharmacy and were available. Then B said would select those on medicine and insects. They clicked the title *The arthritis foundation's guide to alternative medicine* and identified its location, availability, and format as a print book. For the magazine, the participant noted the library did not provide access to magazines and therefore getting them would not be easy, so the best choice to search for a magazine would be searching Google search engine. To get the journal articles participant B searched the VuFind catalogue and looked for the word “Journal” from the search limits. Without seeing the word “Journal,” they then searched Google Scholar for any journal articles without success. Then B switched to UIUC's library website page and in the search box typed in “medicine approaches arthritis” and clicked search. B noted that the UIUC library website interface was good for searching journal article and the dashboard provided grouped search results that aided making choices. Then B clicked PubMed. At the results page B noted the keywords were not highlighted which made it difficult to select the best journal articles. The participant strongly advised that the system should highlight search keywords to ease the work of selecting relevant materials from the search results list. Since science changes rapidly participant B preferred to sort the results by publication date.

To get the book, magazine, and journal article, participant C started with UIUC's VuFind catalogue, typed in “global warming effect on endangered animals” and clicked search. From the search

results right-clicked on “Electronic” search limit option under Format, and obtained one result. C noted “this is not good enough," then reduced the keywords to “effects of global warming” and searched again. At the search lists page C looked for titles with the words “global warming” or those related to it. C continued to check in the table of contents for selected titles, selecting the title “Global warming: implications for freshwater and marine fish” to identify possible keywords in the table of contents. To get the magazine, participant C said would ask a friend for help. Much as the participant was well aware that the library had magazines, they could not find them nor knew where to search or find the print. To get the article, participant C searched with “global warming and endangered animals” in the VuFind catalogue, then selected the title *Animals on the edge: reporting from the frontline of extinction* by Chris Weston from the results list and noted that "... I would look at the references or citations to this book and see what journal articles are referenced and then look for them online.”

Participant D typed in “race fraternity recruitment” as keywords in the UIUC’s VuFind catalogue to get a book. At the results page selected books where displayed whose title matched the keywords. To get the journal articles, participant D opened UIUC's library wesbite and clicked the advanced search option that opened the Journal and Article Locator (JAL) webpage. At the Journal and Article Locator (JAL) webpage D said they would enter in the name of the journal and search for it if it was known. But because the journal name was not known, D switched to UIUC's library website again. Then D clicked the article option on the UIUC's library website, in the search box typed "race fraternity recruitment' as keywords, and then from the search options, selected Multi-Subject Resources and pressed enter. At the UIUC library's dashboard, D selected EBSCOHost to get the full text of the article. At the EBSCOHost interface D selected articles, sorted out the most relevant and current, then e-mailed and download articles and citations.

Participant E started from VuFind catalogue and entered “arthritis medicine approaches treating Africa” in the simple search box but got no results. Then E changed the keywords to “medicine approaches arthritis Africa,” but still got no results. Then E clicked on the access points options, selected keywords and changed the keywords to “arthritis Africa” and pressed enter. E reviewed the two items in

the results lists and noted they would be a good start. To get the journal and magazine participant E searched the Google search engine. In the Google search engine search box E typed “alternative medicine for treating arthritis in Africa,” and reviewed the results but they were not helpful. Then E highlighted and copied the search keywords in the search box, opened Google Scholar, pasted the copied keywords in the search box and searched. At the results page the participant noted that the results were too specific and therefore they needed to reduce on the number of keywords. Then E deleted “medicine approaches” and left “treating arthritis Africa,” then scrolled down the results page and clicked on the title “Rheumatoid arthritis in blacks in South Africa” and said this would be a good article from the *Annals of the Rheumatic Diseases* - which is a journal. To get the magazine, participant E noted that they would go and talk to the librarian because this is something that had not happened in their research life.

To get the book, participant F said they would repeat the same process as in question two by searching UIUC’s VuFind catalogue. To get the journal and magazine, participant F first searched UIUC’s VuFind simple search for “ethical issues stem cell research,” then clicked on the title link to the journal website and then found the full text of the article. To get the magazine, participant F added the word “magazine” to the keywords “ethical issues stem cell research” to get “ethical issues stem cell research magazine” and searched, then identified titles whose source matched magazine, and when not sure clicked on the title to open the website and confirm that it is a magazine.

Like participant F, three participants (G, H, L) searched the VuFind catalogue to get the book. First each of the three participants entered search keywords “medicine arthritis Africa”. At the results page identified books whose title and subject words matched the keywords used. To get the articles, participants (G, H, L) searched Google scholar using the same search keywords “medicine arthritis Africa.” At the results page participant H and L identified the items whose titles matched the keywords searched. These participants noted they had never searched for magazine articles and therefore had no idea how to go about searching for them.

Participant N started from the VuFind simple search box and entered “arthritis + Africa” as keywords and pressed search, getting no results. N then changed the keywords to “arthritis Africa” and

got results. From the results N said would use the *The Cambridge world history of human disease* book title as a start. To get the magazine and journal, participant N searched Google Scholar with "arthritis + Africa" and looked through the results list to identify magazines. The participant paid attention to the title of the articles, author names, and magazine or journal names.

4.3.2.4 Empirical search strategy.

Question four required participants to get APA and MLA citation references. For participants from the social sciences and humanities discipline were asked to find either the MLA or APA citation style of an item with the following details: Title: Driving records of persons arrested for illegal drug use; Main Author: Crancer, Alfred; Other Names: Quiring, Dennis L.; Published; [Olympia]: State of Washington Dept. of Motor Vehicles, 1968. For the participants from the sciences the item details were: Title: Pounder's marine diesel engines and gas turbines; Main Author: Edited by Doug Woodyard; Published: Amsterdam; Elsevier/Butterworth-Heinemann, 2009; and Edition: 9th ed.

To get the citation for the item *Pounder's marine diesel engines and gas turbines* participant N opened Google scholar and in the search box typed in the title of the item "Pounder's marine diesel engines and gas turbines," then clicked search. The search item showed up in the results page, then N clicked on Google Scholar's "Cite" function and received the citation. Seven participants (B, C, D, F, H, K, L) all used Google scholar's "Cite" features to get this citation. Four participant (A, G, I, M) used the "cite" feature of UIUC's VuFind catalogue to make the citation. The participants who used VuFind searched using the title "Pounder's marine diesel engines and gas turbines," clicked the first item on the list to go to the long bibliographic display, and then clicked the "Cite this" feature to obtain the APA and MLA citations for the item. Participant E said they would use the Mendeley citation manager to make citation but since it was not installed on the research computer did not attempt this question. Participant J was too caught up by time to complete question four.

4.3.3 Individual Interviews

The individual interviews happened immediately after the user study. In this part of the study, the researcher asked the participant to provide one positive and one negative incident while using the VuFind catalogue or a system of their own. A positive incident was one when VuFind catalogue or any other system helped the participants to complete a task effectively, efficiently, or pleasantly. A negative incident was when VuFind catalogue or any other system of their own hindered or challenged the participants in completing their task.

Six participants (C, G, H, I, K, and M) said that question one that required searching for a known item (Bibliographic search strategy) was the most pleasant to search. For example, participant M noted that searching for a known item using VuFind was the most effective because "… I did this with little interpretation of what terms will be best to search for. I went right and it did not take long." On the other hand, six participants (A, B, E, J, L, and N) said that question one challenged them the most compared to other questions. For example, participant B noted that "… question one never gave us what we wanted to get and therefore was difficult to answer." Participant E said that "… getting this item in VuFind catalogue was very hard for me but when I used Google Scholar it was easier," and participant L observed that "… even if I had a lot of time, keywords, and all the information I needed, looking up through the title using two different things, like the article title and the encyclopedia name I couldn't find it. This was the hardest because there was a book and there was a part of the book."

Four participants (B, E, J, and L) said that question two that required participants to express their need in topical terms (analytical strategy search strategy) was the most pleasant to search. For example, participant B said that "… searching with topical terms gave me many results from which I chose what to use unlike the other questions." On the other hand, five participants (C, F, G, H, and I) said that question two challenged them most compared to other questions. For example, participant I said that "… for question two I tried and failed to get anything."

Two participants (F, and N) said that question three that required participants to formulate their needs through a known and appreciated item like a book (search by analogy) was the most pleasant of all

the four questions, while three participants (D, K, and M) said that question three challenged them most compared to other questions. For example, participant M said that "I don't find the catalogue as useful for searching the periodicals because I guess my experience in using electronic catalogues is that [they] are just not good … and I have found other ways of doing that … so I am happy to do it the way I have always been doing it." None of the participants commented that question four was negative but participants A and D confirmed that it was the easiest question attempted compared to the other three questions.

4.4 Conclusion

Chapter four presented data on fourteen graduate students from thirteen academic units with an average of three years of graduate study and varying experiences with computers and library catalogues. The data presented show how graduate students planned to search library information retrieval systems like UIUC's VuFind catalogue and other commercial databases like the Google search engine and Google Scholar (task analysis) and how they actually searched these systems (user study) with different information tasks (scenarios). Participants had differing views on how to answer the tasks (task analysis) and how they actually answered (user study) each of the information tasks. Each information task presented different challenges and required unique approaches in order to have relevant results. In the following chapter the researcher presents a detailed discussion summarizing the research findings. The discussion integrates the results with the literature review, speculates on the meaning of the results, and provides recommendations for future research and implications for practice.

Tables

Table 4.1. Survey Results

Participant	Academic Major	Year of Study	Computer experience	Familiarity with library catalogue	Using search engines	Using library catalogues	Familiarity with UIUC's VuFind
A	Community Health	2	Intermediate	Uncertain	Often	Sometimes	No
B	Nutritional Sciences	2	Intermediate	No	Often	Rarely	No
C	Agricultural and Consumer Economics	3	Expert	Yes	Often	Often	No
D	Human Resource Development	4.5	Intermediate	Yes	Often	Often	Yes
E	Human Resource Development	2	Expert	Yes	Sometimes	Often	No
F	Food Science	2	Intermediate	Uncertain	Often	Sometimes	No
G	Transport Engineering	2	Intermediate	No	Sometimes	Never	No
H	Statistics	4	Expert	Yes	Often	Sometimes	Uncertain
I	Education - Mathematics	4	Intermediate	Yes	Sometimes	Sometimes	Yes
J	Languages - French	3	Intermediate	Yes	Often	Often	Yes
K	Civil Engineering	4	Expert	Yes	Sometimes	Sometimes	No
L	Architecture	3	Intermediate	Yes	Often	Sometimes	No
M	Economics	4	Expert	Yes	Sometimes	Sometimes	Yes
N	Law	3	Expert	Yes	Often	Often	No

Table 4.2. Tabulation of the Interview Discussion

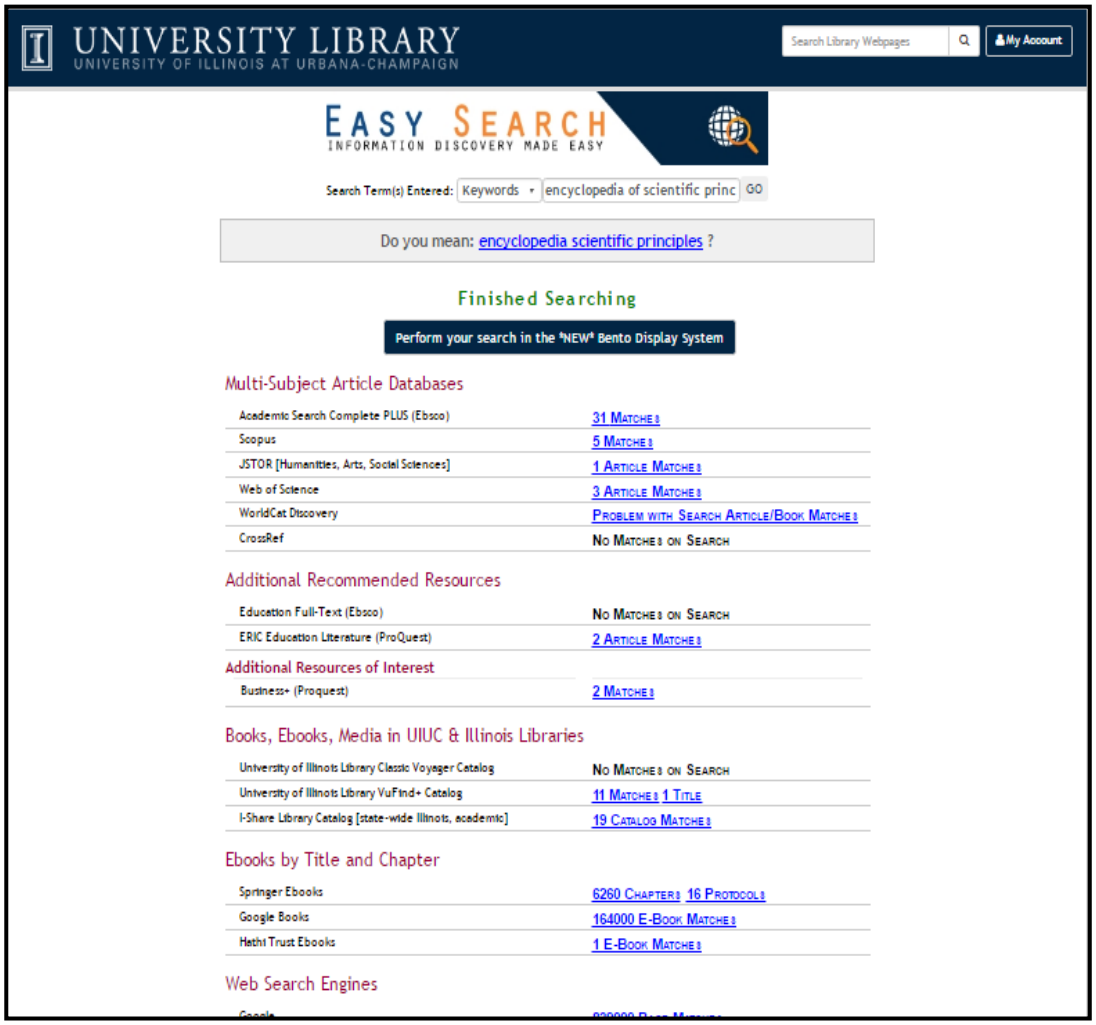
Information Task/ Questions	**Participants**	
	Positive Events	**Negative Events**
Question One	C, G, H, I, K, M	A, B, E, J, L, N
Question Two	B, I, J, L	C, F, G, H, I
Question Three	F, N	D, K, M
Question Four	A, D	

Figures

Figure 4.1. Screenshot of the UIUC VuFind Simple Search Box

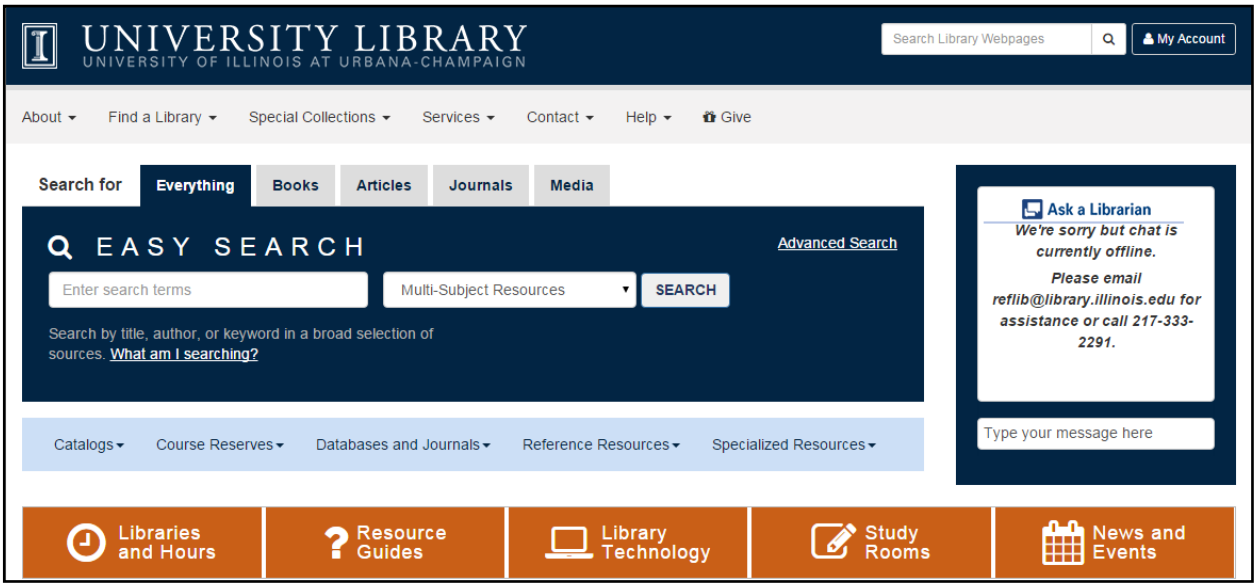
Screenshot of the UIUC VuFind Simple Search Box.

Figure 4.2. Screenshot of the UIUC Library Dashboard



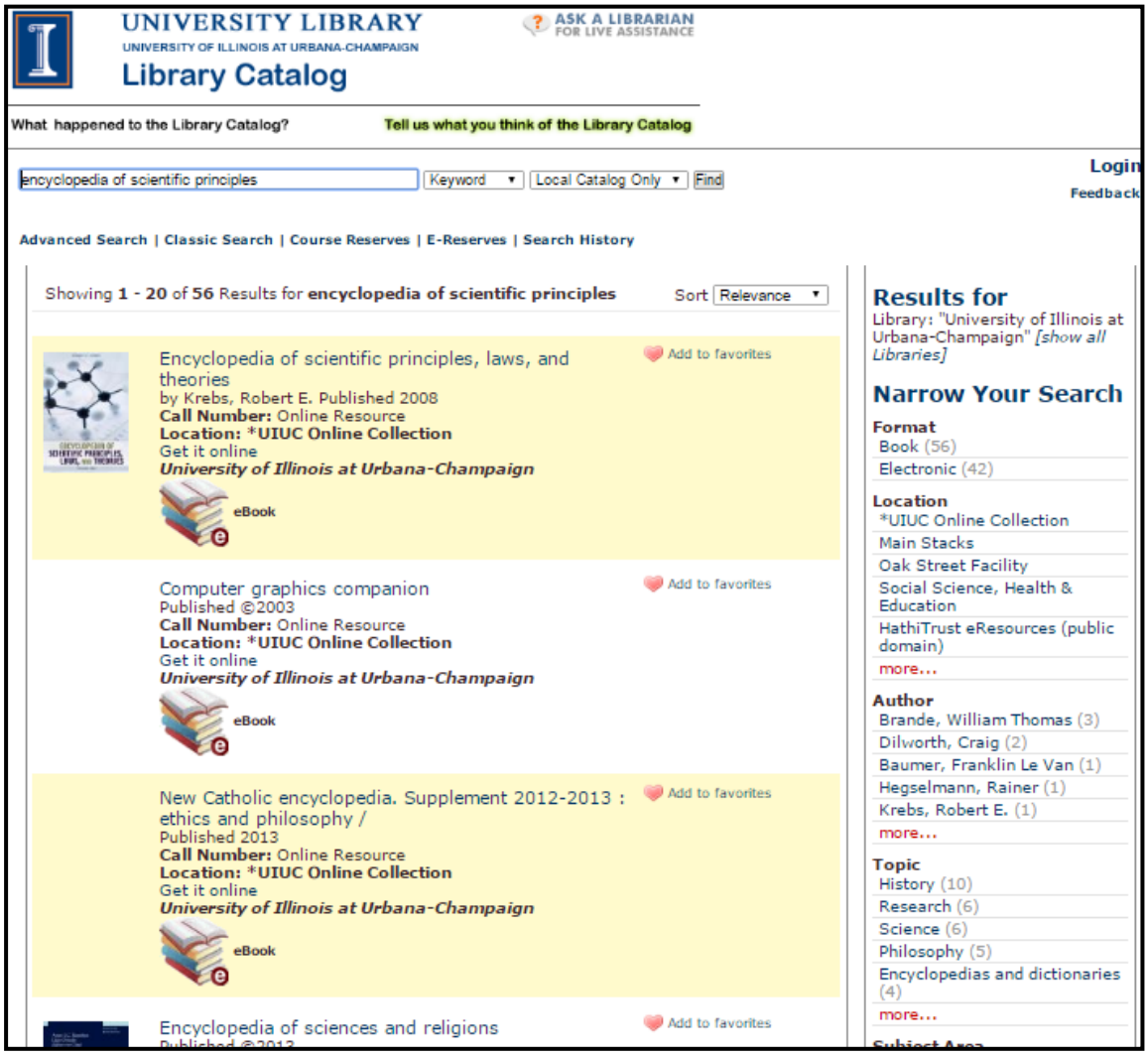
Screenshot of the UIUC Library Dashboard. The dashboard groups search results into broader categories and databases searched

Figure 4.3. University of Illinois at Urbana-Champaign (UIUC) Library Website



University of Illinois at Urbana-Champaign (UIUC) Library website illustrating the different search options and the Basic search box.

Figure 4.4. Screenshot of UIUC's VuFind search results – Short Bibliographic Display.



Screenshot of UIUC's VuFind search results. Each item is displayed with a few bibliographic details to help user determine the relevancy of the item. This display is referred to as Short Bibliographic Display.

Figure 4.5. Screenshot of the UIUC's VuFind Long Bibliographic Display.

Screenshot of the UIUC's VuFind Long Bibliographic Display. This is the screen that shows when the title of the first item (*Encyclopedia of scientific principles, laws, and theories*) in Figure 5 was clicked. The Long Bibliographic display gives more details for the item and allows the user more options like location & availability, table of contents, user reviews, etc. to decide how to proceed.

CHAPTER 5

DISCUSSION

5.1 Overview

Chapter five discusses the research findings presented in chapter four. The discussion is centered on the search features participants used to complete specific types of information tasks and how they understood the function of these features. The graduate students observed in the study used different search features while searching, with the choice of the system to search and search features used dependent on the searcher's knowledge of the system and experience searching similar systems. The graduate students selected familiar system features that they used in the past and searched in similar ways despite the type of task performed. This discussion integrates the results with the literature review, speculates on the meaning of the results, and provides recommendations for future research and implications for practice.

5.1.1 Research Question 1: What features of VuFind do graduate students use to complete specific types of information tasks?

Participants in this study use basic search for nearly everything because they get results no matter what terms they use. Basic search allows them to adopt a course of action that is low effort. They also tend to use this option to reformulate a search because the simple search box appears at every level of the search. These observations lend support to the finding that that the graduate students in this study seem to fit the profile of exploratory information searching behavior that is similar to that described by Bates (1989) and Ellis (1989).

Study participants rarely used the advanced search option. Exceptions include searching for local library collections or print collections. Advanced search is used as a secondary alternative when the basic search option returns too many results. It would seem that students still approach online catalogs as a list of local print holdings of the library as described by Charles Ammi Cutter in La Barre (2012). Advanced search is useful for participants because it provides the ability to limit the search parameters by format

and media type. Participants used the expanded and augmented entry options as found in the UIUC's easy search to search electronic resources in much the same way they used VuFind's field-directed search options. This means that when UIUC's expanded and augmented entry points are added to VuFind's search functionality, participants confidently use them to refine their search. Participants most frequently search using author, title, subject and keywords options because these features offer clear and quick alternatives to search reformulation with minimal effort. It would seem that despite the information task performed, field-directed search options offer the observed students flexibility in directing a search and support narrowing search results. Participants used UIUC Library dashboard, a categorized results list based on data harvested from the different resources searched (See Figure 2), because it offers a categorized list of results and allows users to expand their search to other databases within the VuFind search and discovery environment. Given the voluminous search results frequently obtained by participants, the dashboard offers much needed support for search reformulation.

5.1.2 Research Question 2: How do graduate students understand the function of VuFind's features?

VuFind's features are understood by participants in terms of perceived database size because when the user believes that there is a wide breadth of holdings in the VuFind database, they also believe it will give them highly relevant and current information. This finding means that user confidence in VuFind is more highly connected to the perceived breadth and size of the collection, and less connected to the search features available for users. Participants understand that VuFind's system functionality is able to support search reformulation strategies with minimal effort and in the least time possible. Participants prefer too many results to receiving no results. This finding means that the presence or absence of a search feature may not necessarily affect the search process. Instead, the ease with which a searcher is able to selectively use search features that would expend the least average effort is a paramount consideration. Participants also perceive VuFind's search features in terms of how the system presents and orders search results. The clear preference is for results that are organized in systematic and logical

order. Student participants also understand the function of VuFind's search features in ways that help guide them in selecting preferred format of information materials. This finding means that system functions should help orient the user, and help them make informed decisions during each search. There is also a strong relationship between the format of information materials represented in the system and owned by the library, and users' search behavior.

5.2 Analysis of the Results.

The discussion in this section integrates the results of this study with the literature and explores previous findings from online catalogue user studies and those of Illinois's VuFind installation to support the discussion in Section 5.1.1 and 5.1.2.

The behavior of the graduate students in this study reflects the patterns of exploratory searchers in Bates (1989) Berrypicking model of information seeking behavior, and in Ellis' (1989) descriptions of the search tactic, chaining, which assists users in identifying similar items (Ellis, 1989). In this case and as observed by Hildreth (1995) and Nowkarizi (2008) a search box becomes a very important feature a user expects to be found at every level of the catalogue interface.

Graduate students in this study use next generation catalogue features and understand its functionality in the same way that Charles Ammi Cutter defined the catalogue as a list of the holdings of the library that allows access to the library's collections. Graduate students in this study used federated searching options to search local library collections. Participants got frustrated when the catalogue failed to perform this role, for example when attempting to find a known item.

Next generation catalogues offer basic search as the default option in order to accommodate the expectations of today's users. In line with this fact, and as observed by Breeding (2010), Major (2012), and Skinner (2012), these graduate students defaulted to this type of searching (basic/simple search) to avoid spending much of their time reformulating queries. The basic search feature emerged out of the recognition that today's users spend hardly any time reading instructions, thus the usefulness of user assistance scored low on all types of tasks (Skinner, 2012).

In his 2010 book *Next-gen library catalogs*, Breeding (2010) observed that a both network of linkages throughout the interface of an information system between and among related terms and items; and providing discovery pathways is a powerful connecting force for search. The UIUC Library dashboard incorporates these suggestions by combining a summary of the information registries searched with connections to external applications (APIs). For that matter, networks of linkages (APIs) between related terms/items and discovery pathways/trails in the interface increased navigability and interactability. With this kind of deep interlinking the next generation catalogue remains "a connecting force" among all the information registries and online catalogs. The information provided on the UIUC Library dashboard was found to be responsive, informative, and interactive at that level of the search process.

The search formulation and reformulation strategies used by the observed graduate students align with the sequence of searching suggested by Huang and Efthimiadis (2009). Comparing the the graduate student's behavior between UIUC's library website and the VuFind installation, the findings are such that:

a) if the result list was satisfactory and there were relevant results, then their focus would shift to a specific item;

b) if there were too many results then their focus would shift to search reformulation features to narrow down the list so that it showed only the items that were more relevant; and

c) if there were no results, or if the results were not relevant, their attention would shift to reformulating the query.

Thus, features that supported query reformulation were those most highly preferred. These features put the graduate students in control of the system. The research findings of the current study are in agreement with Moore and Greene (2012) that systematic ordering, relevance ordering, and multiple output formats are important for supporting and sustaining search reformulation strategies for any kind of search. Given the expected voluminous search results, graduate students anticipated finding some form of assistance feature for reformulating a search on the interface.

The search within and interlinking options allow chaining, (Ellis, 1989) and exploratory searching (Bates, 1989). Application programming interfaces (APIs) in the output and external links, as well as the presence of a search box in the bibliographic display of every page (Breeding, 2010; Hildreth, 1995b; and Major, 2012) are important additions to search within and interlinking functionality. The empirical results from this research agrees with Ellis (1989), Bates (1989), Breeding (2010), Hildreth (1987b) and Major (2012) that search within and interlinking to cited and related terms - features supported in Google Scholar and Web of Science - are desired in the broader information landscape, specifically for analytical, search by analogy, and empirical search tasks. Few next generation catalogues offer this feature.

As evident in Kules and Capra's 2012 study, standardizing access points, field directed searching options, and bibliographic details are influential in the search process, since access points, field directed search options, and bibliographic features facilitate output and external links. Also important is the bibliographic display of entries as cross-references (Nowkarizi, 2008). This is because the task at hand influences the format of the information materials sought by graduate students, which in turn determined which database, search features and keywords they used in searching. In this case, the graduate students used the output and external links, specifically features that support sorting and relevance rankings, ordering, citation, search within, print, save, e-mailing, download full text and multiple output formats.

System responsiveness to a search query - a condition the participants referred to as "sensitivity" was an essential element in meeting searchers' demands. User goals and intentions, as well as the status of the user's anomalous states of knowledge (Belkin, 1980), background (Borgman, 1989), experience with search systems (Belkin, Seeger, & Wersing, 1983) and subject expertise (Leckie, Pettigrew, and Sylvain, 1996) all figure as important aspects of search. Therefore, for any type of information task, the availability of field directed search options, the terms selected during the process of searching, and the efficiency with which the search was performed all have important implications for the user's search successes.

In performing tasks, the observed graduate students adopted a course of action that would expend the probable least average effort as discussed in Zipf's principle of least effort (Case, 2012). During the

search process they sometimes debated whether to borrow a book from the library, request a book through I-Share, order a copy through Amazon, or buy a digital copy. The reasons for and against their probable choice was sometimes based on the ease of access to the material in order to have a copy for themselves as quickly and easily as possible. Search features such as interlibrary loan, location, item availability, and downloading were considered powerful because they provided alternative access to the selected material. For example, graduate students referred interlibrary loan as a “nice” and “very excellent” feature.

5.3 Interpretation of the Results

Disparities in the way participants understood the function of search features of next generation catalogues and other Web applications are discussed below.

When choosing a search tool to use, the observed graduate students consider the size of the database but not the search features available for use. A majority of the participants were convinced that if the database is big, e.g. Google Scholar, Worldcat, or I-Share Catalogue, it will give search results despite the keywords used for searching. They believe that a library catalogue will respond with many search results if its indexed database is bigger - a process they refer to as "sensitivity" of the system. Google Scholar and WorldCat are considered by this group to be fairly sensitive because their databases are massive and have enormous amounts of information available to search. These users believe that a library catalogue of a small library with a small collection will give limited to no search results. Graduate students in the current study prefer to start their search with the I-Share catalogue as opposed to UIUC’s VuFind because I-Share is “massive,” i.e. its database size is big, it searches more library collections (including collection from other libraries), and thus it has minimal chances of getting no search results. Therefore, sensitivity of online catalogues would be increased by the breadth of the collections within the databases similar to UIUC Library Easy Search.

Participants most often searched using many keywords in a single search without carefully considering which search features and keywords to use. These graduate students’ prior experience with search features informed which keywords and search options were selected, for instance choosing

whether to choose between the advanced search or basic search box. These graduate students believed that using many search keywords would result in more relevant and fewer or more manageable numbers of search results. The participants in this study understood that using many keywords would narrow down their search from the outset, without necessarily requiring them to narrow from the search results in the output or using facets. Therefore, they most often used many keywords for a database that is perceived to have a bigger index and collection details with a goal of narrowing the search for a reasonable number of results.

Graduate students in the current study most often elected to use a search feature if in previous successful instances, similar features worked while using minimal effort, for instance, getting access to the fulltext of an article with a single click or finding the location or availability of the item in the local library or through interlibrary loan. They became accustomed to using a system because of a unique feature that successfully supported their searching. To be accustomed to using the feature in a particular system, such a feature must have been encountered for the first time while using that system, a condition referred to as “the first cut is the deepest”. Such a feature must have also been found to be extremely relevant to the user’s current and future information needs. This success means that participants will use the same feature(s) each time a similar task was presented.

The graduate students in this study came to the online catalogue expecting one thing, to search for and find the required item, and repeatedly searched by switching between search keywords and selecting multiple access points, despite failing in prior instances. It did not matter whether the prior search was successful or not. Search features and tactics that support these two functions (keyword searching and multiple access points) were preferred by the graduate students, and were used continuously. The presence or absence of a search feature did not necessarily affect the search process, but the failure of the system to provide relevant results in the shortest time possible with minimal clicks/browsing was frustrating.

The participants found the most useful application of the advanced search function was searching local library collections. This feature also allows entering many separate keywords in multiple search

boxes in support of a user goal to narrow down the search to a small number of search results. In the event of a failed search, these graduate students would seek assistance from the librarian through chat, or physically visit the library.

Graduate students in the current study believed that online catalogues like UIUC's VuFind, I-Share, and Worldcat are used for searching non-current information materials and print-only materials. UIUC's Library website and the embedded search of Google Scholar were used for searching current information materials like electronic journal articles and e-books. The “no results found” phenomena that was common with UIUC’s VuFind during the study has influenced these student’s understanding that even with the presence of relevant results catalogues may indicate no results.

While UIUC’s VuFind installation has citation and other helpful features such as fulltext materials, item location and availability, table of contents; participants preferred to use systems that have worked for them in the past. They preferred not to explore new ways of search because they felt comfortable with familiar tactics that they have used. This is in line with Sadeh’s (2013) finding that next generation catalogue users stick to their old ways of doing rather than learning something new that might create challenges. Next generation catalogue designers have made improvements to catalogues such as making searchers able to easily run comparisons across different search engines and commercial databases like Google Scholar and WorldCat. However, such features have failed to measure up to the expectation of the users in terms of relevance of results, and ease of use.

In conclusion, the end goal in searching for a known item is to retrieve only that item (this is a high precision search) While field directed search options are important for the user’s success in locating the relevant items, regardless of the type of information task, these graduate students failed to make good use of all available options during searching. For the searcher, all that matters is getting the sought after item. Thus searchers spent a great deal of their time interacting with the system’s output to identify and link to the relevant item. This often increases, rather than decreases search time. Searchers scanned the output to match keywords used in the search and this helped them to determine the relevance of the search results. Few participants used the search limits much as they provided alternatives to get the desired item.

Next generation catalogues functionality should be further improved to allow searchers spend limited time searching.

The findings from this research have also showed that many results are preferred compared to no results, but not results presented in a random order. Rather, search results should be organized in a systematic and logical order preferably similar to the UIUC Library dashboard. The UIUC Library dashboard is not a feature commonly found in most next generation catalogues and these results suggest that adding the dashboard to VuFind may enhance search outcomes. In this case, topical searches presumed to produce many search results, the UIUC Library dashboard supported presenting the search results in a user friendly format that could easily be interpreted. Searchers need features to support narrowing down search results with ease and satisfaction.

5.4 Recommendations for Future Research

The purpose of this section is to briefly outline a series of topics for future research on the theoretical and applied aspects of next generation catalogues. The present research concentrated on trying to understand user search strategies and the search behavior of a small sample of graduate students. This work captured a limited but foundational understanding of the features of the UIUC VuFind installation and other Web applications that graduate students used when searching, and how they did or did not understand the function of these features. An interesting complement to the findings described in the present research would be further qualitative research on user search strategies with a focus on the interrelationship of user tasks, search strategies, and user selection of search features. Of special interest would be the criteria that inform search feature selection.

To function most effectively, next generation catalogues must meet the needs of both the novice searcher, who may not understand the inclusion of a wide variety of sources in a single results list, and the expert scholar, who desires to perform advanced, subject-specific searches (Moore & Greene, 2012, p. 159). One assumption underlying this study, that graduate student participants were ‘expert searchers’ was proven false. It would be a useful extension to this research to study proven ‘experts’.

Another possible extension would be to design a similar study that observes library and information science practitioners, and/or participants with LIS training. It would also be useful to conduct a comparative study of novice and expert users. While LIS practitioners were eliminated from this study, it would be interesting to see how their search strategies and behavior could inform the future studies. Future work should also include and assessment of the opinions of LIS practitioners towards the catalogue as a work tool.

5.4.1 Implications for practice.

Once a user finds a relevant item, this item becomes an anchor. Search output enables a user to navigate to related items which the system identifies on the basis of similarities of data, e.g. the same author or subject, usage analyses that generate recommendations of the form "users interested in this item also expressed an interest in...", or works that cite or are cited in the original work. Because the information landscape is so large and diverse, the UIUC Library dashboard offers users organized and grouped search results based on the different databases searched. The UIUC Library dashboard is currently not implemented in the UIUC VuFind installation and neither implemented in any of the UIUC library catalogues. This research indicates that implementation of the dashboard could increase the navigability of next generation catalogues. The ease with which a catalogue allows the user to mediate between and across visually appealing and intuitively functionally designed pages is known as a catalogue's navigability.

The degree to which next generation catalogue functionality provides mechanisms that allow dynamic communication, which is responsive and informative to a given need for any type of user can be referred to as interactability. This research indicates that the following features would increase interactability: searching within results, following citations, finding related items, citing items, cite counts, the ability to save items, or to view them in HTML, as well as providing search boxes on every page. For example, smart interlinking should allow connection between author names and their institutional Web portals to enable searchers to conduct exploratory discovery of prominent scholars in their subjects, as well as of research teams involved in cutting edge research projects. Background

information sources such as biographies, encyclopedia, and dictionaries should also appear on the results list.

The following aspects of a catalogue were identified by participants as improving catalogue functionality, in particular, interactability and usability. Search limits allow searchers to reformulate a search before or after searching by author, subject, title, call number. Other specialized system limits, such as publication date, version, language, and formats, and media, after conducting a preliminary search are also useful. Facets facilitate narrowing search results but these are rarely used because the interface is not intuitively designed, but if facets are represented at the right time for the user conducting a search, this could improve usability. Search features such as browsing and navigation, relevance rankings, interface, bibliographic display, output and external links, and search limits improve interactability and usability.

By improving search performance, next generation catalogues would better meet the user's expectation by supporting simple, straightforward queries that would free users from having to select the most appropriate keywords for searching, especially when their information need is interdisciplinary. The system should enable users to discover new materials that they were not previously aware of (discoverability), and accommodate all kinds of search tasks through user assistance options like auto complete of queries, controlling for synonyms and homonyms, and the use of natural language. The system's basic search allows users to describe their information need with a short or long phrase without needing to use advanced search options. Basic search should offer multiple post-search options such as field directed search, for assessing findings, refining results, and navigating to other results of possible interest. Search results often challenge users because they are often unaware that the full text of an item is not part of the searchable bibliographic record.

How a system and its users negotiate each other's language is called negotiability. This is the measure of the effectiveness and efficiency of a next generation catalogue to retrieve relevant and exclude non-relevant documents. How users think about their information needs is strongly constrained by the retrieval language that is available to them, for example users may try to use natural language even when it is not appropriate, and this understanding impacts how they think. Insofar as the language of retrieval is

limited, so too is the way users' thinking about what they want to find. Therefore, next generation catalogue searchability should accommodate all input options. In the ideal case, the user and the system should understand each other's language. The "no results found" situation frustrates and stops users from using online catalogues. The language of retrieval not only limits how users will articulate what they want, but can also constrain the very thought process in which they determine what they want. Increasing the variety of languages, like users' natural language, in the catalogues metadata records may increase sensitivity, as well as negotiability.

System responsiveness is the degree to which catalogue functionality will help the user explicitly formulate a statement of needs and focuses on discovering and responding to user queries as these evolve through the search process. In line with the above catalogue improvements, challenges to system responsiveness are related to the problems of matching user queries to system controlled indexed terms. Because users are often known to only vaguely formulate their needs, the user-document relationship will help to improve next generation catalogue's responsiveness. This could be achieved by allowing the user to input details into a system in such a way that the system could attempt to approximate the user's goals. Such details could include whether the search goal is short or long term; the user's status and research role; and user background information such as system expertise and knowledge level in the field. While these improvements could have serious privacy implications, this information can be corrected using a variety of technological solutions, such as cookies.

The flexibility with which a next generation catalogue supports a variety of search strategies adequate for different tasks, as well as assisting the user in overcoming individual and context-dependent resource limits through a proper fit between demands of the task and the resources available, is termed searchability. To improve the searchability of next generation catalogues, designers should ensure that the following details are captured and indexed by the system: tables of contents, book indexes, annotations, abstracts, introductions, book jacket materials, reviews, additional subject headings, and natural language from vendor databases, e.g. reviews and rankings. The differences in user and system vocabulary are the major reason for user dissatisfaction. The "no results found" phenomenon is further complicated by the

fact that for a given document it is impossible to predict exactly what description a trained indexer will assign or create. Likewise, it is impossible to predict what specific aspects of the topic a searcher will pursue and which specific phrases or terms the searcher will use. Increasing the information stored in the bibliographic details, and the vocabulary used to describe the items as earlier described will help to overcome these challenges, thus increasing the searchability and performance of next generation catalogues.

5.5 Conclusion

This research focused on understanding the search strategies of a small group of graduate students. In so doing, it achieved a limited but foundational understanding of the features of the UIUC VuFind installation and other Web applications that participants used when searching, and how they did or did not understand the function of these features. This research project has demonstrated that while next generation catalogues have many search features, participants used the basic search option for most searches and rarely used the advanced search option but selected it as a secondary alternative, especially when searching for local library or print collections. Participants frequently conducted known-item searching, and used tactics such as chaining, and search within results that offered clear alternatives to searching and search reformulation respectively.

The evidence indicates that participants understand the function of VuFind features based on their perception that it will give relevant and current information because of the large collection size at UIUC; because of prior experiences with quick, minimal effort search reformulation strategies; and their preference for large result sets, presented in systematic and logical order. This research confirms that information tasks guide and shape the way searchers select and use system features. Participant search processes change during and after using a specific system. This exploratory study improves our understanding of users' search strategies and behavior, specifically how a small group graduate students interact with one VuFind installation.

Building on these findings, future research will seek to explore:

a) how tasks guide and shape the use of search features of next generation catalogues and the criteria for search feature selection;

b) how expert users select, use and understand search features of next generation catalogues; and

c) an assessment of how LIS practitioners use next generation catalogues.

REFERENCES

Ahmad, H., Mushtaq, M., & Imran, S. M. (2012). The use of search strategies in OPAC: A comparative study of Central Library, IIT Delhi; P. K. Kelkar Library, IIT Kanpur and Allama Iqbal Library, Kashmir University. International Research: Journal of Library & Information Science, 2(2), 170–183.

American Library Association, Association of College and Research Libraries. (2013). *Instruction for diverse populations multilingual glossary definitions*. Retrieved from http://www.ala.org/acrl/sites/ala.org.acrl/files/content/aboutacrl/directoryofleadership/sections/is/iswebsite/projpubs/idpdefinitions.pdf

Annett, J., & Stanton, N. A. (2000). (1st Ed.). *Task analysis*. London: CRC Press.

Barbour, R. S. (1998). Mixing qualitative methods: Quality assurance or qualitative quagmire? *Qualitative Health Research, 8*(3), 352-361.

Barry, C. L., & Schamber, L. (1998). Users' criteria for relevance evaluation: A cross-situational comparison. *Information processing & management, 34*(2), 219-236.

Barton, J., & Mak, L. (2012). Old hopes, new possibilities: Next-generation catalogues and the centralization of access. *Library Trends, 61*(1), 83-106.

Bates, M. J. (1979). Information search tactics. *Journal of the American Society for information Science*, 30, 205-14. doi: 10.1002/asi.4630300406

Bates, M. J. (1986). Subject access, online catalogs: A design model. *Journal of the American Society for Information Science, 37*(6), 357-376.

Bates, M. J. (1989). *The design of browsing and berrypicking techniques for the online search interface*. Retrieved from https://pages.gseis.ucla.edu/faculty/bates/berrypicking.html

Bates, M. J. (1990). Where should the person stop and the information search interface start? *Information Processing & Management, 26*(5), 575-591.

Bates, M. J. (2002). Toward an integrated model of information seeking and searching. *The New Review of Information Behaviour Research*, 3, 1-15. Retrieved from http://ptarpp2.uitm.edu.my/silibus/towardanintegratedmodel.pdf

Bates, M. J. (2007). What is browsing—really? A model drawing from behavioural science research *Information Research, 12*(4). Retrieved from http://InformationR.net/ir/12-4/paper330.html

Bauer, K. (2008). Yale University Library VuFind Test—Undergraduates. *Usability and assessment studies of Yale University Library projects.*

Bauer, K., & Peterson-Hart, A. (2012). Does faceted display in a library catalog increase use of subject headings? *Library Hi Tech*, *30*(2), 347–358. doi:10.1108/07378831211240003

Bawden, D. (2006). Users, user studies and human information behavior: A three-decade perspective on Tom Wilson's "On user studies and information needs". *Journal of Documentation, 62*(6), 671-679. Retrieved from https://www.city.ac.uk/__data/assets/pdf_file/0006/79800/users20paper.pdf

Belkin, N. J. (1980). Anomalous states of knowledge as a basis for information retrieval. *Canadian Journal of Information Science, 5*, 133-143.

Belkin, N. J., & Vickery, A. (1985). Interaction in information systems: A review of research from document retrieval to knowledge-based systems, *Library and Information Research Report, 35*. London: British Library.

Belkin, N. J., Seeger, T., & Wersig, G. (1983). Distributed expert problem treatment as a model for information system analysis and design. *Journal of Information Science, 5*, 153-167.

Bell, W. J. (1991). Searching behaviour: The behavioral ecology of finding resources. London: Chapman and Hall.

Blankenship, D. (2010). *Applied research and evaluation methods in recreation*. Champaign, IL: Human Kinetics.

Blecic, D. D. et al. (1998). Using transaction log analysis to improve OPAC retrieval results. *College and Research Libraries, 59*(1), 39-50. Retrieved from http://crl.acrl.org/content/59/1/39.full.pdf+html

Blenkle, M., Ellis, R., & Haake, E. (2015). Only the first results count: User-feedback-modified relevance ranking in E-LIB Bremen. *Insights, 28*(2), 75-80.
Borgman, C. L. (1986a). Why are online catalogues hard to use? Lessons learned from information retrieval studies. *Journal of the American Society for Information Science, 37*(6), 387-400.
Borgman, C. L. (1986b). The user's mental model of an information retrieval system: An experiment on a prototype online catalogue, *International Journal of Man-Machine Studies, 24*(1), 47-64.
Borgman, C. L. (1989). All users of information retrieval systems are not created equal: An exploration into individual differences. *Information Processing & Management, 25*(3), 237-251.
Borgman, C. L. (1996). Why are online catalogs still hard to use? *Journal of the American Society for Information Science, 47*(7), 493-503.
Borgman, C. L., Hirsch, S. G., & Hiller, J. (1996). Rethinking online monitoring methods for information retrieval systems: from search product to search process. *Journal of the American Society for Information Science, 47*(7), 568-583
Borgman, C. L., Hirsh, S. G., Walter, V. A., & Gallagher, A. L. (1995). Children's searching behavior on browsing and keyword online catalogues: The Science Library Catalogue project. *Journal of the American Society for Information Science, 46*(9), 663-684. Retrieved from http://asis.org/Publications/JASIS/Best_Jasist/1996Borgmanetal.pdf
Breeding, M. (2010). Next-gen library catalogs. New York: Neal-Schuman Publishers.
Breeding, M. (2016). libraries.org: A directory of libraries throughout the world. Accessed from *http://www.librarytechnology.org/libraries/*
Bromley, D. B. (1990). Academic contributions to psychological counselling: I. A philosophy of science for the study of individual cases. *Counselling Psychology Quarterly, 3*(3), 299-307.
Brooks, H. M., Daniels, P. J., & Belkin, N. J. (1985). Problem descriptions and user models: Developing an intelligent interface for document retrieval systems. In K. P. Jones (Ed.) *Informatics 8: Advances in Intelligent Retrieval* (pp. 191-214). London, Aslib.
Butterfield, K. (2010). Online Public Access Catalogs (OPACs). In *Encyclopedia of Library and Information Sciences* (3rd ed.). Taylor & Francis: New York. doi: 10.1081/E-ELIS3-120045435
Cai, H. H., Dou, T., & Jiang, A. (2011). Effective approaches to the evaluation and selection of a discovery tool. *International Conference on Asian Digital Libraries, Lecture Notes in Computer Science 7008*: 347-356.
Calhoun, K. (2009). *Online catalogs: What users and librarians want*. An OCLC report. Dublin: OCLC Online Computer Library Center, Inc.
Carroll, J. M. (2000). *Making use: Scenario-based design of human-computer interactions*. Cambridge, MA: MIT Press.
Carter, T. M., & Levine-Clark, M. (2013). *ALA Glossary of Library and Information Science*. Chicago, IL: ALA editions.
Case, D. O. (Ed.). (2012). *Looking for information: A survey of research on information seeking, needs, and behavior* (3rd ed.). Bingley, UK: Emerald.
Chambers, S. (2013). *Catalogue 2.0: The future of the library catalogue*. Chicago: Neal-Schuman.
Cherry, J. M. (1992). Improving subject access in OPACs: An exploratory study of conversion of users' queries. *Journal of Academic Librarianship, 18*(2), 95–99.
Chickering, F. W., & Yang, S. Q. (2014). Evaluation and comparison of discovery tools: An update. *Information Technology and Libraries (Online), 33*(2), 5-30.
Christensen, A. (2013). Next-generation catalogues: What do users think? In S. Chambers (Ed.) *Catalogue 2.0: The future of the library catalogue* (pp. 1-15). London, UK: Facet.
Cochrane, P. A. (1985). Classification as an online subject access tool: Challenge and opportunity. In *Redesigning of catalogs and indexes for improved online subject access: Selected papers of Pauline A. Cochrane* (pp. 278-390). Phoenix, AZ: Oryx Press.
Connaway, L. S., Budd, J. M., & Kochtanek, T. R. (1995). An investigation of the use of an online catalog: User characteristics and transaction log analysis. *Library Resources & Technical Services, 39*(2), 142–152. Retrieved from http://downloads.alcts.ala.org/lrts/lrtsv39no2.pdf

Connaway, L. S., Johnson, D. W., & Searing, S. E. (1997). Online catalogs from the users' perspective: The use of focus group interviews. *College & Research Libraries*, *58*(5), 403–420. Retrieved from http://crl.acrl.org/content/58/5/403.full.pdf

Cooper, A., Reimann, R., & Cronin, D. (2007). (3rd Ed.). *About face 3: The essentials of interaction design*. Indianapolis: John Wiley & Sons.

Cothran, T. (2011). Google Scholar acceptance and use among graduate students: A quantitative study. *Library & Information Science Research, 33*(4), 293-301.

Creswell, John W. (1994). Research design qualitative and quantitative approaches. CA: USA: Sage.

Crystal, A., & Ellington, B. (2004). Task analysis and human-computer interaction: Approaches, techniques, and levels of analysis. *Proceedings of Americas Conference on Information Systems 2004, Savannah, GA*, 3202-3210. http://aisel.aisnet.org/amcis2004/391

Dempsey, L. (2006). The library catalogue in the new discovery environment: Some thoughts. *Ariadne, 48*. Retrieved from http://www.ariadne.ac.uk/issue48/dempsey/

Denton, W., & Coysh, S. J. (2011). Usability testing of VuFind at an academic library. *Library Hi Tech, 29*(2), 301-319.

Denzin, N. K. (1970). *The research act: A theoretical introduction to sociological methods*. Chicago: Aldine.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2000). *The handbook of qualitative research*. Thousand Oaks, CA: Sage Publications, Ltd.

Dervin, B. (1983, 1999). On studying information seeking methodologically: The implications of connecting metatheory to method. *Information Processing & Management, 35*, 727-750.

Dervin, B., & Nilan, M. (1986). Information needs and uses. In M. Williams (Ed.), *Annual Review of Information Science & Technology, Vol 21* (pp. 3-33). White Plains, NY: Knowledge Industry.

Doubleday, A., Ryan, M. Springett, M., & Sutcliffe, A. (1997). A comparison of usability techniques for evaluating design. *Proceedings of the 2nd conference on Designing interactive systems: Processes, practices, methods, and techniques, Netherlands*, 101–110. doi: 10.1145/263552.263583

Dul, J. & Hak, T. (2008). *Case study methodology in business research*. Amsterdam: Elsevier BH.

Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review, 14* (4), 532-550.

Ellis, D. (1987). The derivation of a behavioural model for information retrieval system design. *PhD thesis, University of Sheffield*. Accessible from http://etheses.whiterose.ac.uk/2975/

Ellis, D. (1989). A behavioural approach to information retrieval system design. *Journal of documentation, 45*(3), 171-212.

Emanuel, J. (2011). Usability of the VuFind next-generation online catalog. *Information Technology and Libraries, 30*(1), 44-52.

Embrey, D. (2000). *Task analysis techniques*. Retrieved from Human Reliability website: http://www.humanreliability.com/articles/Task%20Analysis%20Techniques.pdf

Fagan, J. C. (2013). Usability studies of faceted browsing: A literature review. *Information Technology and Libraries, 29*(2), 58-66. Retrieved from http://napoleon.bc.edu/ojs/index.php/ital/article/viewFile/3144/2758

Farradane, J. (1979). The nature of information. *Journal of Information Science, 1*(1), 13-17. Retrieved from http://jis.sagepub.com/content/1/1/13.full.pdf+html

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin, 51*(4), 327-358.

Foster, A. (2004). A nonlinear model of informationseeking behavior. *Journal of the American society for Information Science and Technology*, 55(3), 228-237. doi: 10.1002/asi.10359

Foster, A., & Ford, N. (2003). Serendipity and information seeking: An empirical study. *Journal of Documentation, 59*(3), 321-340.

Gallaway, T. O. & Hines, M. F. (2012). Competitive usability and the catalogue: A process for justification and selection of a next-generation catalogue or web-scale discovery system. *Library Trends, 61*(1), 173-185.

Given, L. M. (2008). *The Sage encyclopedia of qualitative research methods*. Los Angeles, CA: Sage Publications.

Goddard, W., & Melville, S. (2011). *Research methodology: An introduction*. South Africa: Juta and Company Ltd.

Greene, J. C., & Caracelli, V. J. (1997). *Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms*. San Francisco, CA: Jossey-Bass.

Grossman, T., & Fitzmaurice, G. (2010). ToolClips: An investigation of contextual video assistance for functionality understanding. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, USA, 2010,* pp. 1515-1524. doi: 10.1145/1753326.1753552

Hancock-Beaulieu, M. (1989). Online catalogues: A case for the user. In C. R. Hildreth (Ed.), *The online catalogue: Developments and directions* (pp. 25-46). London: The Library Association.

Harper, M., & Cole, P. (2012). Member checking: can benefits be gained similar to group therapy?. *The Qualitative Report, 17*(2), 510-517.

Hawkins, D. T. and Wagers, R. (1982). Online bibliographic search strategy development, *Online 6*(3), 12-19.

Haynes, S.R., Purao, S. & Skattebo, A.L. (2009). Scenario-based methods for evaluating collaborative systems. *Computer Supported Cooperative Work, 18*(4), 331-356. doi:10.1007/s10606-009-9095-x

Herner, S. (1970). Browsing. In M. A. Drake (Ed.) *Encyclopedia of library and information science* (pp. 408-415). New York, NY: Marcel Dekker.

Hevey, D. (2010). Think-aloud methods. In N. J. Salkind (Ed.), *Encyclopedia of research design*. Thousand Oaks, CA: Sage Publications. doi:10.4135/9781412961288.n460

Hildreth, C. R. (1984). Pursuing the ideal: Generations of online catalogs. In B. Aveney & B. Butler (Eds.), *Online catalogs, online reference: Converging trends, proceedings of the 1983 ALA/LITA Preconference Institute, June 23-24, Los Angeles,* 31-56. Chicago, IL: American Library Association.

Hildreth, C. R. (1985). The user interface in online catalogs: The telling difference. In J. Kinsella (Ed.) *Online public access to library files* (pp. 111-132). Oxford, UK: Elsevier International Bulletins.

Hildreth, C. R. (1987a). Beyond Boolean: Designing the next generation of online catalogs. *Library Trends, 35*(4), 647-667.

Hildreth, C. R. (1987b). Online public access catalogs: Evaluation, selection, and effect. In D. G. Genaway (Ed.), *Proceedings of the Conference on Integrated Online Library Systems* (pp. 43-57). Canfield, OH: Genaway & Associates.

Hildreth, C. R. (1988). Online library catalogues as information retrieval systems: What can we learn from research?" In P. A. Yates-Mercer (Ed.), *Proceedings of the Silver Jubilee Conference of the City University's Department of Information Science* (pp. 9-25). London: Taylor Graham.

Hildreth, C. R. (1989a). Extending the access and reference service capabilities of the online public access catalog. In L. C. Smith (Ed.), *Questions and answers: Strategies for using the electronic reference collection: Proceedings of the Twenty-Fourth Annual Clinic on Library Applications of Data Processing, April 5-7,* (pp. 14-33). Urbana, IL: University of Illinois at Urbana-Champaign Publications Office.

Hildreth, C. R. (1989b). General introduction; OPAC research: Laying the groundwork for future OPAC design. In C. R. Hildreth (Ed.), *The online catalogue: Development and directions* (pp. 1-24). London: The Library Association.

Hildreth, C. R. (1990) *Appropriate user interfaces for subject searching in bibliographic retrieval systems*. Albany, NY: Forest Press.

Hildreth, C. R. (1991a). Advancing toward the E3OPAC: The imperative and the path. In N. Van Pulis (Ed.), *Think tank on the present and future of the online catalog: Proceedings. Reference and Adult Services Division of the American Library Association Catalog Use Committee.* RASD Occasional Papers, 9, 17-38. Chicago: Reference and Adult Services Division, American Library Association.

Hildreth, C. R. (1991b). End users and structured searching of online catalogues: Recent research findings. In R. Fugman (Ed.) *Tools for knowledge organization and the human interface*. *Proceedings of the 1st International ISKO-Conference, Darmstadt, 14-17 August 1990*, 9-24.

Hildreth, C. R. (1993). Extending the online catalog: The point of diminishing returns. *Proceedings of the 1993 Annual Clinic on Data Processing Applications for Libraries,4-6 April 1993*, (pp. 84-100). Urbana, IL: University of Illinois at Champaign-Urbana Publications Office.

Hildreth, C. R. (1995a). *Online catalog design models: Are we moving in the right direction?* Report commissioned by the Council on Library Resources, August, 1995. Retrieved from http://myweb.cwpost.liu.edu/childret/clr-opac.html

Hildreth, C. R. (1995b). The GUI OPAC: Approach with caution. *The Public-Access Computer Systems Review*, *6*(5), 6-18. Retrieved from https://journals.tdl.org/pacsr/index.php/pacsr/article/view/5997/5626

Hildreth, C. R. (2001a). Accounting for users' inflated assessments of on-line catalogue search performance and usefulness: An experimental study. *Information Research, 6*(2), January 2001. Retrieved from http://InformationR.net/ir/6-2/paper101.html

Hildreth, C. R. (2001b). The use and understanding of keyword searching in a university online catalog. *Information Technology and Libraries, 16*(2), 52-62.

Hjerppe, R. (1989). HYPERCAT at LIBLAB in Sweden: A progress report. In C. R. Hildreth (Ed.), *The online catalogue: Development and directions* (pp. 177-209). London: The Library Association.

Hjørland, B. (2013). Facet analysis: The logical approach to knowledge organization. *Information Processing & Management, 49*(2), 545-557. doi: 10.1016/j.ipm.2012.10.001

Ho, B., Kelley, K., & Garrison, S. (2009). Implementing VuFind as an alternative to Voyager's WebVoyage interface: One library's experience. *Library Hi Tech, 27*(1), 82-92.

Holstein, J. A. & Gubrium, J. F. (1995). *Qualitative Research Methods, Vol. 37. The active interview*. Thousand Oaks, CA: Sage Publications.

Huang, J., & Efthimiadis, E. N. (2009, November). Analyzing and evaluating query reformulation strategies in web search logs. In *Proceedings of the 18th ACM conference on Information and knowledge management*, 77-86. ACM.

Hughes, H. (2007). Critical incident technique. In S. Lipu, K. Williamson, & A. Lloyd (Eds.) *Exploring methods in information literacy research. Topics in Australasian Library and Information Studies, 28*, 49-66, http://eprints.qut.edu.au/17545/1/17545.pdf

Hunter, R. N. (1991). Successes and failures of patrons searching the online catalog at a large academic library: A transaction log analysis. *RQ, 30*(3), 395-402. Retrieved from http://www.jstor.org/stable/25828813

Hussein, A. (2015). The use of triangulation in social sciences research: Can qualitative and quantitative methods be combined? *Journal of Comparative Social Work, 4*(1), 1-12.

Jeffries, R., Miller, J. R., Wharton, C., & Uyeda, K. (1991, April). User interface evaluation in the real world: a comparison of four techniques. In S. P. Robertson, G. M. Olson., & J. S. Olson (Eds.), *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 119-124).

Johnson, B. L., & Fauske, J. R. (2000). Principals and the political economy of environmental enactment. *Educational Administration Quarterly, 36*, 159–185.

Johnston, N., Salaz, A., & O'Connell, R. (2013). Determining usability of VuFind for users in the United Arab Emirates. *Code4Lib Journal, 19*. Retrieved from http://journal.code4lib.org/articles/7880

Kerlinger, F. N. (1986). *Foundations of behavior research* (3rd ed.). New York: Holt, Rinehart and Winston.

Kim, J. (2012). Scenarios in information seeking and information retrieval research: A methodological application and discussion. *Library & Information Science Research, 34*, 300–307.

Kirwan, B., & Ainsworth, L. K. (Eds.). (1992). *A guide to task analysis: The task analysis working group*. Boca Raton, FL: CRC Press.

Kules, B., & Capra, R. (2012). Influence of training and stage of search on gaze behavior in a library catalog faceted search interface. *Journal of the American Society for Information Science and Technology*, 63(1), 114–138.

Kwasnik, B. H. (1992). A descriptive study of the functional components of browsing. In J. A. Larson & C. Unger (Eds.), *Proceedings of the IFIP TC2/WG2.7 Working Conference on Engineering for Human-Computer Interaction*, Ellivuori, Finland, 10-14 August 1992 (pp. 191-203). Amsterdam: Elsevier Science Publishers.

La Barre, K. (2006). *The use of faceted analytico-synthetic theory in the practice of website construction and design* (Unpublished doctoral dissertation). Indiana University, Bloomington, Indiana.

La Barre, K. (2007). Faceted navigation and browsing features in new OPACS: Robust support for scholarly information seeking? *Knowledge Organization, 34*(2), 78-90.

La Barre, K. (2012). Introduction. *Library Trends, 61*(1), 1-6.

Larson, R. R. (1991). The decline of subject searching: Long-term trends and patterns of index use in an online catalog. *Journal of the American Society for Information Science, 42*(3), 197–215. doi: 10.1002/(SICI)1097-4571(199104)42:3<197:AID-ASI6>3.0.CO;2-T

Lavrakas, P. J. (2008). Introduction. In P.J. Lavrakas (Ed.), *Encyclopedia of survey research methods*. Thousand Oaks, CA: Sage Publications. doi: 10.4135%2F9781412963947

Leckie, G., Pettigrew, K., & Sylvain, C. (1996). Modeling the information seeking of professionals: a general model derived from research on engineers, health care professionals and lawyers. *Library Quarterly, 66*(2), 161-193.

Lewis-Beck, M. S., Bryman, A., & Liao, T. F. (Eds.). (2004). *The Sage encyclopedia of social science research methods*. Thousand Oaks, CA: Sage Publications, Inc. doi: 10.4135/9781412950589

Liao, Y., Finn, M., & Lu, J. (2007). Information-seeking behavior of international graduate students vs. American graduate students: A user study at Virginia Tech 2005. *College & Research Libraries, 68*(1), 5-25.

Liew, C. L., Foo, S., & Chennupati, K. R. (2000). A study of graduate student end-users' use and perception of electronic journals. *Online Information Review, 24*(4), 302-315.

Liljegren, E., 2006. Usability in a medical technology context assessment of methods for usability evaluation of medical equipment. *International Journal of Industrial Ergonomics 36*(4), 345–352.

Lindgaard, G. (2006). Notions of thoroughness, efficiency, and validity: Are they valid in HCI practice? *International Journal of Industrial Ergonomics, 36*(12), 1069-1074.

Liu, G., & Winn, D. (2009). Chinese graduate students and the Canadian academic library: a user study at the University of Windsor. *The Journal of Academic Librarianship, 35*(6), 565-573.

Liu, Z. (2006). Print vs. electronic resources: A study of user perceptions, preferences, and use. *Information Processing & Management, 42*(2), 583-592.

Liu, Z., & Yang, Z. Y. L. (2004). Factors influencing distance-education graduate students' use of information sources: A user study. *The Journal of Academic Librarianship, 30*(1), 24-35.

Long, C. E. (2000). Improving subject searching in web-based OPACs. *Journal of Internet Cataloging, 2*(3-4), 158–186.

Long, K. J. (2004). Unit of analysis. In M. S. Lewis-Beck & A. Bryman & T. F. Liao, *The Sage encyclopedia of social science research methods*. doi: 10.4135/9781412950589

Madhusudhan, M., & Aggarwal, S. (2011). Web-based online public access catalogues of IIT libraries in India: an evaluative study. *Program, 45*(4), 415-438. doi: 10.1108/00330331111182102

Majors, R. (2012). Comparative user experience of next-generation catalogue interfaces. *Library Trends, 61*(1), 186-207.

Markey, K. (1983). *Online catalog use: Results of surveys and focus interviews in several libraries* (OCLC Research Report OCLC/OPR/RR-83/3). Dublin, Ohio: Online Computer Library Center.

Markey, K. (1984). Barriers to effective use of online catalogs. In B. Aveney & B. Butler (Eds.), *Online catalogs, online reference: Converging trends, proceedings of the 1983 ALA/LITA Preconference Institute, June 23-24, Los Angeles*, 51-78. Chicago, IL: American Library Association.

Markey, K. (1989). Subject searching strategies for online catalogues through the Dewey decimal classification. In C. R. Hildreth (Ed.), *The online catalogue: Development and directions* (pp. 61-83). London: The Library Association.

Markey, K. (2007a). The online library catalog: Paradise lost and paradise regained? *D-Lib Magazine, 13*(1/2). doi: 10.1045/january2007-markey

Markey, K. (2007b). Twenty-five years of end-user searching, part 2: Future research directions. *Journal of the American Society for Information Science and Technology, 58*(8), 1123-1130.

Mathews, J. R., Lawrence, G. S. & Ferguson, D. K. (1983). *Using online catalogs: A nationwide survey*. New York: Neal-Schuman Publishers.

Mathison, S. (2005). (Ed.). Think-aloud protocol. In S. Mathison (Ed.), *Encyclopedia of evaluation* (p. 420). Thousand Oaks, CA: Sage Publications, Inc. doi: 10.4135/9781412950558.n545

Maxwell, J. A., & Loomis, D. M. (Eds.). (2003). Mixed methods design: An alternative approach. In A. Tashakkori & C. Teddlie (Eds.) *Handbook of mixed methods in social and behavioral research,* (pp. 241-272). Thousand Oaks, CA: Sage Publications.

Mercun, T., & Zumer, M. (2008). New generation of catalogues for the new generation of users: A comparison of six library catalogues. *Program*, *42*(3), 243-261.

Mi, J., & Weng, C. (2008). Revitalizing the Library OPAC: Interface, searching, and display challenges, *Information Technology and Libraries*, *27*(1), 5-22.

Miksa, F. (2012). The legacy of the library catalogue for the present. *Library Trends*, *61*(1), 7-34.

Miller, D.C. and Salkind, N.J. (2002). Techniques for increasing response rates. In *Handbook of research design & social measurement* (6th ed.) (pp. 305-310). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781412984386.n54

Millsap, L., and Ferl, T. E. (1993). Search patterns of remote users: An analysis of OPAC transaction logs. *Information Technology and Libraries, 12*(3), 321–343.

Mischo, W. H., Schlembach, M. C., & Norman, M. A. (2009). User search behaviors within a library gateway. In *Proceedings of the 9th ACM/IEEE-CS Joint Conference on Digital Libraries (JCDL '09)*, USA, 431-432. doi: 10.1145/1555400.1555498

Mitchell, E. S. (1986). Multiple triangulation: A methodology for nursing science. *Advances in Nursing Science, 8*(3), 18-26.

Mitev, N. N., & Walter, S. (1986) Information retrieval aids in an online public access catalogue: Automatic intelligent search sequencing. In K. P. Jones (Ed.) *Informatics 8: Advances in Intelligent Retrieval* (pp. 215-226). London, Aslib.

Moore, K. B. & Greene, C. (2012). Choosing discovery: A literature review on the selection and evaluation of discovery layers. *Journal of Web Librarianship*, *6*(3), 145-163. doi: 10.1080/19322909.2012.689602

Nielsen, J. (1993). *Usability engineering.* San Diego: Morgan Kaufmann.

Nielsen, J. (2000). *Why you only need to test with 5 users.* Retrieved from Nielsen Norman Group website: http://useit.com/alertbox/20000319.html

Nielsen, J., & Landauer, T. K. (1993). A mathematical model of the finding of usability problems. *Proceedings of ACM INTERCHI'93 Conference, Amsterdam, The Netherlands, Apri*l 24–29, 1993, 206–213.

Nielsen, J., & Mack, R. L. (Eds.). (1994). *Usability inspection methods.* New York, NY: Wiley & Sons.

Niu, X., & Hemminger, B. M. (2011). Beyond text querying and ranking list: How people are searching through faceted catalogs in two library environments. In *Proceedings of the American Society for Information Science and Technology, 47*(1), 1-9. doi: 10.1002/meet.14504701294

Noble, G. and O'Connor, S. (1986). Attitudes toward technology as predictors of online catalogue use. *College and Research Libraries, 47*, 605-610.

Nowkarizi, M. (2008). Analysis of interface vocabulary and users' understanding in Integrated Iranian Library Software. In *2008 International Conference on Advanced Computer Theory and Engineering* (pp. 94-100).

O'Connor, B. C. (1993). Browsing: A framework for seeking functional information. *Knowledge: Creation, Diffusion, Utilization, 15*(2), 211-232.
Park, T. K. (1993). The nature of relevance in information retrieval: An empirical study. *The Library Quarterly, 63*(3), 318-351. Retrieved from http://www.jstor.org/stable/pdfplus/4308837.pdf
Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.
Pejtersen, A. M. (1984). Design of a computer-aided user-system dialogue based on an analysis of users' search behavior. *Social Science Information Studies, 4*, 167-183.
Pirmann, C. (2012). Tags in the catalogue: Insights from a usability study of LibraryThing for libraries. *Library Trends, 61*(1), 234-248.
Poo, D. C. C., & Khoo, C. S. G. (2010). Online catalog subject searching. In *Encyclopedia of library and information sciences* (3rd ed.). New York: Taylor & Francis. doi: 10.1081/E-ELIS3-120008863
Preater, A. (2010). *Mental models and user experience of a next-generation library catalogue* (Unpublished master's thesis). Northumbria University, Newcastle upon Tyne, UK. Retrieved from http://m.preater.com/wp-content/uploads/2011/12/Andrew-Preater-MSc-Dissertation-final.pdf
Prommann, M. and Zhang, T. (2015). Applying hierarchical task analysis method to discovery layer evaluation. *Information Technology & Libraries, 34*(1), 77-105.
Ramdeen, S., & Hemminger, B. M. (2012). A tale of two interfaces: How facets affect the library catalog search. *Journal of the American Society for Information Science and Technology, 63*(4), 702–715. doi:10.1002/asi.21689
Rice, R. E., McCreadie, M. & Chang, S. L. (2001). *Accessing and browsing information and communication*. Cambridge, MA: MIT Press.
Ruzegea, M. (2012). The usability of OPAC interface features: The perspective of postgraduate students at International Islamic University Malaysia (IIUM) [Special Section]. *Library Philosophy and Practice, 2012*(February). Retrieved from http://digitalcommons.unl.edu/libphilprac/691/
Sauperl, A., & Saye, J. D. (2009). Have we made any progress? Catalogues of the future revisited. *Journal of Documentation, 65*(3), 500–514. doi:10.1108/00220410910952447
Serenko, A. (2006). The use of interface agents for email notification in critical incidents. *International Journal of Human Computer Studies, 64*(11), 1084–1098. Retrieved from http://www.aserenko.com/papers/Serenko_CIT_Agents.pdf
Shahi, D. (2015). Chapter 1: Apache Solr: An Introduction. In *Apache Solr: A practical approach to enterprise search* (pp. 1-9). New York: Apress.
Skinner, D. G. (2012). A comparison of searching functionality of a VuFind catalogue implementation and the traditional catalogue. *Library Trends, 61*(1), 209-217.
Slone, D. J. (2000). Encounters with the OPAC: On-line searching in public libraries. *Journal of the American Society for Information Science, 51*(8), 757-773. doi: 10.1002/(SICI)1097-4571(2000)51:8<757::AID-ASI80>3.0.CO;2-T
Smith, M. L., & Kleine, P. L. (1986). Qualitative research and evaluation: Triangulation and multimethods reconsidered [Special issue]. *New Directions for Program Evaluation, 1986*(30), 55-71. doi: 10.1002/ev.1426
Spool, J., & Schroeder,W. (2001). Testing websites: Five users is nowhere near enough. *Proceedings CHI 2001, Extended Abstracts, ACM,* 285–286.
Stake, Robert E. (1995). *The art of case study research.* Thousand Oaks: Sage.
Stanton, N. A. (2006). Hierarchical task analysis: developments, applications and extensions. *Applied Ergonomics, 37*(1), 55–79.
Stiemerling, O., & Cremers, A. B. (1998). The use of cooperation scenarios in the design and evaluation of a CSCW system. *IEEE Transactions on Software Engineering, 24*(12), 1171-1181.
Su, L. T (1994). The relevance of recall and precision in user evaluation. *Journal of the American Society for Information Science, 45*(3), 207-217.
Sutcliffe, A. (2002). *The domain theory: patterns for knowledge and software reuse*. Mahwah, NJ: Lawrence Erlbaum.

Tague, J. M. (1989). Negotiation at the OPAC interface. In C. R. Hildreth (Ed.), *The online catalogue: Development and directions* (pp. 25-46). London: The Library Association.
Tam, W., Cox, A. M., & Bussey, A. (2009). Student user preferences for features of next-generation OPACs: A case study of University of Sheffield international students. *Program: Electronic Library and Information Systems, 43*(4), 349–374.
Tan, W. S., Liu, D., & Bishu, R. (2009). Web evaluation: Heuristic evaluation vs. user testing. *International Journal of Industrial Ergonomics, 39*(4), 621-627.
Taylor, R. S. (1968). Question negotiation and information seeking in libraries. *College & Research Libraries, 29*(3), 178-194
Tenopir, C. (2003). *Use and users of electronic library resources: An overview and analysis of recent research studies* (Research Report No. 120). Retrieved from Council on Library and Information Resources website: http://www.clir.org/pubs/abstract//reports/pub120
Thurmond, V. A. (2001). The point of triangulation. *Journal of Nursing Scholarship, 33*(3), 253-258.
Toms, E. G. (2000). Understanding and facilitating the browsing of electronic text. *International Journal of Human-Computer Studies, 52*(3), 423-452.
Twidale, M., Randall, D., & Bentley, R. (1994). Situated evaluation for cooperative systems. *Proceedings of the 1994 ACM Conference on Computer Supported Cooperative Work (CSCW), USA*, 441-452. doi: 10.1145/192844.193066
University of Illinois. (2016). *Illinois facts: Campus facts*. Retrieved July 20, 2016, from http://illinois.edu/about/facts.html
Vogt, W.P. (2005). *Dictionary of statistics and methodology*. doi: 10.4135/9781412983907
Wallace, P. M. (1993). How do patrons search the online catalog when no one's looking? Transaction log analysis and implications for bibliographic instruction and system design. *RQ*, *33*(2), 239–252. Retrieved from http://www.jstor.org/stable/20862411
Walter, S. (1989). The Okapi online catalogue research projects. In C. R. Hildreth, *The online catalogue: Developments and directions* (pp. 84-106). London: The Library Association.
Wang, K.-C., Hsieh, A.-T., & Huan, T.-C. (2000). Critical service features in group package tour: An exploratory research. *Tourism Management, 21*, 177–189.
Wildemuth, B. M., De Bliek, R., & Friedman, C. P. (1993). Measure of searcher performance: A psychometric evaluation. *Information Processing & Management, 29*(5), 533-550. doi: 10.1016/0306-4573(93)90078-R
Willis, G.B. (2005). Cognitive interviewing in practice: Think-aloud, verbal probing, and other techniques. In Gordon B. Willis (Ed.), *Cognitive interviewing* (pp. 42-66). Thousand Oaks, CA: Sage Publications. doi: 10.4135/9781412983655.n4
Willson, R., & Given, L. M. (2010). The effect of spelling and retrieval system familiarity on search behavior in online public access catalogs: A mixed methods study. *Journal of the American Society for Information Science and Technology*, *61*(12), 2461–2476. doi:10.1002/asi.21433
Wilson, T. D. (1981). On user studies and information needs. *Journal of Documentation, 37*, 3-15.
Wilson, T. D. (1994). Information needs and uses: Fifty years of progress? In B. C. Vickery (Ed.), *Fifty years of information progress: A Journal of Documentation review* (pp. 15-51). London: Aslib.
Wool, G. (1996). The many faces of a catalog record: A snapshot of bibliographic display practices for monographs in online catalog. *Information Technology and Libraries, 15*(3), 173-195.
Woolrych, A. & Cockton, G., 2002. Testing a conjecture based on the DR-AR model of usability inspection method effectiveness. In H. Sharp, et al. (Eds.), *Proceeding of HCI 2002 Conference, 2*. British Computer Society, London, 2002.
Yang, S. Q., & Hofmann, M. A. (2010). The next generation library catalog: A comparative study of the OPACs of Koha, Evergreen, and Voyager. *Information Technology and Libraries*, *29*(3), 141-150.
Yee, M. M. (1991) System design and cataloging meet the user: User interfaces to online public access catalogs. *Journal of the American Society for Information Science*, *42*, 78-98. Retrieved from http://escholarship.org/uc/item/2rp099x6

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks: Sage Publications.
Zavalina, O. L. (2012). Subject access: Conceptual models, functional requirements, and empirical data. *Journal of Library Metadata, 12*(2-3), 140–163. doi:10.1080/19386389.2012.699829
Zucker, D. M. (2009). How to do case study research. *School of Nursing Faculty Publication Series.* http://scholarworks.umass.edu/nursing_faculty_pubs/2/

APPENDIX A: DATA COLLECTION INSTRUMENTS

A.1 Participant recruitment survey.

i)Academic major or department: Year of study:

ii)Self-rated computer experience:

- Novice☐
- Intermediate☐
- Expert☐

iii)Are you familiar with library catalogues?

- Yes☐
- No☐
- Uncertain☐

iv)How often do you use search engines?

- Never☐
- Rarely☐
- Sometimes☐
- Often☐
- Frequently☐

v)How often do you use a library catalogue?

- Never☐
- Rarely☐
- Sometimes☐
- Often☐
- Frequently☐

vi)Are you familiar with VuFind library catalogues?

- Yes☐
- No☐
- Uncertain☐
- Uncertain☐

vii)What is your preferred form of contact for this research?

E-mail:

Telephone:

viii)What is the best day and time for you to meet for this research study – (please select all that applies to you)

Day	**Time Tick (√)**				
	9:00-11:00am	11:00am-1:00pm	1:00-3:00pm	3:00-5:00pm	5:00-7:00pm
Monday	☐	☐	☐	☐	☐
Tuesday	☐	☐	☐	☐	☐
Wednesday	☐	☐	☐	☐	☐
Thursday	☐	☐	☐	☐	☐
Friday	☐	☐	☐	☐	☐
Saturday	☐	☐	☐	☐	☐
Sunday	☐	☐	☐	☐	☐

Participant Signature (Type Name) **Date**

A.2 Task analysis brief to the participants.

Interviewer: I would like to talk to you about how you would go about searching a library catalogue or any information retrieval systems of your choice to find materials that will answers the four questions that I am giving. These questions do not in any way relate to your current academic work, nor class assignments, but you might have performed similar searches before. All our conversations will be audio recorded using Audacity installed on my computer. During our conversation I will ask you leading questions to help me understand how you would go about performing these searches. In this exercise you will not be allowed to use a computer or look at the library catalogue interface. Rather, our conversation will be centered on understanding the preparations and thought process you go through before searching a library catalogues. I am interested in knowing how you would prepare for searching a library catalogue before the search process. I am giving you four tasks written on this piece of paper. Each of the tasks addresses a different category of really life research questions that you might be familiar with. The first thing that I would like you to do for each task in this study is that I am asking you if you could:

a) tell me the kind of materials you expect or desire to get to answer the question
b) give a step-by-step process, stating the different VuFind features that you would use to get or search for each or one of the materials you have selected in (a) above. In this case I am asking you to order the steps in form of a flowchart starting from the first step you take to the last step when you think you will have the material or details of the materials that will help you to locate the items from the library.
c) give reasons why you think such features would give you the material/s you intend to use to answer the question
d) alternative search strategies you would take to get the preferred materials in case the steps you choose to take earlier did not return items of interest
e) Other than VuFind, what system would you use to get the materials that you have failed to get by using VuFind
f) Tell me about your feelings and thoughts in relation to the first approach and your alternative. Why choose the first approach, and not the alternative coming first?
g) Earlier on you said you would use system …….in case VuFind did not return good results. Tell me the features you would use from the preferred system as the case in (b) above

Hands on Task Scenarios/ Questions

Discipline: Social Sciences and Humanities

- Find encyclopedia article with a title "*Background checks"* from the Encyclopedia of Privacy, [Two Volumes], Santa Barbara, CA: Greenwood, edited by William G. Staples.
- Find sources that give general overview and background information on the beneficial aspects of steroids for sports
- Find a book, magazine and journal article for any one of the following topics:
    - Global warming and habitats of endangered animals
    - Race and fraternities
- I need to have this citation in MLA and APA styles
    - **Title:** Driving records of persons arrested for illegal drug use

    - **Main Author:**Crancer, Alfred
    - **Other Names:**Quiring, Dennis L.
    - **Published:**[Olympia]: State of Washington Dept. of Motor Vehicles, 1968.
- Find English drama titles of the 17th century era written based on William Shakespeare's Romeo and Juliet.

Discipline: Sciences

- Find encyclopedia article with a title *"Archimedes' theories"* from the *Encyclopedia of Scientific Principles, Laws, and Theories*, [Two Volumes], Santa Barbara, CA: Greenwood, edited by Robert E. Krebs.
- Find sources that give general overview and background information on the ethical issues of stem cell research
- Find a book, magazine and journal article to answer one of the following questions:
    - What are the trends in designing energy-efficient houses?
    - What alternative medicine approaches to treating arthritis in Africa?
- I need to have this citation in MLA and APA styles
    - **Title:** Pounder's marine diesel engines and gas turbines
    - **Main Author:**Edited by Doug Woodyard
    - **Published:**Amsterdam ; Elsevier/Butterworth-Heinemann, 2009.
    - **Edition:**9th ed.
- Find English drama titles of the 17th century era written based on science fiction

A.3 Usability testing brief to the participants.

Interviewer: Welcome to the second part of our study. In this part of the study you will use the computer before you to perform searches for the tasks given to you. I am giving you four tasks. The computer before you is connected to the Internet. You will use VuFind, UIUC's Library Catalogue running in the browser (Google Chrome/ Internet Explorer/ Mozilla Firefox) to perform the tasks. All your searches will be recorded in real-time using Camtasia screen capture software and later analysed for this research. This software will record your voice/ sound and capture the curse movements, clicks and any other actions and behavior that you will perform on the computer. This software will not capture any of your identity (name, face/ picture), but your sound/ voice will be audio recorded to help in the analysis of the curse movements. You're free to perform your searches as you wish and change your search strategies as the tasks will demand. While performing these tasks, please follow the sequence of the questions to help the researcher make comparison during the analysis.

Usability Hands on Task Scenarios/ Questions

Discipline: Social Sciences and Humanities

- Find encyclopedia article with a title "*Background checks"* from the Encyclopedia of Privacy, [Two Volumes], Santa Barbara, CA: Greenwood, edited by William G. Staples.
- Find sources that give general overview and background information on the beneficial aspects of steroids for sports
- Find a book, magazine and journal article to answer one of the following questions:
    - What are the effects of global warming on the habitats of endangered animals?
    - What is the impact of race on fraternity recruitment?
- I need to have this citation in MLA and APA styles
    - **Title:** Driving records of persons arrested for illegal drug use
    - **Main Author:**Crancer, Alfred
    - **Other Names:**Quiring, Dennis L.
    - **Published:**[Olympia]: State of Washington Dept. of Motor Vehicles, 1968.
- Find English drama titles of the 17th century era written based on William Shakespeare's Romeo and Juliet

Discipline: Sciences

- Find encyclopedia article with a title "*Archimedes' theories"* from the *Encyclopedia of Scientific Principles, Laws, and Theories*, [Two Volumes], Santa Barbara, CA: Greenwood, edited by Robert E. Krebs.
- Find sources that give general overview and background information on the ethical issues of stem cell research
- Find a book, magazine and journal article to answer one of the following questions:
    - What are the trends in designing energy-efficient houses?
    - What alternative medicine approaches to treating arthritis in Africa?
- I need to have this citation in MLA and APA styles
    - **Title:** Pounder's marine diesel engines and gas turbines
    - **Main Author:**Edited by Doug Woodyard
    - **Published:**Amsterdam ; Elsevier/Butterworth-Heinemann, 2009.
    - **Edition:**9th ed.
- Find English drama titles of the 17th century era written based on science fiction

A.4 Individual discussion questions.

Interviewer: In this part of the study, I ask you to provide one positive and one negative critical incident covering the following events with respect to using VuFind catalogue. A positive incident might be when VuFind catalogue helped you to complete a task effectively, efficiently, or pleasantly. A negative incident might be when VuFind catalogue hindered or challenged you in completing your task.

a) Incident category: (bibliographic strategy, analytical strategy, analogy strategy, and empirical strategy)
b) Name the nature of a specific memorable event in the process of using VuFind that captured or demanded your attention
c) What was the outcome of this situation?
d) Why do you consider this specific event critical, important, and worth attention?
e) What are your feelings about this incident?
f) What actions did you take during the incident?
g) Did you change the way you used VuFind after that incident? If yes, please specify.
h) What things do you wish to change in future after this incident?
i) What actions should an 'ideal' VuFind catalogue take in addition or instead?

By analysing the data collected from these questions as earlier described in sections 7.2 and 7.3, the research will have a complete understanding of the graduate students' actions and behavior. To keep the conversation flowing, I will continue defining the situation by following these general questions:

- Could you say something more about …?
- Can you give a more detailed description of …?
- Can you give a more detailed description of how …?
- Do you have further examples of …?
- You then mean that…?
- What do you mean by …?
- Does the expression… cover what you have just expressed?

A.5 Participant recruitment notice board advert.

A RESEARCH STUDY TO EVALUATE A LIBRARY SEARCH TOOL

Be a part of a library search tool evaluation research study.

- ❖ Are you a non-Library and Information Science (LIS) graduate student at the University of Illinois at Urbana-Champaign?
- ❖ Have you completed over one year of coursework?
- ❖ Do you have demonstrated library catalogue and Web applications searching and use experience?

If you answered **YES** you may be eligible to participate in a usability study. Participants will receive a $20 credit to the Illini Union Bookstore. Study time: 1 hour and 20 minutes.

Study location: UIUC's Library Scholarly Commons, 1408 W. Gregory Dr., Urbana, IL 61801, Telephone 217-333-2290.

- ✓ Contact Fredrick at flugya@illinois.edu

A.6 Participant recruitment e-mail – GradLinks message

Subject: Request to participate in a study to evaluate a library search tool

You are invited to participate in a research study on evaluating a library search tool. This study is conducted by Fredrick Kiwuwa Lugya, under the directorship of Prof Kathryn La Barre and other three committee members at the University of Illinois at Urbana Champaign. Fredrick is gathering this information for his doctoral dissertation.

This study will take approximately one and half hours of your time. You will be asked to talk about your search strategies, perform searches with a library search tool, and engage in individual or group discussion based on your schedule. Participants will be rewarded with a $20 credit card Illini Union Bookstore card for their time. If you wish to participant contact Fredrick at flugya@illinois.edu

Yours Sincerely

Fredrick Kiwuwa Lugya
Doctoral student at the University of Illinois at Urbana-Champaign (Researcher)

APPENDIX B: RESEARCH STUDY CONSENT FORM

RESEARCH STUDY TO EVALUATE A LIBRARY SEARCH TOOL

You are invited to participate in a research study to evaluate a library search tool. This study is conducted by **Frederick Kiwuwa Lugya, under the supervision of Prof Kathryn LaBarre and a team of three other professors in the Graduate School of Library and Information Science at** the University of Illinois Urbana Champaign. Fredrick is gathering this information for his doctoral dissertation in the School.

This study will take approximately **one hour and twenty minutes** of your time. You will respond to questions about your search strategies and behavior and perform search tasks with VuFind library search tool.

Your decision to participate or decline participation in this study is completely voluntary and you have the right to terminate your participation at any time without penalty. You may skip any questions you do not wish to answer.

Your participation in this research will be completely confidential and data will be averaged and reported in aggregate. Possible outlets of dissemination may be published in an international journal of librarianship, but the primary purpose is to provide Fredrick with data for his doctoral dissertation. A summary of results may also be presented at conferences and published in journal articles, but the confidentiality of individual responses will be maintained. Although your participation in this research may not benefit you personally, it will help us develop evaluation criteria to benefit designers of library search tools. A better search tool will also benefit its users.

Given our commitment to the confidentially of individual responses, we believe there are no risks to individuals participating in this study.

If you have questions about this project, you may contact Prof Kathryn LaBarre at 217-244-4449 or by email at klabarre@illinois.edu**.** If you have any questions about your rights as a research participant in the study, please contact the University of Illinois Institutional Review Board at 217-333-3670 (collect calls accepted if you identify yourself as a research participant) or via email at irb@illinois.edu.

Please sign a copy of this consent form for your records, if you so desire.

I have read and understand the above consent form, I certify that I am a non-LIS graduate student, 18 years old or older and, by signing this form, I indicate my willingness voluntarily take part in the study.

_____ _____

Participant Signature **Date**