ARE ONLINE CATALOGS FOR CHILDREN GIVING THEM WHAT THEY NEED?

CHILDREN'S COGNITIVE DEVELOPMENT AND INFORMATION

SEEKING AND THEIR IMPACT ON DESIGN

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Research shows children in an online environment often search by browsing, which relies heavily on recognition and content knowledge, so catalog systems for children must use effective symbols or pictorial representations, which correspond with children's own cognitive schema and level of recognition knowledge. This study was designed to look at the success of young children (ages 5 to 8) in searching 3 online public library catalogs designed for them, and it focused specifically on the pictorial representations and text descriptors used in the systems' browsing hierarchy. The overriding question seeks to answer if young children (ages 5 to 8) are really poor searchers because of cognitive development and lack of technology skills or if system design is the major reason for poor search results and is answered by looking at a series of questions. The overriding research question in this dissertation is: Do current children's online catalog designs function in a manner that is compatible with information seeking by children?

Although these results can not be generalized, this study indicates that there was a disconnect between the cognitive abilities of young users and catalog design. The study looked at search success on the 3 catalogs in relation to the catalog characteristics and individual user characteristics and makes 3 significant contributions to the field of library and information science. The first contribution is the modification of an existing model posed by Cooper and O'Connor and modified by Abbas (2002). The second significant contribution is the proposal of a new model – Creel's second best choice (SBC) model – that addresses the cognitive gap and design flaws that impact the choices participants in this study made. The third significant

contribution is that this study addresses and fills a gap in the literature. Before this study, there was a significant lack of research on children ages 5 to 8 using public library catalogs.

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TABLE OF CONTENTS

Appendix

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

> I wish I had known that the solution for needing to teach our users how to search our catalog was to create a system that didn't need to be taught—and that we would spend years asking vendors for systems that solved our problems but did little to serve our users
>
> -- Roy Tennant

Inspiration for this Study

Over the last ten years of working in public libraries, observation of younger and younger children using the library catalog, and not always successfully, brought into focus the need for research into the browsing interfaces they use. On a weekly basis, parents and children left story time and sat down at the computers to play games and look for books. Children have particular information needs and information seeking behavior (Hirsh, 1996; Walter, 2001; Cooper, 2002a). Just as children's information seeking is heavily dependent on their cognitive level and domain knowledge, adults' information seeking behavior is also affected by cognitive styles. Adults, however, exhibit the ability to search keywords and revise their searches in an iterative style, which allows them to improvise based on domain knowledge (Belkin, Brooks, & Daniels, 1987; Robins, 2000; Bilal & Kirby, 2002; Vakkari, Pennanen, & Serola, 2003). In contrast, research shows elementary school children often search by browsing, which relies heavily on recognition knowledge (Marchionini, 1995; Hirsh, 1997; Busey & Doerr, 1993). Children's cognitive and developmental levels influence their information seeking, and many of the problems children face when searching online catalogs and the Internet are due to these cognitive and developmental levels (Cooper, 2002a, Hirsh, 1996; Solomon, 1991).

Need for this Study: A Statement of the Problem

Information seeking technology specifically designed for children, like children's library catalogs, should be appropriate for "these users' information needs, information seeking behavior, cognitive processes, knowledge structures, and expectations" (Bilal & Wang, 2005, p1303). Since the late 1980s, reports have indicated that children struggle when searching online library catalogs (Hooten, 1989; Edmonds, Moore, & Balcom, 1990; Moore & St. George, 1991; Solomon, 1993). Kid's Catalog, one of the first commercial catalogs to have a specific interface for children, made its debut in 1993 (Busey and Doerr, 1993). Since then, researchers have focused on children's information seeking using online catalogs in schools or catalogs designed for very specific audiences, like the Science Library Catalog (SLC) for use by science students. Additionally, literature on very young children, who have just begun reading, and their use of online catalogs in public library settings to find information is lacking. Libraries across the country purchase online library catalogs with interfaces specifically for children and place their faith in these systems to meet children's needs. The research literature on these issues – for example, cognitive abilities and domain knowledge – affecting children and their search behavior showed that research on online library catalogs used by very young children was lacking. This awareness inspired the pilot study, which revealed that participants relied heavily on the images and not just the text descriptors of the icons and indicated additional research was necessary.

Significance of this Study

This study makes 3 significant contributions to the field of library and information science, especially in the area of children's information seeking and their use of library catalogs.

- The first contribution is the modification of an existing model posed by Cooper and O'Connor that was later modified by Abbas (2002). This study looks at the Abbas modifications, adds an additional layer of representation, and explores the impact of this additional layer.

- The second significant contribution is the proposal of a new model. *Creel's second best choice (SBC) model* is discussed in detail in Chapter 6. The model addresses the cognitive gap and design flaws that influence the choices participants in *this* study made.

- The third significant contribution is that this study addresses and fills a gap in the literature. Before this study, there was a significant lack of research on children ages 5-8 using public library catalogs.

Purpose of the Study

There are two main purposes to this study. First, this study seeks to determine if the catalogs are meeting children's information seeking needs by providing cognitively sound interfaces, which lead to searching success. Second, this study seeks to answer whether or not libraries' faith in these online children's interfaces is justified. The research questions detailed in the subsequent section further address the purposes of this study.

Research Questions

Due to the advent of catalogs designed for children, academic scholars of library science as well as practitioners of the field should be interested in how well these catalogs work. If young children are truly poor searchers because they lack sufficient cognitive development and lack sufficient technological skills, then creating a catalog that is child friendly for the youngest users may not be a realistic goal. However, it is also possible that the difficulties children encounter as they search are also due in part to system design. This leads to the overriding research question in this dissertation:

> Do current children's online catalog designs function in a manner that is compatible with information seeking by children?

In order to answer the overriding question, it is important to determine what factors affect the search success of children and attempt to devise a research design that allows us to estimate the magnitude of each factor's effect on successful searching. These factors can be grouped into two broad categories: catalog characteristics and individual characteristics. In order to assess the effectiveness of catalog design, two questions must be answered.

1. Do the catalogs and labels used by libraries and library vendors assist children ages 5-8 in locating tasks?

2. Do the subject categories and labels used cognitively match the level of development of children ages 5-8?

If the difficulties encountered by children while searching are a result of cognitive and technological limitations, then the individual characteristics of children should influence searching. Consequently, the answer to the overarching research question depends in part on the answers to these questions.

3. Does the individual level characteristic of age affect the success of children ages 5-8 in locating an assigned task?

4. Does the individual level characteristic of gender affect the success of children ages 5-8 in locating an assigned task?

5. Does the individual level characteristic of race affect the success of children ages 5-8 in locating an assigned task?

6. Does the individual level characteristic of perseverance affect the success of children ages 5-8 in locating an assigned task?

7. Does the individual level characteristic of computer usage affect the success of children ages 5-8 in locating an assigned task?

Definition of Terminology for this Study

Investigations into how children function in the age of online catalogs and the Internet have only recently taken a major spotlight in the academic research of library and information science. This recent influx of research over the last ten years into their search behavior and the ambiguity of terms, often misused and misunderstood, make it necessary to define a variety of terms in light of this new technology. The majority of the terminology for this dissertation is found in the Glossary. For convenience of the reader, the following definitions have been included here as well.

By definition, an *online catalog* is a current and complete record of a library's holdings that are accessible through a computer terminal, and an *Online Public Access Catalog* (OPAC) is a catalog system in which "information is stored on a database loaded in a computer which can be used directly by a user via a remote terminal" (Keenan & Johnston, 2000, p. 182). Basically, OPACs are in many ways traditional card catalogs transformed into an electronic medium (Chu, 2003). For the duration of this dissertation, the two terms – online catalog and OPAC – are used synonymously; additionally for the duration of this dissertation, information retrieval systems refer to the online catalogs, OPACs, and search engines.

Even though the McGraw-Hill Dictionary of Scientific and Technical Terms (2003) defines the *Internet* as a "worldwide system of interconnected computer networks, communicating by means of TCP/IP and associated protocols" and the *World Wide Web* as "a part of the Internet that contains linked text, image, sound, and video documents," these terms are used interchangeably in the research and in this dissertation.

In an online environment, browsing involves seeking information by "going through an index by clicking on topics" (Kuiper, Volman & Terwel, 2005, p. 289). *Search browsing*, also known as directed browsing or browsing with a specific goal is "a closely directed and structured activity where the desired product or goal is known" (Rice, McCreadie, & Chang, 2001, p. 179).

Description of this Dissertation

Although research on children's information seeking has taken place for decades (Joyce & Joyce, 1970; Armstrong & Costa, 1983; Edmonds, Moore & Balcom, 1990; Moore & St. George, 1991; Solomon, 1993; McGregor, 1994; Borgman, Hirsh, Walter, & Gallagher, 1995; Hirsh, 1997), this present study focuses *primarily* on 1992 through the present in order to concentrate on the most recent trends. It is also important to note that the studies cited focus on a wide range of ages of children and students, while this dissertation studied and reported specifically on children in the 5 to 8 year old range.

There are 5 additional chapters beyond this introduction. Chapter 2 contains a literature review of prior research that is broken down into the following parts: a brief history of library services to children, a brief history of online catalogs, children's cognitive and developmental stages, children's information seeking behavior, and theories affecting the study. It is important to first look at the cognitive and developmental stages affecting the way children search before looking at the current theories and prior research. Children's information seeking behavior in general and studies primarily since 1992 are the focus. Chapter 3 presents the pilot study conducted in 2005. Chapter 4 is the methodology and provides a description of where the study took place, the catalogs investigated, and the process. Chapter 5 containing the analysis of the results of this study is next. The chapter includes the statistical analysis, analysis of the icons, and analysis of the taxonomies created by searching. Chapter 6 is the final chapter containing a summary conclusion, the theories in light of this study, a proposed model, discussion, limitations of the study, future implications and studies, and significant contributions and recommendations.

CHAPTER 2

PRIOR RESEARCH AND THEORETICAL BASIS

Chapter 2 contains an overview of the literature that serves as the foundation for this study investigating factors contributing to children's online search success. In addition to recent research into children's search habits, research on children's cognitive and developmental stages, their information seeking behavior, and the theories affecting children's searching are well-established areas that provide a valuable theoretical framework for this dissertation. There is a discussion of the contributions of research in these various categories as well as the unanswered questions that arise as a result of their findings. Since the study takes place in a public library setting in a children's room, there is a brief presentation of children's librarians, services, and publishing along with the brief history of online catalogs in libraries since there is a direct relation to the research topic. The discussion of youth searching online catalogs and the Internet presented here is limited primarily to work since 1992. A variety of factors, describe below, make this limitation appropriate.

Children are increasingly exposed to technology at younger ages, and it "may be assumed that young library patrons are more accepting of computer technology because they learn to use computers in school" (Edmonds, Moore, & Balcom, 1990). In 1993, Kid's Catalog, a new catalog designed specifically for children to address the issues research reported that they encounter when searching, debuted (Busey & Doerr, 1993). The research done since 1992 reports on children's increased use of technology and online catalogs designed specifically for them. Additionally, focusing the literature review primarily on the research conducted since 1992 will allow for an emphasis on more recent developments influencing catalog design and online information retrieval.

Children's Librarians, Services, and Publishing: A Historical Look

"Public libraries in the United States have defined children's library services to provide access to information and programming for children from birth through the end of middle school…" (Woolls, 2003, p. 522). The Association for Library Service to Children (ALSC), a division of the American Library Association (ALA), deems library services for children as those for children birth through age fourteen (American Library Association, 2006b). "During the last quarter of the nineteenth and the first half of the twentieth centuries, a number of factors converged to create the patterns of children's services in libraries still evident in the United States" (Vandergrift, 1996). The following factors created the right atmosphere for the creation and growth of children's services and women ready to react to the issues of society:

- A shift in the way public education and childhood were viewed
- Social and financial alterations in a period of immigrant growth and a depressed economy
- Accelerated development of industrialization and urbanization
- A frontier that was no longer open
- World War I and World War II
- An increased acceptance of women as a part of the job force (Vandergrift, 1996; Jenkins, 1996)

These factors worked together to create an influx of women into the field of librarianship and other social welfare professions. "Publicly supported schools, libraries, and social welfare agencies were among the institutions established during this time, and social welfare professions grew up around this agencies" (Jenkins, 1996). At the same time, the librarian field itself was changing as it became more professional and specializations within the field developed; additionally, the catalyst of Carnegie funding for libraries coupled with the interest in libraries as real locations and the growth of children's publishing combined to create the field of children's services (Vandergrift, 1996). From the onset, the goal of the women who took the lead was to provide "good" books for children in an appealing environment with responsive service to promote the love of reading quality books and the know-how to use them (Vandergrift, 1996). These women also worked to support educational goals by providing lending libraries to schools and worked to promote social, moral, and civic growth (Vandergrift, 1996).

It is important when looking at the history of library service to children and children's literature to consider the New England book women and their friendship as a driving force behind the growth of this field (Bush, 1996). Although these four women are not a complete list of the many men and women instrumental in the growth of youth services, Caroline Hewins, Anne Carroll Moore, Alice Jordan and Bertha Mahony "were all very representative of certain demographic/sociological trends in the late nineteenth century" (Bush, 1996). They were all citizens born into the middle class of the United States who achieved higher education and entered typical professions (Bush, 1996).

Hewins, a librarian, had a major impact on the "public librarian services for children and the publishing, selling, and reading of children's books" (Bush, 1996). She was one of the creators of the Connecticut State Library Association and was an active voice in the ALA. Additionally, Hewins served as mentor to many including Moore (Bush, 1996). Moore followed Hewins' example and created strong bonds with the schools and community, and her peers viewed her as warm, enthusiastic leader in the library field (Bush, 1996). Hewins and Moore met and mentored Jordon after she sought their advice when she became the first children's librarian in Boston Public Library's (BPL) Children's Room (Bush, 1996). She eventually became head of BPL's children's services and founder of what became the New England Round Table of Children's Literature of the New England Library Association. The final voice of these

4 New England book women belongs not to a librarian but to a bookseller. Mahony inspired by "her childhood love of books and stories and her adult interest in libraries and bookstores burst into a bold idea which was to be enormously fruitful" (Bush, 1996). This bold idea was the creation of the Bookshop for Boys and Girls. She was able as founder and administrator of the Bookshop for Boys and Girls to use the knowledge of children's librarians and to provide an enormous service and influence to libraries (Bush, 1996). Jordan mentored Mahony who later developed a relationship with Hewins and Moore. "Caroline Hewins, Anne Carroll Moore, Alice Jordan, and Bertha Mahony are notable for their work in numerous areas: children's librarianship, bookselling, teaching, literary criticism, writing, organizing, and leadership of professional associations" (Bush, 1996).

In addition to these New England book women, some of the most generally recognized leaders in the field of youth services in libraries were those who were active in the ALA's youth services divisions (Jenkins, 1996). "The authority of youth services librarians was most visible through their work in selecting and bestowing children's book awards and in compiling widely circulated bibliographies of the 'best books' for children" (Jenkins, 1996). The following figure depicts selected milestones in the development of services, libraries, and book publishing for children.

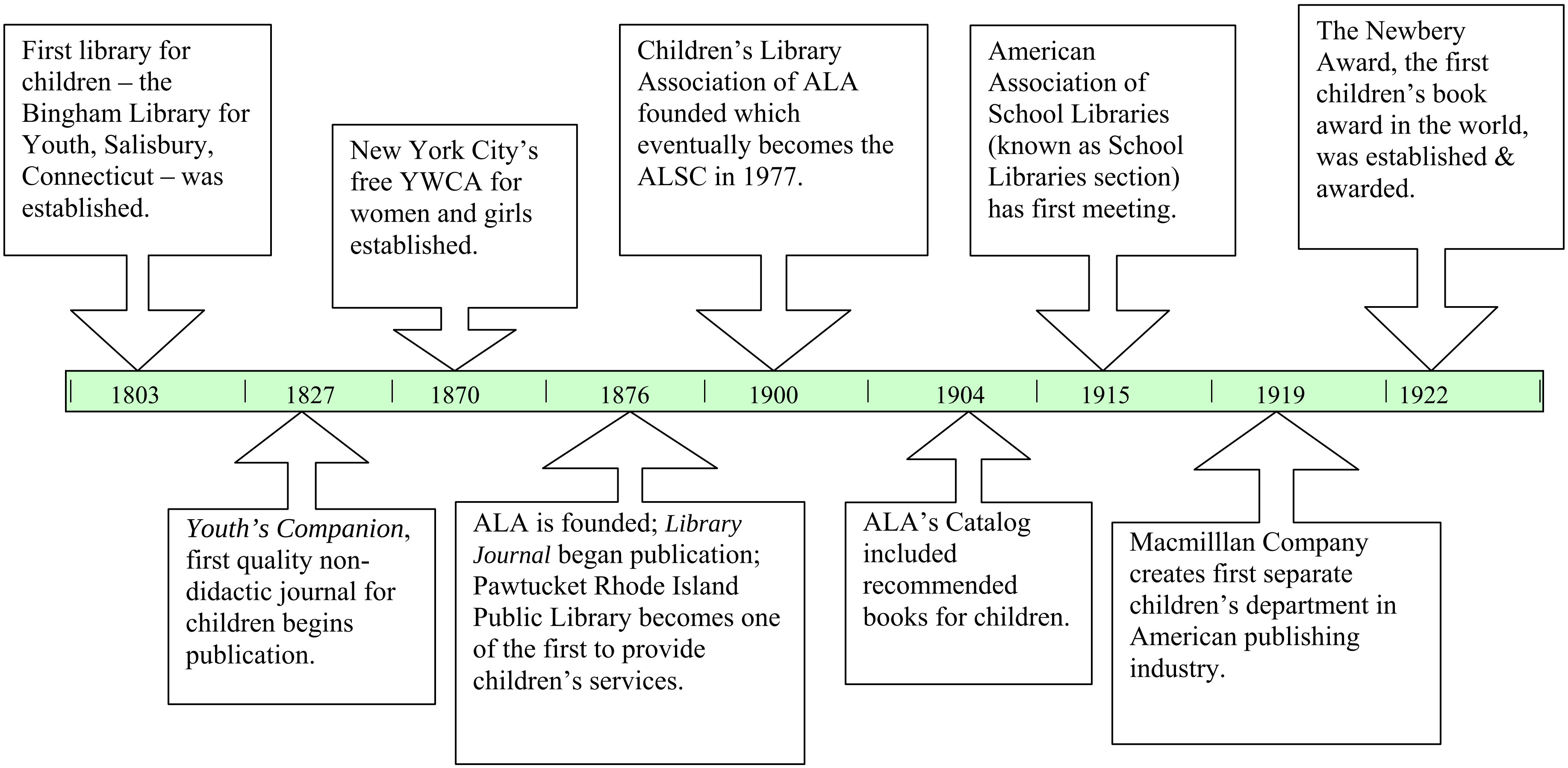


Figure 1. Selected milestones in the development of services, libraries, and book publishing for children (Vandergrift, 1996; American Library Association, 2006a).

OPACs and Online Catalogs in Libraries: A Historical Look

"Catalog cards were first written by hand in library script, then typed, and ultimately ordered from vendors or the library of Congress. Later they were produced via bibliographic utilities such as OCLC using MARC records" (Butterfield, 2003, p. 2268). OCLC (Online Computer Library Center) is a "nonprofit, membership, computer library service and research organization" (OCLC, 2007). "MARC is the acronym for MAchine-Readable Cataloging" (Library of Congress, 2006). MARC supplies the method "by which computers exchange, use, and interpret bibliographic information, and its data elements make up the foundation of most library catalogs used today" (Library of Congress, 2006). Online catalogs developed because the technology existed and because of the creation and extensive acceptance of MARC which led to accumulation and storage of bibliographic records (Butterfield, 2003). Since the MARC records had been created and stored, this led to the natural progression of making these records available to "librarians, libraries, and the public by adapting or creating search interfaces and emerging computer and database technologies" (Butterfield, 2003, p. 2268).

Peters (1991) determined that for the development and acceptance of Online Public Library Catalogs (OPACs) to take place, the following things needed to be in place: the technology had to exist; it had to be seen as cost efficient for potential buyers; the catalog had to meet users' needs; and the catalogs had to meet the goals and needs of the library system. Universities were the primary creators of early online catalogs until the 1970s when commercial providers began to take the place as the main developers (Butterfield, 2003). OPACs have been classified in the past as having three generations – the first was the card catalog in electronic format; the second generation added enhancements, such as subject access points; and the third merged OPACs into something more similar to the online catalog with remote access (Chu, 2003). Figure 2 provides selected milestones in the development of OPACs created for use in libraries.

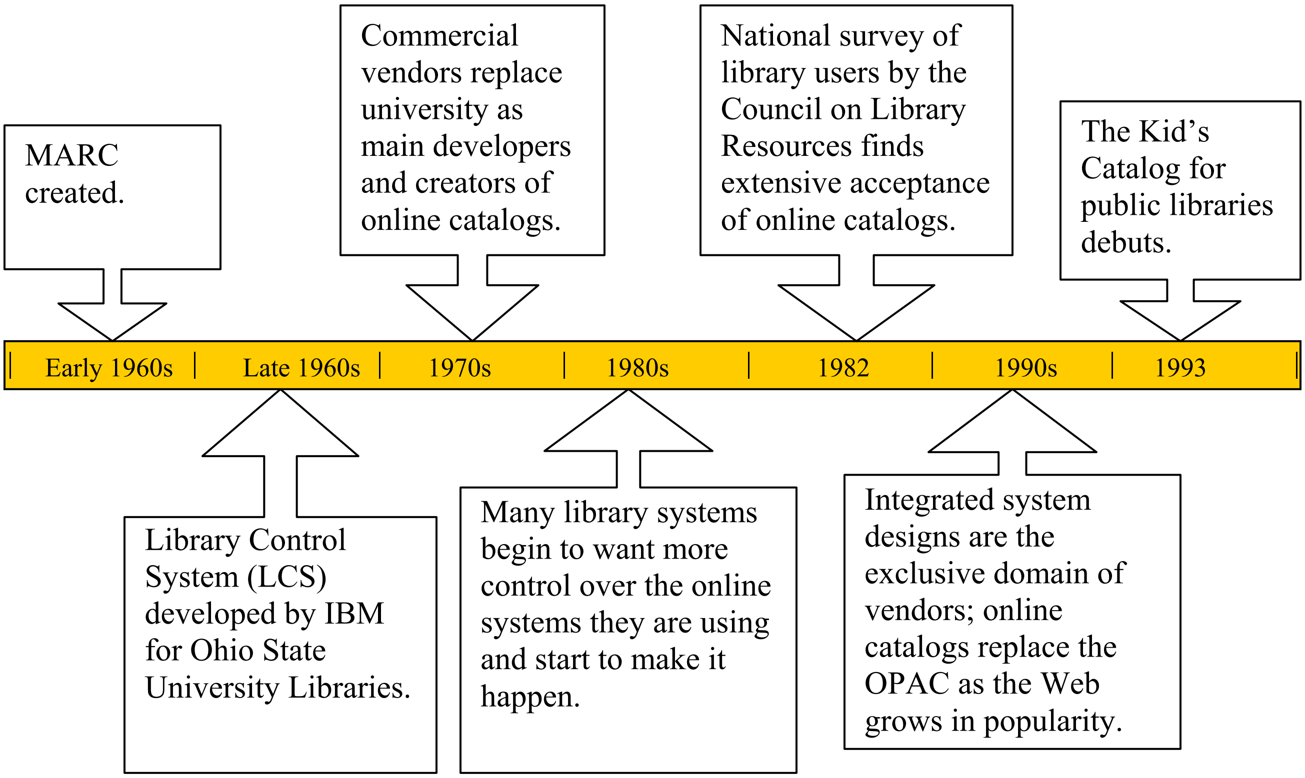


Figure 2. Selected milestones in the development of OPACs and online catalogs in libraries (Butterfield, 2003; Busey & Doerr, 1993; Edmonds, Moore, & Balcom, 1990).

Children's Cognitive and Developmental Stages

"Growing up in a specific place and time, socioeconomic status, gender, cultural and religious background, access to health care, education, and support for family life within the larger society all affect the nature of childhood" (Gross, 2006, p. 2). In addition to these factors, many of the problems children face when searching online catalogs and the Internet are due to their cognitive and developmental stages. "Child development encompasses several domains:

cognitive, social, physical, and emotional. These domains are closely related in that they overlap and influence each other" (Cooper, 2005, p. 287).

Although cognitive development is sequential, recent research indicates the traditional view of cognitive development as strictly linear is not entirely correct; research suggests children go through a series of over-lapping changes impacted by their interaction with external environmental factors and internal factors (Cooper, 2005; Gross, 2006). Additionally, a child may perform differently on cognitive tasks for a variety of reasons at any given time (Garbarino, Stott, & faculty of the Erikson Institute, 1992). "These changes reflect successive reorganizations or shifts in the quality of functioning and occur in all spheres of development, physiological, cognitive, social, and emotional" (Garbarino et al., 1992, p. 9). Children's abilities to recognize, recall, understand, and communicate are dependent on intellect and emotional aptitude (Garbarino et al., 1992). Additionally, the acquisition of new cognitive skills builds on the foundation of already acquired skills (Cooper, 2005). Children progress at different rates, and an individual child can even experience uneven progress within a stage – they may be adept at one skill while lacking in another (Cooper, 2005).

"Learning to read may be the greatest cognitive challenge that young children face" (Copper, 2005, p. 292). They must move from "concrete and sensory" to "abstract and symbolic" in their understanding (Cooper, 2005, p. 292). The struggle to read is not the only cognitive challenge children face when using an interface. Walter, Borgman, and Hirsh (1996) attribute some of the difficulty experienced in searching by children to their lack of vocabulary and knowledge base, which are dependent on their still-evolving memory functions and caused by lack of experience. Additionally, even though children gain vocabulary progressively through the school curriculum, this gained vocabulary does not necessarily match the controlled vocabulary of the online catalog's subject headings (Everhart & Hatcher, 2005).

Children at the younger age spectrum are at even more of a disadvantage. As non-readers or beginning readers, children under age eight or 3rd grade gain information largely from visual or auditory sources (Cooper, 2002a). Children in the two to seven age range are still in Piaget's preoperational stage and transition into the concrete operations around age seven (Piaget & Inhelder, 1969). Additionally, it is in this preoperational stage that children begin to utilize symbols and begin reading (Gross, 2006). In general, it is at this concrete-operational stage that children go from being self-centered and expecting others to have their same opinion and perspective to being able to classify objects, arrange objects, and engage in abstract thinking (Piaget & Inhelder, 1969; Cooper, 2002a). During the concrete operational stage (7 to 11), children start to obtain the capability to perform cognitive exercises dependent on logical reasoning versus intuitive actions (Hamachek, 1990). During the concrete operational stage, children also increase in their ability to classify, or group objects and events based on common characteristics (Hamachek, 1990). All of these concrete-operational activities are necessary for successful searching (Cooper, 2002a). Even though the process is continuous, Garbarino et al. (1992, p. 16) break the process down into the following broad periods:

> "In infancy (from birth to two years), the child experiences his or her world in a perceptual, action-oriented, non verbal fashion. The infant's capacities, affects, and behaviors serve as sources of information. In the preschool period (from two to six years), the advent of language and symbolic thinking brings about the ability to share meaning with other people. The child has achieved a significant capacity to understand and respond to adult inquiry, but performance is closely tied to the contexts in which it is elicited. In the school age period (from six to twelve years), with the development of the ability to think about thinking and the ability to think more logically, the child is developing increasingly more adultlike capacities to communicate and respond. The child's motivations, however, are also becoming more complex and difficult to discern."

Children have a lack of experience and knowledge base (Broch, 2000). Erikson's view on human development also contains stages of cognitive development affecting children and information searching (Gross, 2006). "The elementary school years are marked by the development of many skills and by the child's increasing ability to take responsibility for being productive at school and at school" (Gross, 2006, p. 4).

Categorization is a primary method used by children to make sense of the world around them (Markman, 1989). "Categorization, then, is a means of simplifying the environment, of reducing the load on memory, and of helping us to store and retrieve information efficiently" (Markman, 1989, p. 11). "The *meaning* of a word refers to the *concept* that the word expresses" (Markman, 1989, p. 12). Concepts are organized into categories, which are then further installed into taxonomies. "The practice of taxonomy reflects the human instinct to organize our experiences and perceptions of the world" (Drake, 2003, p. 2770). Taxonomies are used by information retrieval systems to assist in searching and to organize information. Taxonomy involves the practice of matching groups of items with previously defined labels but can also include the creation and arrangement of the items (Drake, 2003). As stated by Waxman and Hatch (1992, p. 153) "a fundamental feature of human conceptual and semantic organization is the ability to locate an individual object (e.g. a dog) in multiple taxonomic classes at various hierarchical levels (e.g. collie, dog, animal)." "Taxonomic systems are a pervasive and extremely important kind of organization of categories" (Markman, 1989, p. 14). Taxonomic systems are readily found in online environments like the Internet and library catalogs. Take for example the iii catalog for children, animals (general) leads to ten choices including birds (more specific), which leads to eighteen even more specific types of birds as choices.

Traditionally, it has been accepted that in young children, there is often an inability to categorize and an inflexibility in labeling; they generally accept the base-level label for objects (e.g. dog) while rejecting non-basic-level labels (Waxman and Hatch, 1992). However in Waxman and Hatch's (1992) study of three year olds (n=20) and four year olds (n=20), 75% of the three year olds and 92% of the four year olds were able to produce more than one label at least half of the time by employing a contrast questions method. Their findings are in line with the view that children as young as three years of age can construct conceptual and semantic hierarchical systems of organization (Waxman and Hatch, 1992). McGarrigle also found that preschool children when provided subclasses and superordinate classes containing adjectives with which they had personal experience were able to consider and identify them successfully (Garbarino et al., 1992). Numerous studies have come after Piaget showing "many children, well advanced agewise in the period of concrete-operational thought, failed standard tests of class inclusion" (Winer, 1980, p. 310).

There are other abilities children have, for example memory, which depend not only on Piaget's cognitive levels but also on their experience, the situation they are in (the experiment), and their motivation (Garbarino et al., 1992). "The ability to provide information depends on children's feelings about being competent, their attitudes toward adults, and the ways in which they defend themselves from difficult consequences or feelings" (Garbarino et al., 1992, p. 11). Users utilize the cognitive ability to reflect on experiences and make sense of their environment (Marchionini, 1995). Children's cognitive abilities while developed in stages are certainly fluid and based on many factors (Cooper, 2005; Gross, 2006; Garbarino et al., 1992; Broch, 2000).

In addition to the ability of understanding the taxonomy inherent in the online catalog, children must also grasp the symbolic representation intended by the designers of the system. As defined by DeLoache, a “symbol is something that someone intends to stand for or represent something other than itself” (2002, p. 207). Children must be able to understand the intended abstract meaning and know the concrete object; this is called dual representation. Children’s success with understanding and using symbolic representations is dependent on representational insight (DeLoache, 2002). Representational insight is “the recognition of the existence of a symbol-referent relation” (DeLoache, 2002, p. 219).

In the pilot study, described in Chapter 3, and in this study, children participated in a production task; they generated and/or identified the labels used on the images in the 3 catalogs while identifying the path to locating a specific task. This called on them to use higher mental processes such as directed memory, or recall memory, and logical thinking. These higher processes are based in social interaction (Garbarino et al., 1992). Cognitive development is molded by interacting with the environment and culture in which they develop; they gain knowledge through their culture and learn to view things through the cultural lens (Cooper, 2004). “Central to the cognitive point of view is what DeMey (1977) referred to as the information processor’s model of the world, determined by prior experience and education” (Kuhlthau, 2004, p. 5). This model of the world is constantly changing as users acquire new knowledge and experiences.

Even though children have been receiving information since birth, it is at a later age and developmental stage that they are able to access textual information found in catalogs and on the Internet as they begin to read (Cooper, 2002a). “Memory involves perceiving, coding, storing, and retaining information and retrieving this information at a later time through recognition or recall. Memory is an active process that involves both construction and reconstruction, both conscious and unconscious inferences and interpretations” (Garbarino et al., 1992, p. 42).

Recognition knowledge is the ability to recognize information, and recall knowledge is the ability to recall information from experience and memory. Recall knowledge, which is a more advanced cognitive skill, is harder for children to accomplish because of lack of domain knowledge or subject expertise (Cooper, 2002a). Additionally, prior knowledge impacts children's ability to recall and "affects their execution of basic processes and strategies, their metacognitive knowledge, and their acquisition of new strategies" (Schneider, 2002, p. 246). "Searching on a known item should place minimal demands on memory, while an attempt to find one or more items needed to write a report would place substantial demands on all components of the information processing systems" (Solomon, 1991, p. 34). An increase in domain knowledge impacts the use of strategy by decreasing the need for it and improving on the use of other processes (Schneider, 2002). Research also indicates that knowledge on a topic being searched impacts the search process and formulation of the search (Allen, 1991). "It makes sense that a younger child with a smaller stock knowledge will have less experience on which to conceptualize abstractly" (Cooper, 2004, p. 186).

Children in the preoperational stage, and even some in the beginning of the concrete-operational stage of searching, are unable to recall alternative words to use or abstract concepts necessary to modify search strategy (Borgman, Hirsh, Walter, & Gallagher, 1995). Solomon (1991) also describes children in the preoperational stage as having potential problems coming up with alternative keywords for items in a catalog and potentially as not seeing other points of view or sides to a problem. It is expected that children in the concrete stage will have difficulty using rules, generalizing, and applying logic to problem solving while those transitioning into the formalized stage, usually around the age of eleven or twelve and continuing through adulthood, begin to exhibit these abilities (Edmonds, Moore and Balcom, 1990).

Although Bhavnani and Bates (2002, p.7) were not working with children, they noted "another promising direction for research is to distinguish the declarative and procedural knowledge for subject content, from the declarative and procedural knowledge for information structure and organization." The knowledge children have about subject content verses their knowledge about structure and organization of the online catalog should also be investigated.

Subject browsing catalogs are also designed to attempt to incorporate children's cognitive abilities, like lack of recall knowledge, by providing images and text to prompt children's memories (Busey and Doerr, 1993). As stated by Joyce and Joyce, "From aspects of the world with which they have direct contact, children are able to produce raw data, or, to put it in another way, they can obtain information through their own perceptual apparatus. They can then proceed to transform this information into knowledge" (1970, p. 1). In order for children to acquire information about things they have not personally experienced and to turn that gained information into knowledge, creators of online catalogs must design them in a way that allows the user know how the editing and structuring – organizing – affects the information (Joyce and Joyce, 1970).

In addition to these cognitive influences on children's information seeking, the relationship between the text and the images plays an important role in children's success in searching. Marsh and White (2003) developed a taxonomy of relationships between images and text, which could be looked at with the possibility of application to IR systems for children. The common errors that children make or problems they encounter when searching in online environments, as reported by Kuhlthau (1991), Borgman, Gallagher, Walter and Rosenberg (1991), Busey and Doerr (1993), Solomon (1993), Walter et al. (1996), Hirsh (1997), and

Revelle et al. (2002), are included in Table 1 and reflect both cognitive, physical, and mechanical induced problems.

Table 1

Common Problems Children Encounter in Searching Online Environments

Problems Children Encounter in Searching OPACs & Online Catalogs:	Problems Children Encounter in Searching the Internet & World Wide Web:
Typing / Keyboarding	Typing / Keyboarding
Spelling	Spelling
Adequate Vocabulary	Adequate Vocabulary
Reading	Search Strategy Formulation
Alphabetizing	Boolean Operators – conjunction (AND) and disjunction (OR)
Search Strategy Formulation	Concept Selection
Boolean Logic	Search Refinement
Domain Knowledge	Domain Knowledge
Controlled Vocabulary and Subject Headings	Controlled Vocabulary
Spacing and punctuation	

Note. (Kuhlthau, 1991; Borgman et al., 1991; Busey and Doerr, 1993; Solomon, 1993; Walter et al., 1996; Hirsh, 1997; & Revelle et al., 2002).

It is important to note there are problems that appear to be unique to certain environments. In searching the Internet and World Wide Web, reading was not reported as problem. One explanation for this could be the age of the participants in the research. Of the research on the Internet utilized for this study, only one included children as young as age five (Yan, 2005); Yan's study dealt with their understanding of the Internet and not their searching online. In online catalogs and OPACs, alphabetizing in addition to spacing and punctuation are part of the mechanics of the systems (Butterfield, 2003). However, it becomes apparent that mastering sequencing, understanding rules, and knowing alphabetizing is not enough to successfully use the catalog; it becomes clear that using the catalog in some instances requires “a working knowledge” of AACR2 (Edmonds et al., 1990). Overall, it is clear that children’s information seeking is influenced by their cognitive and developmental levels. But what does the research say about how children search?

Children’s Information Seeking Behavior

Early research on information seeking focused on the sources used to answer information needs (Case, 2006); in the 1970s, research changed its focus away from the sources being used and structured systems to “the person as a finder, creator, and user of information” (Case, 2006, p. 6). As defined by Ingwersen and Jarvelin (2005), information seeking is “human behavior dealing with searching or seeking information by means of *information sources* and (interactive) *information retrieval* systems” (p. 386). Children have a variety of information needs and must have access to information including the use of interactive information retrieval systems like online catalogs (Hooten, 1989). “Age should not be a barrier to the ability to access, receive, and utilize information” (Hooten, 1989, p. 268).

According to Schacter, Chung, and Dorr (1998), the search behavior of elementary school children is reactive. They do not “systematically plan or employ elaborate analytical search strategies” (Schacter et al., 1998, p. 847). Children often use browsing strategies no matter what the information task; the vagueness or specificity of the task did not affect whether they browsed or not (Schacter et al., 1998). The research of Borgman, Hirsh, Walter, and Gallagher (1995) supported this assertion when they found that children show a high level of browsing with open research tasks since browsing is a mode of searching that relies on recognition memory instead of recall memory. As found in Rice, McCreadie, and Chang (2001), browse searching allows for more flexibility and allows for adaptation in contrast to searching via submitting keyword queries. Browsing uses a smaller "cognitive load than analytical search strategies do. Browsing is highly dependent on human perceptual abilities to recognize relevant information" (Marchionini, 1995, p. 103).

Children under eleven years of age are still lacking cognitive abilities dependent on recall terms and concept making them less successful in searching; even though children over age ten are more successful, they may still be unsuccessful at times due to information not yet found in their knowledge base. Garbarino et al. (1992) point out the need children have for concrete retrieval cues; additionally, children's lack of experience and knowledge base means they often have trouble modifying their search (Broch, 2000).

Children's lack of variety of terminology is exacerbated by the use of controlled vocabulary in information retrieval systems. However, children were successful in searching by keyword when they did not have to construct search strategies and remember specific search terms (Walter et al., 1996). Even when they do have the right terms to use they are further hampered by keyboarding and spelling errors (Walter et al., 1996). Children, as well as adults, have trouble using Boolean search features; generally, children especially struggle with disjunction (Revelle et al., 2002).

Additionally, children's affective states influence children's searching (Kuhlthau, 1991; Broch, 2000). Kuhlthau's (1991) Information Search Process (ISP) model, which addresses affective states, is discussed in more detail later in this chapter in the theoretical basis of this study. However, Broch's (2000) presentation of the ISP model is detailed in Table 2; it is included here because she takes the ISP model and discusses stage by stage the implications for children searching on the Web (Broch, 2000). Even though the ISP model was designed for more complex tasks than Web searching, the model still applies and some of the traditional "pitfalls" encountered in searching may be even deeper on the Web (Broch, 2000).

Children often search on imposed queries for school assignments, which can lead to low motivation and lack of background knowledge or domain knowledge (Broch, 2000). The historically held view is that the majority of children using the public library are there in relation to school assignments. This view is supported by research performed on traditional reference services in the public library. The type of task, well-defined or ill-defined, also has a significant effect on children's search process (Bilal, 2002). A well-defined search task may provide the vocabulary necessary for a more specific and meaningful keyword search (Schacter et al., 1998).

"A self-generated question is internally derived, held, and transacted by the same individual" (Gross & Saxton, 2001, p. 170). "An imposed query, on the other hand, is a question that is developed by one person and then given to someone else who will receive, hold, and transact the query for that person (i.e., the imposer)" (Gross & Saxton, 2001, p. 170-171).

Table 2

Information Search Process Stages and the Internet

Stage	Description/Possible Pitfalls (Kuhlthau, 1997)	WWW (Why maybe Worse on the Web)
1. Initiation	Thoughts need to turn from “what does the teacher want?” to “what do I want to know and learn?”	Evidence that children are anxious to use the computer and may be less inclined to spend time up front thinking about what they are interested in (Jacobson and Ignacio, Nahl and Harada).
2. Selection	Identify general area of interest	Will ease of locating information on the Internet become a primary determinant of what students choose to research?
3. Exploration	Users may try to collect copious/consistent information before their focus is formulated (see next stage); complicated due to inconsistent info	There is even more information, it may be even more inconsistent, and it may not have undergone a review process. Tremendous amounts of time can be spent.
4. Formulation	Important for students to “formulate a focused perspective” and to get an “understanding of what is enough . . . to avoid feeling overwhelmed” (716)”	It is almost impossible not to feel overwhelmed. Issue of “enough” is much more complex in abundant environment.
5. Collection	Gather information pertaining to focus	Evaluation of resources is more critical. As more time is spent in exploration, less time remains to peruse and evaluate critically. Librarian is not necessarily an authority, although she or he may still be perceived as such.
6. Presentation	Need to incorporate a personal perspective	Cutting and pasting makes it too easy to produce a report without incorporating a personal perspective. Complicated if formulation stage is not effectively resolved (which may be more likely to happen in digital library).

Note. (Broch, 2000)

Although the assumption found in library and information science literature indicates that reference evaluations have historically been conducted as though the questions are self-generated by users, this is often not the case due to queries imposed on children by parents, school assignments, etc. (Gross & Saxton, 2002; Gross, 2006). Gross (2001) found 32% to 43% of materials checked out at three schools were driven by imposed queries; however, younger children exhibit a higher number of self-generated circulations. Bilal's (2001, 2002) research indicates that lack of interest in a topic may lead to low motivation and success in finding the information; Gross (2006) also addresses how feelings impact searching on imposed queries and the importance of context to questions (Gross, 2004).

The following research focusing on the way children use the computer and Internet in the public library is especially important for this particular study since this dissertation evaluates the participants' time normally spent on the computer and the Internet in relation to their success on the search tasks. In *Children's Access to and Use of Technology Evaluation* (CATE), Gross, Dresang and Holt (2004) found children's use of technology in the public library centers on games more than on educational directed research and communication, such as chat or email. Sandvig (2000) also reported the three most common uses of the Internet in San Francisco's Public Library's Electronic Discovery Centers were chatting, playing arcade-style games, and playing multi-user dungeon games. A small study conducted by Burnett and Wilkinson (2005) reported children benefited from informal, open-ended time with the Internet. Watson (1998) asserts that by understanding students' perceptions of themselves, the relationship between the information problem, the Internet as a resource, and the outcome of the students' research can be constructed.

"In search of better approaches, a growing number of educators are now experimenting with a new generation of search tools that presort results using simple, visual formats, rather than the endless lists of Web hits that often confuse students, and send them off on searches that waste valuable learning time" (Trotter, 2004, p. 8). Many different elements impact information seeking success such as experience and search goals (Slone, 2003). The section that follows presents what a sampling of the research has found.

Prior Research on Children Searching Online Catalogs and the Internet

The scope of the prior research focuses on children searching online catalogs and the Internet. The Science Library Catalog (SLC) was the focus of five of the online catalog research studies, three were based on school library catalogs, one compared a public library online catalog and classic catalog, one presented SearchKids, a catalog prototype designed for children, and one presented the Kids' Catalog. Of the thirteen Internet research studies, three focused specifically on children searching Yahooligans!, one focused on children's understanding of Yahooligans!®[1] and KidsClick! hierarchies, one compared children and graduate students using Yahooligans!, six focused on children searching in general through a variety of search engines, one focused on children's perceptions about the Internet, and one focused on the Internet and CD-ROMs. It is important to notice that of the twenty-four studies presented here only one of them, the Yan (2005) study, dealt with children as young as age five. Five of the studies reported – Solomon (1993; 1994; 1997), Revelle et al. (2002), and Kafai & Bates (1997) – did deal with children in an age range including six to eight years. This study seeks to fill further the gap of young children's search behavior using specifically browsing interfaces of catalogs for children.

[1] Yahoo, Inc., kids.yahoo.com

Prior Research by Collection Methods

As detailed in Table 3, the first methods of collection used by researchers are observation and interviews.

Table 3

Observation and Interviews

Researcher	Participants	Outcomes
Solomon, 1993; 1994; 1997	Approximately 500 1st through 6th grade students	Solomon observed and interviewed students using their school's OPAC.
Busey & Doerr, 1993	Undisclosed number of students in 1st through 5th grade	Researchers tested a subject browsing and keyword catalog specifically designed for children.
Borgman et al., 1995; Walter et al., 1996	131 children ages 9 to 12	Researchers observed and interviewed students in 4 different experiments using the SLC.
Hirsh, 1997	64 5th grade students	Hirsh observed students searching in 2 search sessions of the SLC and then interviewed them.
Hirsh, 1999	10 5th grade students	Hirsh interviewed students 2 times during the research process and observed them searching the Web.
Bilal, 2000	22 7th grade students	Bilal recorded students' search sessions on a fact-based search task using Yahooligans!; students were given an Internet/Web Quiz, an exit interview and a teacher assessment.
Bilal, 2001	17 7th grade students	Bilal recorded students' search sessions on a research search task using Yahooligans!; students were given a pre-questionnaire, an Internet/Web quiz, an exit interview and a teacher assessment.

(table continues)

Table 3 *(continued).*

Researcher	Participants	Outcomes
Bilal, 2002	22 7th grade students	Bilal recorded students' search sessions on a self-generated search task using Yahooligans!; students were given an exit interview.
Bilal & Kirby, 2002	22 7th grade students and 12 graduate students	Researchers recorded students' search sessions on a fact-finding search task using Yahooligans!; students were given an exit interview.
Gross et al., 2004	675 4th through 8th grade public library users	Researchers, using direct observations, surveys, focus groups, and interviews at three branches, described children's use of networked technology.
Revelle et al., 2002	106 2nd and 3rd grade students	Researchers, using direct observations and interviews, studied children's success with a visual hierarchical information structure for a search task and construction of complex search using a paper prototype and computer prototype "SearchKids"

Table 4 details studies in which the primary method of information collection was the interview.

Table 4

Interviews Only

Researcher	Participants	Outcomes
Watson, 1998	8th grade students	Watson gathered students' personal perceptions on technology by conducting unstructured interviews; data was collected as an anecdote or story.
Shenton and Dixon, 2003	188 children ages 7 through 18	Researchers gathered students' personal perceptions on searching the Internet and CD-ROMS by conducting one-on-one interviews and focus groups.

(table continues)

Table 4 *(continued).*

Researcher	Participants	Outcomes
Yan, 2005	83 children ages 5 through 12	Yan gathered students' personal understanding of the complexity of social and technical complexity of the Internet via interviews and surveys.
Bilal and Wang, 2005	11 middle school children	Researchers explored children's understanding of the structure of Yahooligans! and KidsClick! children by constructing hierarchical maps for two science categories.
Edmonds et al., 1990	207 4th, 6th, and 8th grade students	Researchers measured the student's skills, understanding of, and preferences for the online catalog verses the card catalog in a public library setting.

The final method of data collection is observation as detailed in Table 5.

Table 5

Observations Only

Researcher	Participants	Outcomes
Kafai & Bates, 1997	Students ages 6 through 12	Researchers observed students instructed on searching the Web and searching for a class project or assignment.
Schacter et al., 1998	32 5th and 6th grade students	Researchers observed students searching the Internet to search two tasks using observations and relevance rating sheets.
Large, A., Beheshti, J. & Rahman, T. (2002b)	53 6th grade students	Researchers observed students searching the Web on an assigned school project in groups.

Prior Research Findings

Online Catalogs

Children bring a variety of skills, abilities, interests, and needs into their information searching. Online catalogs for children are designed for searches using the following 3 methods: subject hierarchy, keyword, or a combination of subject and keyword. The subject hierarchy catalogs are designed with children's browsing preference in mind. For children seeking materials in the print form, online catalogs are the "primary access tool" (Everhart & Hatcher, 2005, p. 37). Research studies have reported that success in searching online catalogs varies "from 10% on a touch screen online catalog (Edmonds et al., 1990) to 66% on a standard online catalog (Solomon, 1993) to 80% in some of the Science Library Catalog experiments (Borgman et al., 1995)" (Hirsh, 1997, p. 725). Children's success rates are affected by the types of search strategies, search tasks, subject being searched, and domain knowledge of the children (Hirsh, 1997).

Early research on OPAC use from the 1980s focused on the kinds of searches that conducted by users and reported that over 50% of searches conducted were subject searches (Marchionini, 1995). These studies also reported that there were design flaws in the interface and that users lacked understanding of OPACs and libraries (Marchionini, 1995). Based on these first reports of a preference for searching by browsing, second-generation OPACs added subject browsing by controlled vocabulary and then moved to include graphic interfaces (Marchionini, 1995).

Children exhibit both planned and unplanned search strategies. With unplanned strategies children who arrived at the OPAC or online catalog enter their search term where the cursor is blinking without planning. Planned strategies are indicated by children moving the cursor into another search venue, like title or author (Solomon, 1993). In order for children to be capable of using reactive strategies or follow-up moves to improve, refine, or refocus their search, they must have an understanding of the OPAC's results. As users, children bring a variety of skill levels with them when they are searching. Changes in children's backgrounds and prior experiences have implications for how an OPAC's user interface should be designed and how the information access should be designed (Solomon, 1993). Solomon (1993) also provides a detailed classification of OPAC breakdowns by grade and the design implications of the breakdowns (Appendix A). Solomon (1993) found that elementary school children's success varied by how concrete or abstract and how simple or complex the search concepts were. Children in older grades, 4^{th} through 6^{th}, searched on more abstract concepts and experienced higher failure rates (56%) due to a lack of search terms matching controlled vocabulary of the catalog (Solomon, 1993).

In follow-up analysis of the OPAC research, Solomon (1993, 1994) attributes children's success to three factors. First, children, who recognize problems they cannot address or solve, ask for help. Second, children who are at first unsuccessful in their search strategy modify their search strategy and produce successful results. Third, children's interests and language are geared toward simple, concrete objects that translated into successful searches. Solomon (1993; 1994) first used the following three schemes to code search failures: peculiarities of the software, attributes of the subject headings, and lack of skills of the children using the catalog. As Jacobson (1995) points out, it is important to note that of these three reasons children were unsuccessful only one is dependent on the user while the other two are dependent on the system. The following changes to catalog systems designed specifically for use by children were detailed by Solomon (1993 & 1994; Jacobson, 1995) as potential beneficial changes:

- Alert users to vague or unclear queries
- Point out search strategy options
- Content centered on school curriculum, appropriate domain knowledge, and individual interests
- Less emphasis on spacing, spelling, and punctuation
- Context-sensitive help
- Voice synthesis
- A search interface that relies more on recognition and less on recall

Additionally Solomon (1997) reports that students' success was furthered by the "visual representation" of the categories of structure between the children's interests and the OPAC's content, which he describes as recognition-to-recall progression. Although the Science Library Catalog (SLC) – which is discussed in subsequent paragraphs – utilizes this progression, children were hampered at times by the increasing complexity of the levels of "shelves" (Borgman, Gallagher, Krieger, & Bower, 1990; Borgman et al., 1991; Walter and Borgman, 1991; Hirsh, 1997).

Edmonds et al. (1990) found students in both groups lacked necessary alphabetization and identification skills, with only an approximate 10% of the participants being successful in searching the online catalog. The younger students ages eight to twelve had additional problems with the cognitive ability of sequential searching (Edmonds et al., 1990).

Revelle et al. (2002) found that children exhibited a search strategy of trying to get to the answer in the least amount of steps or clicks as possible on the specific animal task. They were also "strikingly adept" at constructing search abilities in contrast to what the literature says. The success of these 2nd and 3rd grade students could be the result of several techniques employed by the SearchKids designers such as scaffolding, the display of "in-progress" search results on the screen they were working on, and the organization of the information, which removed the need for children to determine conjunctive or disjunctive searches (Revelle et al., 2002). Additionally, SearchKids makes use of redundancy by providing multiple pathways to information about animals (Druin et al., 2001). The three areas – the zoo area, the world area, and the search area – include aspects such as an interactive virtual map of the zoo and a globe that zooms and spins.

The Science Library Catalog (SLC) is a project designed with an interface to minimize some of the mechanical difficulties children face like spelling, vocabulary knowledge and typing skills (Borgman et al., 1990; Borgman et al., 1991; Walter and Borgman, 1991). It is also designed to build on children's natural tendencies to explore as well as to increase their existing skills and abilities (Hirsh, 1997; Borgman et al., 1995). The SLC was specifically designed to provide access to science materials for children and to take their information seeking needs and behavior into consideration in the design (Borgman et al., 1990; Borgman et al., 1991; Walter and Borgman, 1991; Hirsh 1997). The interface was based on a subject browsing design to limit the need for specific recall, and the design required no typing and spelling skills. Children were required to understand categorization as the subject headings move from broad to specific subject headings. Subject headings were modified to be age appropriate (Borgman et al., 1990; Borgman et al., 1991; Walter and Borgman, 1991; Hirsh, 1997). The details of the five versions of the SLC and children's success in searching are summarized in Table 6.

Table 6:

Summary of the Science Library Catalog Experiments

Version of SLC	Records in the Database	Available Search Methods	Hierarchical Levels	Special Features	Average Success Rates	Average Search Times
1	1150	Browse	4	--	78%	1.7 min.
2	250	Browse	4	--	81%	1.6 min.
3	1500	Browse	4	Navigational aids	70%	2.6 min.
4	8200	Browse	6	Keyword clustering	60%	3.1 min.
5	1500	Browse & Keyword	4	--	80%	4.9 min.

Note. Hirsh, 1996.

The studies of the SLC indicated that children used "picture browsing (various icons) almost as much as they did analytical search strategies and that they were highly satisfied with the interface and their results" (Marchionini, 1995, p. 123). Borgman et al. (1995) found that children were able to put concepts in to appropriate categories especially when they were familiar with the concepts and terms being used. Hirsh's (1997) analysis shows that success rates varied by browsing task complexity. However, children with high domain knowledge were more successful searchers whether searching for complex or simple tasks. Additionally, higher domain knowledge was reported as an influence on the children's ability to search using a variety of search techniques instead of using one dominate (and maybe unsuccessful) style (Hirsh, 2004).

In Hirsh's (1997) study of the SLC, the complex tasks call for children to search with terminology that is not an exact match in the catalog. Even with the modified vocabulary used as shelf descriptors, it is projected that the terminology was still too difficult for the children to read or understand. Since the SLC has a built in spelling correction program, children using a keyword search approach are the most successful. Children browsing with a simple task, which exactly matches the designated Dewey bookshelves, are often successful in searching. When browsing on a complex task that did not fall into an easily identified bookshelf heading, children are not successful (Hirsh, 1997). SLC research indicates that, "in comparison to a previous study of a Boolean-based system, a browsing, direct-manipulation interface for children is in general a superior approach to information retrieval, being more usable and favored across the population, and less sensitive to children's level of computer experience" (Rice et al., 2001).

In comparison to other keyword driven science catalogs, specifically Orion and Le Pac®[2], children searching in the SLC are more successful when the topics were open-ended or not difficult to spell. There is a strong correlation between successful searching and the search topic. An ideal online catalog would combine browsing and keyword capabilities that do not require correct spelling, alphabetization, controlled vocabulary or Boolean logic (Borgman et al., 1995).

Using previous research (Kuhlthau, 1988; Edmonds et al., 1990; Borgman et al., 1990; Solomon, 1993), Busey and Doerr (1993) designed the Kid's Catalog, which is based on children's information seeking behavior as reported in the literature and information provided by focus groups. Additionally, the focus groups indicated that participants placed a high importance on computers, but that the computers "needed to be more child-oriented, since children often used online public access catalogs (OPACs) without adult assistance" (Busey & Doerr, 1993, p. 77-78). "The Kid's Catalog is a graphical user interface that solves many of the problems children encounter when using traditional public access catalogs" (Busey & Doerr, 1993, p. 77). The following 4 objectives detailed by Busey & Doerr (1993) were established to be accomplished by the design of the Kid's Catalog:

1. Elimination of the impediments found in previous research and literature
2. An interface design that was enjoyable, interactive, and recognized the cognitive abilities and creativity of children as users

[2] Brodart, www.brodart.com

3. An impact on literacy by providing a variety of subject browsing choices and successful searches

4. The ability for individuality at the local library level to provide for currency and relevancy to their children's needs

The Kid's Catalog used a "visual hierarchy" to motivate children through attractive icons and provide autonomy in addition to keyword searching capabilities (Busey & Doerr, 1993).

One study of the ARTEMIS Digital Library (ADL) shows the terms used to represent information are not adequate or age appropriate (Abbas, 2005). In the ADL, external and internal scaffolds exist to aid and guide juvenile users. Why are online catalogs for children not using more scaffolds to insure success?

Internet

In Yan's (2005) study of children's overall understanding of the Internet's technical and social complexities, children's age rather than experience is found to be a better predictor of their understanding, which has implications not only on access but also on the way they search and how they use the computer. Not surprisingly, children in the younger age bracket of five to eight have less understanding of the Internet as a part of a larger system (Yan, 2005). Their lack of understanding of the system at large is one more obstacle they face in being successful searchers.

Large, A., Beheshti, J. & Rahman, T. (2002b) studied the affect of gender on fifty-three 6th grade students searching the Web on an assigned school topic. They studied the differences and similarities of searching between the same-sex groups. Males differed from females in their search term construction with males using more simple keywords and females using more combinations of keywords (Large et al., 2002b). Additionally, males' searches produced more results, and they were more active in their navigation of the Web than females. However, females spent more time looking at each page (Large et al., 2002b).

In three research projects involving Yahooligans! – a search engine and directory designed with keyword and browsing search capabilities – Bilal (2000; 2001; 2002) studied children's use of both browsing searching techniques and keyword searching techniques and their cognitive, affective and physical behaviors when searching the Web via Yahooligans!. Children searched on both assigned and self-generated search tasks. Since the search box is situated above the subject categories, the design of Yahooligans! may draw more children into trying a keyword search before browsing (Bilal, 2000; 2001; 2002). Children in these studies show evidence of being in the concrete cognitive operational stage through using concrete search terms and the formal cognitive operational stage by using abstract search terms. Children's success is influenced by their understanding of the topic (Bilal, 2000; 2001; 2002).

Table 7.

Summary of Bilal's Results

Study Reported	Tasks Type	Results
2000	Assigned	Children searched using keyword and browsing; when searching by keyword they identified concrete concept from the assigned search task 'indicating an interaction between the concrete cognitive operational stage and the formal cognitive operational stage" (p. 660); children exhibited an understanding of the search task, the relationship between terms, the selection of concepts, the formulating of searches, and sufficient domain knowledge.
2001	Assigned	Children experienced more difficulty searching on the assigned research task due to its complex nature; children browsed more than using keyword; children's success was influenced by their domain and topic knowledge.
2002	Self-Generated	"Children were more successful on the fully self-generated task than on the two assigned tasks. In addition, their information seeking behavior varied by task and by success level" (p. 1179); children searched via browsing more often than keyword and were more successful when browsing.

Note. Bilal, 2000; 2001; 2002.

In addition to understanding the topic, prior Web experience leads to greater success as well as Internet search strategy and navigational style (Bilal, 2000; 2001; 2002). When judging hyperlinks and their descriptions, children using topicality (searching for information about the search task) are more successful than those using concrete answers (Bilal, 2000; 2001; 2002). However using concrete answers when judging the relevance of the homepage leads to more successful searching. Bilal (2001) found that children "had more difficulty with the research task," the open-ended task, in comparison to the "fact-based task" (p. 135). Children's searching fails because they search in natural language using vocabulary that is either too broad or too narrow. The type of search task also influences the success of their searching (Appendix B) (Bilal, 2002). Children gain experience through trial and error, which increases their successfulness in searching. Often, children fail to really look into the results they find (Bilal, 2000; 2001; 2002).

There are also problems built into Yahooligans!. As an IR system, it does very selective indexing of sites and homepages (Bilal, 2000). Children are unable to truly know the content of the Web page until they have linked to it. Yahooligans! also does not provide expansive instructions and guidance in the Help command (Bilal, 2000). In addition to an unhelpful "Help" command, Yahooligans! contains a default "and," which means that searches containing more than one term will be treated as linked by the Boolean operator AND, resulting only in search results containing all terms (Broch, 2000). Bilal (2000) quantifies children's searching by describing children's search behavior described in Table 8 and by adding values to their search behavior.

Table 8

Web Search Behavior Defined

Web Search Behavior	Definition	Type of Move
Searching	Typing a search as a single concept, multiple concepts and natural language	Transcribed or Selection Action
Browsing	Visiting subject categories, subcategories, Web sits and homepages	Transcribed or Selection Action
Looping	Reactivation of previously visited Web sites and/or previously executed searches	Transcribed or Selection Action
Backtracking	Use of Netscape Back button	Transcribed
Screen scrolling	Using the navigational errors to skim or read the Web page	Transcribed
Screen scrolling	Using the navigational errors to skim or read the Web page	Transcribed
Mouse movements	Moving the mouse over text and hyperlinks	Transcribed
Exploratory moves	Activating Netscape or Yahooligans! features such as Help, Search, etc.	Transcribed

Note. Bilal, 2000.

Transcribed Moves include all traversal behaviors, and Selection Actions include only those moves that children actively make involving selecting and searching (Bilal, 2000). Domain knowledge, which is influenced by an individual's memory and experience, is imperative for providing acceptable representation of conceptual structures (Bilal & Wang, 2005; Glaser, 1996). While the sample size of eleven does not permit generalizations, the middle school students were able to construct hierarchical maps and explain the relationships between the categories. Their maps on concrete concepts were similar to the IR systems structure but were not similar to the abstract concepts (Bilal and Wang, 2005).

Overall, on a cognitive level, children formulate search strategies that contain the appropriate concrete concepts and abstract concepts as necessary. Children are more successful when conducting a fully self-generated task (73%) than a research-oriented (69%) or a fact-finding task (50%). During fully self-generated tasks, they are more successful browsing than using keyword (Bilal, 2000; 2001; 2002). In the Bilal and Kirby (2002) study comparing graduate students and children's searching, neither group had adequate knowledge of how to use Yahooligans!. Children report liking Yahooligans! because of its colorful graphics, keyword search capability and easy to use nature. However, in spite of these positive feelings about Yahooligans!, 50% of the children fail to find the correct answer to the fact-finding search (Bilal and Kirby, 2002).

Broch (2000) reports children like the graphical interface, multimedia aspects, and immediate results that the Web offers. "Children want access to pictures, videos, or sounds of their favorite animals, space ships, volcanoes, and more. However, young children are being forced to negotiate interfaces (many times labeled 'Appropriate for K-12 Use') that require complex typing, proper spelling, reading skills, or necessitate an understanding of abstract concepts or content knowledge that are beyond young children's still developing abilities" (Druin et al., 2001, p. 398). They also like the amount of information available (Shenton and Dixon, 2003). Search engines are programs that search a specific database of Web sites submitted by either someone who works for the company maintaining the database or by someone who finds the link helpful. In general, there are 3 ways that search engines are designed for searching. They may be search by queries, directories or a combination of search queries and directories.

In addition to mechanical and cognitive difficulties that students face, they also must judge a Web site to be from a reliable source since anyone with the skills can create a site. Commercialism on the Web results in inaccurate search results when sites contain popular but inapplicable search terms to lead more visitors to their site. This commercialism also results in distractions by way of popup advertisements (Broch, 2000). Unlike Yahooligans!, Ask Jeeves®[3] For Kids (AJ4Kids) incorporates a natural language processor (NLP) into its design. The NLP takes the query processes and restates it in terms that will work within the database of sites (Broch, 2000). In Project CATE, a study set in a large urban library system, the largest portion of computer use is games (Gross et al., 2004). Over 83% of students in upper elementary report using the computer for play and just over 59% middle school students report using it for play. Children in this project show only minimal use of communication devices such as email, chat or word processing. It is projected that the lack of communication use is based on lack of reading ability or literacy among the children studied in project CATE. Recreational use of library computers is important to cognitive development and an appropriate use of library resources (Gross et al., 2004).

In Hirsh's (1999) study, students use two basic techniques to sift through their large number of Web results. First, students rely heavily on the summaries listed in the results. Second, students scan or read the first paragraph of the Internet document. As cited in Hirsh's (1999) study, Wallace and Kupperman's research indicates that students did not carefully evaluate Web sites. They settled for any information, even if not correct, just to complete their task. Hirsh proposes that this lack of evaluation may be due to lack of motivation. Low motivation leads to limited exploration and just looking for the answer. Even the advanced students in this study, while proficient in searching, did not make use of advanced features offered by search engines like navigational tools; instead, they resubmit duplicate searches to return to their list of results (Hirsh, 1999). Schacter, Chung, and Dorr (1998) also find that the information problem plays a significant role in how children search. With an ill-defined search task, children use a significantly lower number of analytic behaviors. However, with the ill-defined search task,

[3] IAC Search & Media, Inc., www.askforkids.com

children are significantly more successful in their searching finding more information. One reason for this could be that with an ill-defined search task, there is the possibility for multiple answers (Schacter et al., 1998). Additionally, they found children preferred browsing and searched "fairly intuitively and did not work systematically" (Kuiper et al., 2005, p. 290).

According to Druin (2002) "children have their own likes, dislikes, curiosities and needs that are not the same as their parents or teachers" (p.1). Technology designers bring their own opinions, assumptions and biases about children and technology into the design process (Druin, 2002). Druin (2002) defines 4 roles that children can play in the design process. The first role is that of user in which children are observed using existing technology to impact future designs. The second role is as tester, which involves children testing prototypes. Informant is the third role in which children are involved throughout the design process at various stages as designated by adults. The fourth and final role is that of design partner; children act as true team members negotiating design and input (Druin, 2002; Nesset and Large, 2004). Incorporating children into the designing of information retrieval systems as design partners is another step in creating a successful relationship between children as searchers and the search system. Understanding why children have difficulty searching and what drives their search tasks are two more pieces in designing better information retrieval systems. As Large, Beheshti and Rahman (2002a) point out, the goal should be to determine what children deem a successful design (Appendix C). The International Children's Digital Library (ICDL) is an example of a catalog that attempts to incorporate these principles into the design of the catalog. It was created with children's browsing preference in mind (Druin et al., 2003).

In addition to design issues, children need training. Their enthusiasm for the Web should make training an easy fit (Chen, 2003). Librarians, teachers, and school media specialists need to teach children how to better plan their searches, use criteria for judging their results, and how to organize information in a meaningful way (Hirsh, 1999). Children need to have a conceptual understanding of information on the Web, effective searching techniques and navigational skills. Librarians, information specialists, and teachers need to continue to develop webliographies addressing noteworthy sites for students' use (Broch, 2000) and information skills including problem-solving in an technology environment (Moore & St. George, 1991). More search engines and online catalogs need to incorporate NLP into their design. IR systems will have to include search instructions, search examples, browsing instructions, a natural language interface, interactive help, online tutorials and more (Large, Beheshti, & Rahman, 2002a). IR systems must incorporate children's cognitive, affective and physical domains into their designs (Bilal & Wang, 2005). Although not a complete view of all of the previous research, the research presented shows how children are searching, their success or failure, and their feeling for searching. This study will focus on whether or not the catalogs with hierarchical browsing interfaces for children are meeting their cognitive needs by using icons and text descriptors and hierarchies that make sense to them.

Theoretical Framework and Models Impacting This Study

There have been many theories and models developed to explain the information seeking behavior in light of the user and their information needs, the system being used, and the information available (Wilson, 1981; Belkin, 1990; Bates, 1989). Additionally, there have been many theories and models that may be used to address children's information seeking (Eisenberg & Berkowitz, 1990; Gross, 1995; Dresang, 2005). It is necessary to look at the basic meaning of theory and model as they apply to library and information science. "A theory is a system of assumptions, principles, and relationships posited to explain a specified set of phenomena" (Bates, 2005a, p. 2). "Models are most useful at the description and prediction stages of understanding a phenomenon" (Bates, 2005a, p. 3). Although there are many theories and models which impact children's search behavior, this study focused on the following since they will be used to explain the participants' behavior in the study:

- Cooper and O'Connor's model (Abbas, 2002)
- Kuhlthau's (1991) information search process model
- Cognitive Information Retrieval (Ingwersen, 1996)
- Socio-cognitive theory of users situated in specific contexts and domains (Hjorland, 2005)
- Sense-making (Dervin, 1999)

The Cooper and O'Connor model was born out of the work of Maron and Levien (1967). Their premise was the function of computers as "assistants in the logical analysis of large collections of factual data" (Maron & Levien, 1967, p. 715). "A computer system that will assist in the logical analysis of data must possess two principal features: (1) the capacity to store a large body of factual data, and (2) the ability to execute logical analyses of the data" (Maron & Levien, 1967, p. 715). The chief concern was the creation of a language that would be used to express the information; the secondary concern was the design of the internal representation of information, which is reliant on the specifications of the computer and the organization of the information. Maron & Levien (1967) addressed issues of synonymy and ambiguity; additionally they created a classification of question types from the viewpoint of the system to assist in their database design, shown in blue (O'Connor, Copeland, & Kearns, 2003). O'Connor (1993) created a classification of question types from the seeker perspective, shown in gold. These two classifications of question types were joined to create the MLO (*M*aron, *L*evien, *O*'Connor) matrix as recreated in Table 9 (O'Connor, Copeland, & Kearns, 2003).

Table 9

MLO Matrix

	Look Up	**Deductive Logic**	**Inductive Logic**	**Conversation**
Articulated Query	LA	DA	IA	CA
Vague Awareness	LV	DV	IV	CV
Monitoring	LM	DM	IM	CM
Browsing	LB	DB	IB	CB
Encountering	LE	DE	IE	CE

Note. O'Connor, Copeland, & Kearns, 2003.

"One thinks about answering questions using degrees of depth required based on the complexity of the knowledge gap. These ways appear across the top of the MLO Matrix. As one moves along this horizontal axis, complexity of thought required and the set of possible answers increase" (O'Connor, Copeland, & Kearns, 2003, p. 119). The MLO matrix begins to show the complexity involved in the user's questions and the system's interface; this complexity is further shown in Cooper's addition to this previous research, which O'Connor further adapted (O'Connor, Copeland, & Kearns, 2003)

The Cooper and O'Connor model focuses on the various cognitive variables and representation from the aspect of the system and the user in searching (Abbas, 2002). As depicted in Figure 3, the model "further emphasizes the inherent problem of representation, that of information loss when a document's essence or subject is distilled down into two to three subject terms that is often the practice today" (p. 51, Abbas, 2002).

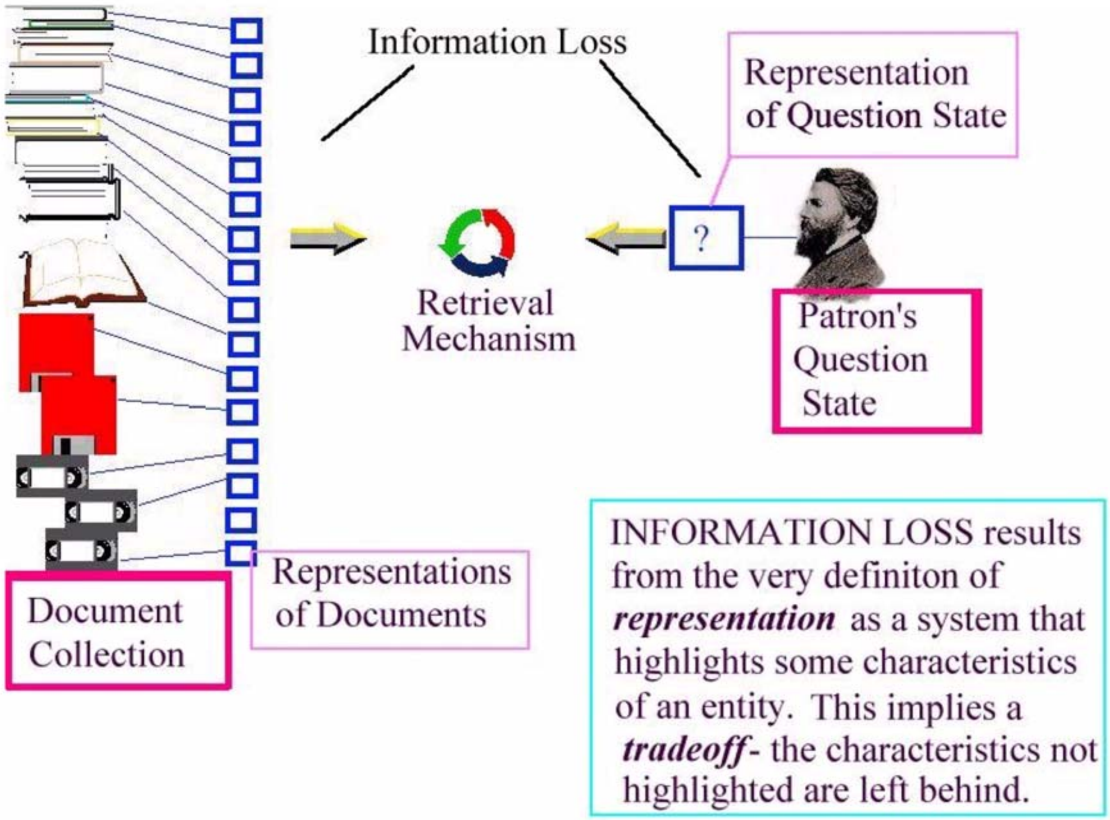


Figure 3. Cooper and O'Connor model (Abbas, 2002).

In the Cooper and O'Connor model, the patron's question state represents the MLO matrix; in addition to complexity of the type of question and possible answers, design and representation further increase the complications.

Abbas (2002) has further adapted this model to show an emphasis on the following: "the user's developmental and cognitive state, domain and system knowledge, and indexer's knowledge of the user's intended purpose(s) for the objects, or the idea of functional representation, can affect representation and retrieval" (p. 51). She places additional emphasis on the indexer's knowledge of user's cognitive ability (Abbas, 2002). Her modification of the Cooper and O'Connor model can be seen in Figure 4.

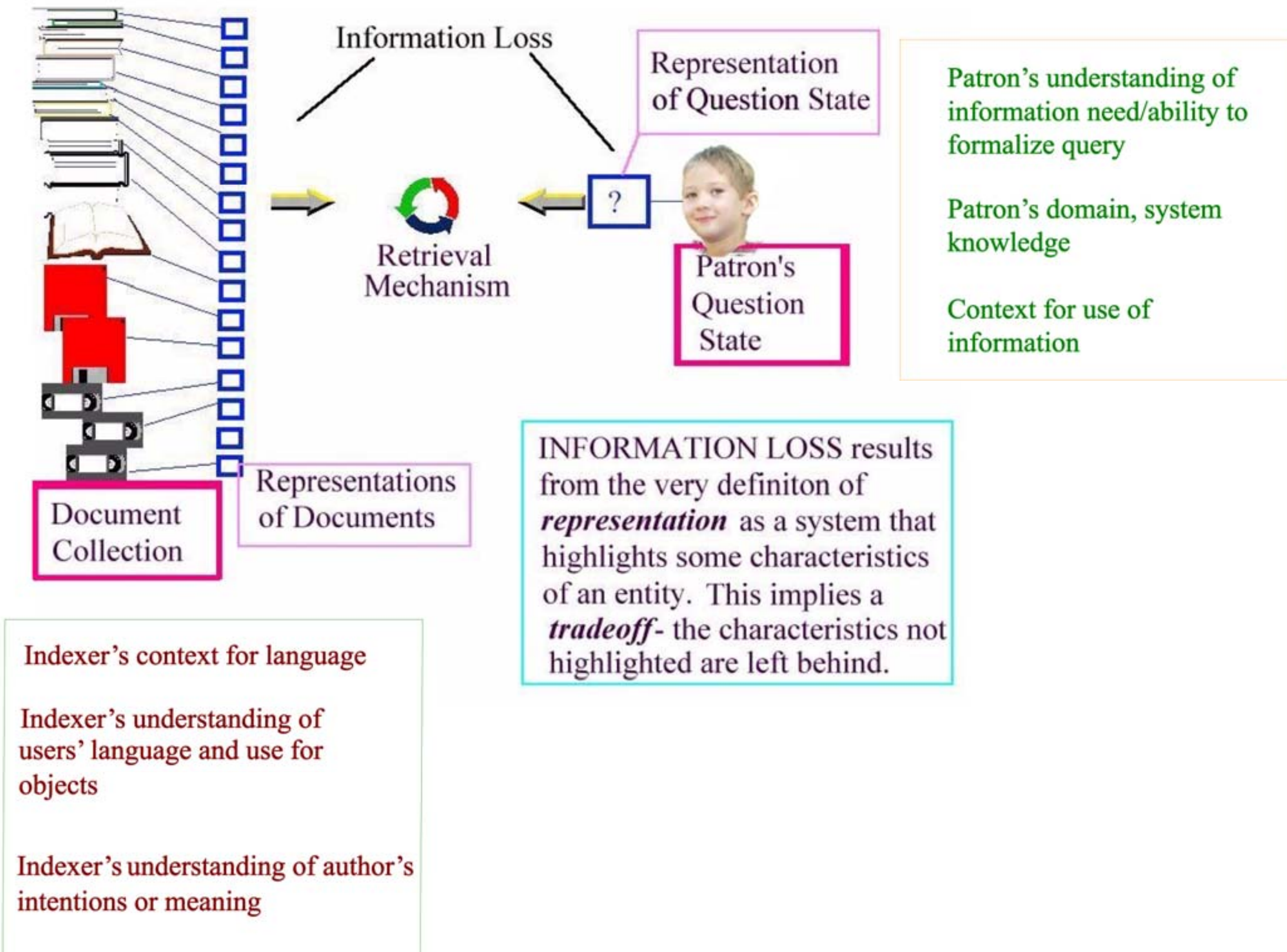


Figure 4. Abbas' (2002) modification of the Cooper and O'Connor model.

Kuhlthau's (1991) information search process (ISP) model describes the six stages of constructive activities that applied by users to find meaning from information to increase their knowledge or understanding on a topic or information need. The six stages are as follows: task initiation, topic selection, prefocus exploration, focus formulation, information collection, and search closure. The ISP model is important because it addresses motivation (what does the teacher want), anxiety's effect, the impact of uncertainty, and the role of sense making (Kuhlthau, 1991). Kuhlthau's (1991) ISP model involves three realms: the affective, the cognitive, and the physical and is further detailed in Table 10.

Table 10

Information Search Process (ISP)

Stages in ISP	Feelings Common to Each Stage	Thoughts Common to Each Stage	Actions Common to Each Stage	Appropriate Task According to Kuhlthau Model
1. Initiation	Uncertainty	General/Vague	Seeking Background Information	Recognize
2. Selection	Optimism			Identity
3. Exploration	Confusion/ Frustration/ Doubt		Seeking Relevant Information	Investigate
4. Formulation	Clarity	Narrowed/ Clearer		Formulate
5. Collection	Sense of Direction	Increased Interest	Seeking Relevant or Focused Information	Gather
6. Presentation	Relief/ Satisfaction or Disappointment	Clearer or Focused		Complete

Note. Kuhlthau, 1991.

Kuhlthau (2004) found that students' feelings progressed throughout the search sequence. "Students' feelings about themselves, the library, the task, and the topic evolved as their understanding of their topic deepened" (Kuhlthau, 2004, p. 41). The fact that the ISP model focuses on the affective and cognitive makes it appropriate for this study since it looks at how the participants felt about the catalogs and how well the catalogs matched their cognitive processes.

In Ingwersen's (1996) exploration of the elements of cognitive information retrieval (IR) theory, he explains that polyrepresentation seeks to include the user's information need and knowledge states – recall knowledge and recognition knowledge. These knowledge states and cognitive/emotional structures are "determined by the experiences gained through time in a social and historical context" (Ingwersen, 1996 p. 6). These experiences must be taken into consideration when pictorial representations are being chosen for IR systems for children. The use of redundancy is also a chief concern (Ingwersen, 1996). As applied to children, the task should be logically linked in a variety of paths. Additionally as Bilal and Wang (2005) address, "Ingwersen (1992) argues that situational classifications provide contexts, whereas categorical classifications often have the form of abstract relations. He also notes that an IR system designer who has some knowledge of the user population should tailor the classification of topics and concepts accordingly" (p. 1311). There are "*five central and interrelated dimensions* of the cognitive view:

1. Information processing takes place in senders *and* recipients of messages
2. Processing takes place *at different levels*
3. During communication of information any actor is *influenced* by its past and present experiences *(time)* and its social, organizational and cultural environment
4. Individual actors *influence* the environment or domain
5. Information is *situational* and *contextual*" (Ingwersen & Jarvelin, 2005, p. 25)

The emphasis of the cognitive information retrieval theory is on information retrieval being "a continuous process of *interpretation* and *cognition* in context by all participating" searchers or system users and the system (Ingwersen & Jarvelin, 2005, p. 29).

In Hjorland's socio-cognitive theory of users situated in specific contexts and domains, children develop a structure of signs and symbols that is first developed externally, in a culture. "When children learn language and symbols the cognitive processes are increasingly mediated by signs, meaning, and symbols, which are internalized in the individual and then reprogram the way cognitive processes work" (Hjorland, 2005, p. 339). Though it originally develops externally, the structure of signs and symbols is internalized influencing the information seeking process. “It emphasizes the internalization of culturally produced signs and symbols and the way cognitive processes are mediated by culturally, historically, and socially constructed meanings. Less priority is given to hardware whether in brains or computers” (Hjorland, 2004, p. 18). The emphasis on domains and domain analysis “might contribute to making IT and information systems better adapted to different user groups and interests” (Hjorland, 2004, p. 21).

Additionally, Dervin’s cyclic sense-making process describes the way in which users seek information and is especially relevant to this study. It is “based on the premise that when faced with information discontinuities or information needs, humans attempt to bridge this gap by defining and making sense of the situation and then devising appropriate information processing approaches to bridge the gap” (David, Song, Hayes, & Fredin, 2007, p. 171).

> Sense-Making assumes that movement is the one irreducible of the human condition and that in the face of endlessly multiple interpretations a focus on verbings offers a different entry for the search for systematic understandings of the human condition. Instead of focusing on elusive, ever-changing and constantly challenging nouns, Sense-Making mandates a focus on the hows of human individual and collective Sense-Making and sense-unmaking, on the varieties of internal and external cognizings, emotings, feelings, and communicatings that make, reinforce, challenge, resist, alter, and reinvent human worlds” (Dervin, 1999, p. 731).

A person in a situation experiences a need for information and goes through a process of making sense of their world (Dervin, 2003). Sense-Making is further clarified by Gross (2006) as having the following three important elements to consider: “(1) *the individual’s context* or *situation*; (2) *the gap*, or the understanding that is missing; and (3) *the use*, or what the individual hopes to feel or do by closing the gap” (p. 26).

In light of what is discussed in the literature review about children’s cognitive development and its impact on searching and the role that technology plays in hindering searching (i.e. lack of mousing skills, typing skills, etc.), this study shows that there is another issue which is not being addressed – that of system design. This issue prompts the questions:

Are young children (ages 5-8) really poor searchers because of cognitive development and lack of technology skills or is system design the major reason for poor search results?

CHAPTER 3

THE PILOT STUDY

The pilot study took place from October 2005 to December 2005 in a public library outside of Houston, Texas; the goal was a preliminary investigation on the impact of age, gender, and icons use in the subject browsing catalog interface designed for children. The study was inspired by an observation of an increase of children just beginning to read attempting to use the library's catalog to look up books from their required reading lists or just exploring the library catalog for fun. In reading the literature about children's information seeking behavior, it became apparent that the majority of studies conducted took place in school libraries or with children ages 6 and older (Kafai & Bates, 1997; Solomon, 1993, 1994, 1997; Hirsh 1997, 1999; Bilal 2000, 2001, 2002). The pilot study focused on Innovative Interfaces®[4] subject hierarchy online library catalog. Participants were children in the 5 to 8 age range. The results from the pilot study were presented in the doctorial candidate poster session at the 2006 annual Association of Library and Information Science Educators (ALISE) (Appendix D).

Pilot Research Questions

1. Do the images used by libraries and library vendors assist children ages 5-8 in locating assigned tasks?
2. Does the individual level characteristic of age affect the success of children ages 5-8 in locating an assigned task?
3. Does the individual level characteristic of gender affect the success of children ages 5-8 in locating an assigned task?
4. Does success or failure impact how children report feeling about the process of locating the search task?

[4] Innovative Interfaces, www.iii.com

Pilot Research Methodology

The goal of this pilot study was to investigate the design of the catalog in light of children's cognitive ability in the 5 to 8 age range while removing known issues like spelling, keyboarding, and mouse capabilities. There were ten participants; 50% male and 50% female. Their age breakdown is as follows: four participants were five years old; two were six years olds; three were seven years olds; and one was eight years old.

It sought to provide basic quantitative information on the following:

1. The impact of the number of paths on success and failure.
2. The impact of gender on success and failure.
3. The impact of age on success and failure.

Description of the Pilot Research Procedures

After going through their own internal review process, the library's parent institution gave their permission to use the library and its customers as the pilot research site. Permission was given by University of North Texas' (UNT) Institutional Review Board (IRB) to conduct the study and the course for Human Participant Protections Education for Research Teams by National Institutes of Health was completed per UNT requirements. Advertisements for participation in the study consisted of flyers and posters posted in the lobby and children's area of the library. Additionally, potential participants received flyers and information about the pilot study when they entered the children's area. After giving and reviewing consent forms, assent forms and/or waiver of assent forms, parents and children had the opportunity to ask questions. Before the participant began, it was explained that any path chosen to explore while looking for the topic was okay and that they would not "get in trouble" for not finding the topic or trying multiple paths. Additionally, if the participant or their parent(s) felt uncomfortable at any point in the study, they could stop participation without penalty. The study took place in a private office in the children's area of the library.

Participants viewed a paper representation of the iii catalog. From the home screen shot of the browsing catalog, they selected the image and text they felt would lead them to information on the search task: dinosaurs. This selection led to another set of pictures from which to select. They continued to select pictures until they felt they have found the one that most represents the topic or were ready to stop. During the process, interviews took place, and participants were asked the following questions:

- Which picture do you want to pick?
- What is it a picture of?
- Why did you pick it?

When they were satisfied that they have found the picture most representing the topic or decided to stop, they were asked the following question:

- Why did you stop?
- Did you find what you were looking for?

After the completing the task or stopping, they were interviewed on the process using the questions below:

- Did you find what you were looking for?
- What did you like about the pictures used?
- What didn't you like about the pictures?

- Did the pictures help you?
- What would you change?
- Can you tell me about pictures that might be better to help kids?
- Is there anything else you would like to tell me today about what you did here today?
- Do you have any questions for me?

Additionally they were shown the following Likert scale in Figure 5 and asked to rate how easy or hard finding information on dinosaurs was.

Very Easy	Easy	Not Easy or Hard	Hard	Very Hard
☺ ☺ ☺	☺ ☺	😐	☹ ☹	☹ ☹ ☹
1	2	3	4	5

Figure 5. Likert scale used in the pilot study.

In order to analyze results, the study was videotaped and transcribed. No identifying information, such as individual names, marked the transcripts or video tapes; participants were assigned a number. Participants received certificates of participation and selected prizes from the prize box/treasure chest; prizes were inexpensive (under $2) age appropriate toys, games, and books.

Pilot Study Results

Question #1: Do the images used by libraries and library vendors assist children in the 5 to 8 year old age range in locating assigned tasks?

Of the ten participants, 70% were successful in finding the search task: dinosaurs and 80% of the participants reported the pictures helped them in the process. However, only one participant was able to verbalize or provide additional information on the pictures; he thought that a dinosaur picture or something less girly than a butterfly should represent nature.

Question #2: Does the individual level characteristic of age affect the success of children in the 5 to 8 year old age range in locating an assigned task?

Success in finding the search task by subject age is shown in Table 11.

Table 11

Pilot Study Success by Age

Age	Number of Participants	Success rate
5	3	75% of the total (n=4) participants were successful.
6	1	50% of the total (n=2) participants were successful
7	2	Just under 67% of the total (n=3) participants were successful
8	1	100% of the total (n=1) participants were successful

These preliminary results indicate that age is not necessarily a determinant in success in the iii catalog.

Question #3: Does the individual level characteristic of gender affect the success of children ages 5-8 in locating an assigned task?

Of the males, 80% were successful, and 60% of the females were successful in completing the search task. The average number of paths tried was 5.7 with one participant finishing successfully after only two paths and one finishing unsuccessfully after eleven. Females averaged 6.4 paths, and males averaged five paths. In this study, persistence by females does not make them more successful; however, 20% difference in success by gender does indicate that gender is a factor in success and merits further study.

Question #4: Does success or failure impact how children report feeling about the process of locating the search task?

As seen in Table 12, over 66% of participants (n=4) rating the process hard or very hard were successful and 50% of the participants (n=1) rating it easy or very easy were unsuccessful.

Table 12

Rating of iii Catalog by Pilot Study Participants

	Easy or Very Easy	Hard or Very Hard
Successful	1	4
Unsuccessful	1	2

For these participants, their success in finding the task did not cause them to rate the process easy or very easy.

Limitations of the Pilot Study

It is necessary to note that the data collected in this quasi-experimental pilot study provides only a small glimpse into children's information seeking in subject hierarchy catalogs. It is limited by its very small number of participants (n=10) and by the fact that it looked at only a single task on a single catalog. Success or failure on a single assigned task can not be used as an indicator of successful catalog design. The design of this study did not take into account participants' cognitive understanding of the search task and the process of the study itself. Additionally, a record of the participants' logic behind their choices was not collected and whether they were using the icons, the text descriptors or both.

Directions for Additional Study from the Pilot

The results of the pilot study indicated that there are potential benefits to additional study into subject hierarchy based catalogs for children. Additional statistical analysis of greater depth is necessary to determine if there is truly a link between individual level characteristics and success and the design of the catalog especially since participants overwhelmingly used the images in the catalog and not just the text of the icon descriptors. This pilot study focused on only one catalog with ten participants searching on one task. Future studies should investigate the three major catalogs used in public libraries and address more participants on more than one task.

CHAPTER 4

RESEARCH DESIGN AND METHODS

Research Questions

If young children are truly poor searchers because they lack sufficient cognitive development and lack sufficient technological skills, then creating a catalog that is child friendly for the youngest users may not be a realistic goal. However, it is also possible that the difficulties children encounter as they search are also due in part to system design. As previously stated, the overriding research question in this dissertation is:

> Do current children's online catalog designs function in a manner that is compatible with information seeking by children?

In order to answer the overriding question, it is important to determine what factors affect the search success of children and attempt to devise a research design that allows us to estimate the magnitude of each factor's effect on successful searching. These factors can be grouped into two broad categories: catalog characteristics and individual characteristics. In order to assess the effectiveness of catalog design, two questions must be answered.

1. Do the catalogs and labels used by libraries and library vendors assist children ages 5-8 in locating tasks?
2. Do the subject categories and labels used cognitively match the level of development of children ages 5-8?

If the difficulties encountered by children while searching are a result of cognitive and technological limitations, then the individual characteristics of children should influence searching. As a consequence, the answer to the overarching research question depends in part on the answers to these questions.

3. Does the individual level characteristic of age affect the success of children ages 5-8 in locating an assigned task?

4. Does the individual level characteristic of gender affect the success of children ages 5-8 in locating an assigned task?

5. Does the individual level characteristic of race affect the success of children ages 5-8 in locating an assigned task?

6. Does the individual level characteristic of perseverance affect the success of children ages 5-8 in locating an assigned task?

7. Does the individual level characteristic of computer usage affect the success of children ages 5-8 in locating an assigned task?

Description of the Participants and Location

The participants in this study were derived from public library customers and surrounding neighborhoods in a location outside of Houston, Texas during June and July 2006. There are over 79,000 children in the school district and over 200,000 residents in the area. The study took place in a public library, which is the result of a partnership of a public library system and the community college system; the branch is a 70,000+ square foot building. The children's section of the library is a separate area from the rest of the library. The experiment was held in a private office in the children's area. Approximately 30% of the population in the area is African American and Hispanic; 25% of the participants were African American and Hispanic. The participants included thirty Caucasians, eleven African Americans, six Asian Americans, two Hispanics, and two other. The participants were ages five to eight years old. The breakdown for the fifty-one participants is as follows: nine were five year olds; fifteen were six year olds; twelve were seven year olds; and fifteen were eight year olds. Twenty-three of the participants were male and twenty-eight were female. No one was excluded based on race or gender; the only reason for exclusion was lack of minimal required reading skills or not meeting the age requirements.

Online Catalogs Investigated

As previously described, the goal of the pilot study was to investigate the design of the catalog in light of children's cognitive ability in the 5 to 8 age range while removing known issues. It sought to provide basic quantitative information on the following:

1. The impact of the number of paths on success and failure.
2. The impact of gender on success and failure.
3. The impact of age on success and failure.

Since the pilot study consisted of only ten participants searching one task, on one catalog, it was determined that this study would investigate three catalogs searching on three tasks. Some of the initial results from the pilot study summarized in chart form are shown in Appendix E.

The following catalogs were selected because they offered a subject hierarchy catalogs with graphical user interfaces and are used in public libraries: Innovative Interfaces®[5] subject hierarchy online library catalog (Appendix F), the formerly Sirsi, now SirsiDynix®[6], subject hierarchy online library catalog (Appendix G), and the formerly Dynix, now SirsiDynix, subject hierarchy online library catalog (Appendix H). KidsOnline's interface is described as an interface where "younger patrons have a fun and easy way to make the Web OPAC interface all their own. They can point and click on a powerful, robust, and intuitive graphics-driven browser (fully customizable!) that can steer them where they need to go in pictures and images that make them want to go there" (Innovative Interfaces, Inc., 2006). Additionally, KidsOnline is meant to

[5] Innovative Interfaces, www.iii.com
[6] SirsiDynix, www.sirsidynix.com

support a broad range of potential library users, from very early readers to non-native-language speaking adults, and fulfill situations in which alternative, picture and category based interface to the library catalog is necessary (J. Heddon, personal communication, January 15, 2007). Dynix's Horizon Information Kids' Portal is described as a system that "uses colorful icons and easy navigation to encourage younger users to explore your library; offers 2,800+ pre-formulated searches to tap nearly 500 knowledge categories" (SirsiDynix, 2007). Information on subject hierarchy icon driven catalog from Sirsi is not available on the SirsiDynix web site. Even though this version of their catalog is still in use and is supported by them, only one call requesting information on their catalog at the time of this publication was returned. Information was supposed to be located and emailed; to date that has not happened.

Variables

The general methodological approach of the present study is quasi-experimental and examines the influence of the user and system design on children's searching and their search success. "Legal, ethical, or practical considerations make it impossible to employ a true experimental design in some research situations" (Singleton & Straits, 2005, p. 206). The quasi-experimental design is a study that takes "an experimental approach without having full experimental control" (Singleton, Straits, & Straits, 1993, p. 230). Although this study did use random assignment of participants to catalogs and used a pretest, it did not use a control group or comparison group. In order to increase validity, participants were given a visual pretest determining if they had used the catalog, determining their knowledge of the search task topic, and determining their computer experience.

The dependent variable is the phenomenon to be explained or predicted (Singleton et al., 1993). In this study, the phenomenon under investigation is successful searching and is operationally defined by total task completion. Each child was given 3 search tasks to complete. For each correct task, the child is given a score of one. Totaltask is the summation of a child's scores across all three tasks. The independent variables, or explanatory variables, are those factors believed to explain the dependent variable or phenomenon under investigation (Singleton et al., 1993). In this study, the independent variables are age, race, gender, total task time, number of attempts, attitude toward search, and catalog type.

"Analysis of variance is used when two or more means are compared to see if there are any reliable differences among them" (Tabachnick & Fidel, 1989, p. 37). The ANOVA utilizes "variance, a measure of variability, to examine the difference between means, a measure of central tendency" (Vaughan, 2001, p. 126). Basically, the ANOVA measures whether the means are significantly different by analyzing the measure of variability. In this study, the means of task 1, task 2, task 3, and totaltask are being compared.

An ordered probit is utilized in order to gauge how the individual level characteristics of the participants affect their ability to search online; an order probit is utilized because the dependent variable, total task completion, ranges from 0 to 3 and is a ratio level variable. The ordered probit allows for the affect of multiple independent variables on the dependent variable to evaluated simultaneously (Long & Freese, 2006). In other words, the direct and interactive effects of gender, age, ethnicity, reported ease of use, time spent on the computer, time spent searching, paths tried, and catalog on totaltask can be assessed.

Search Tasks

Since children five to eight years old are already in school and may have already experienced imposed queries and for evaluation by set criteria such as accuracy of answer and speed, they will be tested on fully-assigned, closed tasks (David et al., 2007). In order to combat low motivation and low domain knowledge, a year's worth of reference statistics were analyzed. This study used the three most repeated topics; they were dinosaurs, sharks, and Texas. Additionally, in order to address the importance of context to questions, the participants were given an explanation of why the study was being conducted, what online library catalogs were used for, and how the researchers picked the topics in the most simplest of terms possible.

In order to meet children's need to have concrete retrieval cues, they were first shown an example of finding information on the cards to ensure they understood the process (Appendix I). In addition, to make certain that the participants had significant knowledge of the search topic, they were shown a card with each search task represented by a collage of images and a text label (Appendix J). Researchers asked participants to identify the search topic subject to measure that they had the appropriate knowledge level of the subjects. In all cases, participants were able to identify the search topic; in fact, 24% of the participants also provided additional background information. When looking at the dinosaurs collage, they identified specific dinosaurs like Pterodactyl and Tyrannosaurus Rex. When looking at the sharks collage, they identified the leopard shark, nurse shark, and great white shark and with the Texas collage, they identified the bluebonnets and the Alamo. Additionally, the participants' skill level was also accessed by gathering information on their previous technology/Internet experiences.

Software and Equipment

The press releases and screen shots of the online catalogs were created in Microsoft Word® 2003[7], and the flyers and posters were created in Microsoft Office Publisher® 2003[8]. The statistical analysis was done using SPSS® 13.0 for Windows® statistical software[9] and Microsoft Office Excel® 2003. The children were recorded using a Sony®[10] HC32 Digital Video recorder.

Description of the Procedures

Since previous permission had been granted for the pilot study, the library's parent institution readily gave their permission to use the library and its customers as the pilot research site. Permission was obtained from the University of North Texas' (UNT) Institutional Review Board (IRB) to conduct the study. Advertisements for participation in the study consisted of flyers and posters, approved by both UNT and the parent library (Appendix K). Researchers posted them in the library and handed them out to the library users following story times and programs. Staff were also instructed in the basics of the study in order to tell library users about it when they were signing their children up for the Summer Reading Program. Researchers gave the potential participants and parents oral explanations of the process. Additionally, they asked parents about the potential participants' reading abilities. This was an informal assessment based solely on the parents' responses to being asked if their child(ren) had begun reading and had basic skills. The reason for minimal reading skills was twofold. First, researchers asked the participants in the post question session about using the images, the text, or both. Second, this

[7] Microsoft Corp., www.microsoft.com
[8] Ibid
[9] SPSS Inc., www.spss.com
[10] Sony Corporation of America, www.sony.com

study investigated the mismatch between the catalog categories and the participants' perception of the images. Additionally when children viewed the task example cards, researchers asked if they could read the words on the card as well as tell them about the pictures.

If they were interested, they received consent forms, assent forms and/or waiver of assent forms to fill out. The researchers reviewed the forms with the parents and participants; afterwards, they had the opportunity to ask questions. Before the participant began, it was explained that any path chosen to explore while looking for the topic was okay and that they would not "get in trouble" for not finding the topic or trying multiple paths. Additionally, if the participant or their parent(s) felt uncomfortable at any point in the study, they could stop participation without penalty. The study took place in a private office in the Kids' Corner, the children's area of the library. The door blinds were left open so that parents were able to monitor the activities if they so desired.

Since previous studies by Walter, Borgman, and Hirsh (1996), Kuhlthau (1991), Revelle et al. (2002), Hirsh (1997), Bilal (2000, 2001, 2002), and Chen (2003) identified the following issues in an electronic environment: typing / keyboarding, spelling, adequate vocabulary, wait time, this study was conducted using a paper version of the online catalogs to investigate the additional issues affecting success. Every screen was captured and printed on card stock for all three catalogs. In order to account for research that shows young children do not look below the fold of the screen, Dynix's interface choices were shown as one "screen" image instead of multiples (Holmes, Robins, Zhang, Salaba, & Byerly, 2006).

The researchers randomly assigned the participants a catalog to view. Researchers accomplished this by randomly alternating catalogs (iii, Sirsi, Dynix) for the day and assigning the participants recruited on that day to the catalog. After sitting at a small table with a video camera to the side, the researchers asked the following pre-process questions of the participants, not the parents, from the data collection tool (Appendix L):

- How often do you use the computer?
  [once a day, once a week, once a month, other:_____]
- What do you do on the computer?
  [play games, type, use the Internet, use the library catalog]
- Have you ever used this catalog?
  [show them a laptop with the catalog]

First, they were given another brief explanation of the study and reminder that they were allowed to stop without penalty. Then, they viewed an example of the process and asked any questions they might have about the study or process. They next viewed the first search task, and the researcher asked them to identify the task and describe the task; researchers presented the tasks in the same order. From the home screen shot of the assigned browsing catalog, they picked the picture that most represented assigned task that would lead them to information on that task. The selection from the main card lead to another set of pictures from which they selected. They continued to select pictures until they felt they had found the one that most represents the topic or requested to stop or go to the next task. The children were allowed to stop searching/participating at any time without penalty. They were interviewed during the process and asked the following questions:

- Which picture do you want to pick?
- What is it a picture of?
- Why did you pick it?

When they were satisfied that they have found the picture most representing the topic or decided to stop, they were asked the following question:

- Why did you stop?

- Did you find what you were looking for?

After the process was completed, they were interviewed on the process using the questions below:

- Did you find what you were looking for?
- What did you like about the pictures used?
- What didn't you like about the pictures?
- Did the pictures help you? [Pictures? Words? Both?]
- What would you change?
- Can you tell me about pictures that might be better to help kids?
- Is there anything else you would like to tell me today about what you did here today?
- Do you have any questions for me?

Additionally they were shown the following Likert scale in Figure 6 and asked to rate how easy or hard finding information on the search tasks were.

Very Easy	Easy	Not Easy or Hard	Hard	Very Hard
☺ ☺ ☺	☺ ☺	😐	☹ ☹	☹ ☹ ☹
1	2	3	4	5

Figure 6. Likert scale used in this study.

The process was repeated for the following two tasks.

The study was videotaped and transcribed in order to analyze results. No identifying information such as individual names was maintained on transcripts or video tapes; participants were assigned a number. After participating, participants were given a certificate of participation and picked a prize from the prize box/treasure chest; prizes were inexpensive (under $2) age appropriate toys and books (Appendix M).

CHAPTER 5

DATA ANALYSIS AND RESULTS

The literature on previous studies shows that children's cognitive and developmental stages impact search behavior and must be taken into account when a system is being designed. Chapter 5 of this study presents the results of statistical analysis along with sections on identification of icons interpreted, taxonomies interpreted and post-interview responses. Previously discussed research shows children in an online environment often search by browsing, which relies heavily on recognition and content knowledge so catalog systems for children must use effective symbols or pictorial representations, which correspond with children's own cognitive schema and level of recognition knowledge.

Research Questions Revisited

The overriding question, seeks to answer if young children (ages 5-8) are really poor searchers because of cognitive development and lack of technology skills or is system design the major reason for poor search results and is answered by looking at the following series of questions. The overriding research question in this dissertation is reiterated here:

> Do current children's online catalog designs function in a manner that is compatible with information seeking by children?

In order to answer this overriding question, the following individual questions must be examined:

1. Did the categories and labels used by libraries and library vendors assist children ages 5-8 in locating assigned tasks?

2. Did the subject categories and labels used cognitively match the level and development of children ages 5-8?

3. Did the individual level characteristic of age affect the success of children ages 5-8 in locating an assigned task?

4. Did the individual level characteristic of gender affect the success of children ages 5-8 in locating an assigned task?

5. Did the individual level characteristic of race affect the success of children ages 5-8 in locating an assigned task?

6. Did the individual level characteristic of perseverance affect the success of children ages 5-8 in locating an assigned task?

7. Did the individual level characteristic of computer usage affect the success of children ages 5-8 in locating an assigned task?

Hypotheses

Based on the pilot study and previous research in the field the following hypotheses were developed:

1. Participants' performance will get increasingly better with each task that they perform.

2. The three catalogs will not be the same in their totaltask performance.
    a. Participants using Dynix will be more successful.

3. As the age of the participant increases, the likelihood that they will complete all three tasks will rise.

4. It is expected that there will be no statistically significant relationship between total task completion and the participants' race.

5. It is expected that there will be no statistically significant relationship between total task completion and the participants' gender.

6. Familiarity with computers will increase the likelihood that a participant will complete all three tasks.

7. Participants who think the searches are easy will complete more tasks.

8. Participants who spend longer amounts of time on the searches are more likely to complete tasks.
    a. Additionally, participants who use multiple paths in a search attempt are more likely to complete tasks.

Statistical Analysis

Table 13 shows the overall percentage of children who completed each task by catalog type. When examining simple frequencies, Dynix®[11] appears to have fared the best. All of the participants who used Dynix were able to complete at least one task. There were two participants or 10% of the Sirsi®[12] users who were unable to complete even one task and five participants or 31.25% of the iii®[13] users who were unable to complete even one task. However, the percentage of children who completed all three tasks appears to be evenly divided among all three catalogs.

Table 13

Success by Catalog

Totaltask	Sirsi	iii	Dynix	Total
0	2	5	0	7
	28.57%	71.43%	0%	100%
	10%	31.25%	0%	13.73%
1	6	3	7	16
	37.5	18.75	43.75%	100%
	30%	18.75%	46.67%	31.37%
2	8	4	4	16
	50%	25%	25%	100%
	40%	25%	26.67%	31.37%
3	4	4	4	12
	33.33%	33.33%	33.33%	100%
	20%	25%	26.67%	23.53%
Total	20	16	15	51
	39.22%	31.37%	29.41%	100%
	100%	100%	100%	100%

[11] SirsiDynix, www.sirsidynix.com
[12] Ibid
[13] Innovative Interfaces, www.iii.com

The results in Table 13 revealed the need for a more sophisticated statistical analysis because a cursory examination might lead one to believe that Dynix outperformed catalogs iii and Sirsi.

To analyze the results more carefully a oneway analysis of variance (ANOVA) test for each individual task was conducted in order to ascertain any differences across the individual tasks assigned in a particular catalog. Each task was labeled Task1, Task2, and Task 3. The following oneway ANOVAs (Figures 7-10) and ANOVA (Figure 11) were done with the task variables letting 1 equal completion and 0 equal failure. Additionally, a variable called totaltask was created; it is the sum of task 1 (dinosaurs), task 2 (sharks), and task 3 (Texas). Totaltask ranges from 0 to 3. The three tasks were always presented in the same order in all three catalogs with a participants.

1. Hypothesis: Participants' performance will get increasingly better with each task that they perform.

Analysis of Variance					
Source	SS	*df*	MS	*F*	Prob > *F*
Between groups	.619607843	2	.309803922	1.27	0.2908
Within groups	11.7333333	48	.244444444		
Total	12.3529412	50	.247058824		

Bartlett's test for equal variances: chi2(2) = 0.3796 Prob>chi2 = 0.827

Figure 7. Oneway ANOVA task1.

Analysis of Variance					
Source	SS	*df*	MS	*F*	Prob > F
Between groups	.311764706	2	.155882353	0.60	0.5519
Within groups	12.4333333	48	.259027778		
Total	12.745098	50	.254901961		

Bartlett's test for equal variances: chi2(2) = 0.0152 Prob>chi2 = 0.992

Figure 8: Oneway ANOVA task2

Analysis of Variance					
Source	SS	*df*	MS	*F*	Prob > *F*
Between groups	.736029412	2	.368014706	1.88	0.1644
Within groups	9.42083333	48	.196267361		
Total	10.1568627	50	.203137255		

Bartlett's test for equal variances: chi2(2) = 1.9278 Prob>chi2 = 0.381

Figure 9. Oneway ANOVA task3.

In each case, the *F* statistic is not significant, meaning the null hypothesis cannot be rejected and the tasks are the same when it comes to completion rates on each of the 3 tasks. Regardless of the task performed, there is no statistical difference in completion rates across the various catalogs. The participants did not improve after each task; the participants were not more successful on task 2 than task 1 and were not more successful on task 3 than task 2 or task 1.

The next step is to examine overall completion rates. Totaltask was created by summing an individual's completion rate across all three tasks.

2. Hypothesis: The three catalogs will not be the same in their totaltask performance.
    a. Participants using Dynix will be more successful.

Analysis of Variance					
Source	SS	*df*	MS	*F*	Prob > *F*
Between groups	1.10955882	2	.554779412	0.55	0.5813
Within groups	48.5375	48	1.01119792		
Total	49.6470588	50	.992941176		

Bartlett's test for equal variances: chi2(2) = 1.9672 Prob>chi2 = 0.374

Figure 10. Oneway ANOVA totaltask.

The *F* statistic is not statistically significant. This means that the null hypothesis cannot be rejected and the catalogs are the same when it comes to the overall completion rates. There is no statistically meaningful difference in means across groups. Additionally, an ANOVA (Figure 11) was conducted using totaltask and catalog.

Number of obs = 51 R-squared = 0.0223
Root MSE = 1.00558 Adj R-squared = -0.0184

Source	Partial SS	*df*	MS	*F*	Prob > *F*
Model	1.10955882	2	.554779412	0.55	0.5813
catalog	1.10955882	2	.554779412	0.55	0.5813
Residual	48.5375	48	1.01119792		
Total	49.6470588	50	.992941176		

Figure 11. ANOVA totaltask catalog.

The low R-square and adjusted R-square mean that almost none of the task completion scores are explained by catalog choice. Basically, the catalog choice does not explain the total number of tasks completed. The *F* statistic also confirms this result with the conclusion that there is no difference between task completion by catalog type.

The general research question is whether or not catalogs designed for children actually meet the search needs of children. Right now, the statistical results seem to indicate that the three catalogs chosen for the quasi experiment (Dynix, iii, and Sirsi) all performed equally well or poorly depending on the viewpoint. There is no statistically significant difference in completion rates across these catalogs. However, with the current analysis, it is impossible to tell how important individual level characteristics such as age and computer experience might be affecting completion rates. The current results of this study indicate that catalog choice appears to have very little to do with successful searching.

In order to ascertain whether or not online catalogs serve the needs of children, it is important to be able to gauge how the individual level characteristics of children affect their ability to search online and to control for these in the model. To do this, an ordered probit was employed to estimate the model. An order probit is appropriate because the dependent variable, total task completion, ranges from 0 to 3 and is a ratio level variable. The results from the ordered probit model can be found in Table 14. The overall model is statistically significant (log likelihood ratio of $chi^2 (9) = 38.62$ and prob $chi^2 = .0000$).

Table 14

Ordered Probit Estimates

LR chi2(9) =	38.62					
Prob > chi2 =	0					
Log likelihood	-49.0515					
Pseudo R2 =	0.2825					
Number of obs =	51					
totaltask	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
gender	-0.1272	0.3370	-0.38	0.7060	-0.7877	0.5333
age	0.7522	0.1846	4.07	0.0000	0.3904	1.1141
minority	-0.4280	0.3539	-1.21	0.2270	-1.1217	0.2658
ease of use	0.4061	0.1882	2.16	0.0310	0.0372	0.7750
computer	0.3071	0.1403	2.19	0.0290	0.0320	0.5821
cat1	-0.7075	0.4405	-1.61	0.1080	-1.5708	0.1558
cat2	-0.2119	0.4311	-0.49	0.6230	-1.0568	0.6329
total paths	0.2416	0.0745	3.24	0.0010	0.0956	0.3876
time	-0.0026	0.0011	-2.50	0.0120	-0.0047	-0.0006
(Ancillary parameters)						
_cut1	4.13499	1.281747				
_cut2	5.739592	1.365894				
_cut3	7.05085	1.458363				

The results in Table 14 are used to examine the direction of the relationship between the various explanatory or independent variables and the dependent variable. In addition, the *z* scores and the corresponding *p* values indicate whether or not the relationship between an independent variable and the dependent variable is statistically significant. Unlike the coefficients in a regression analysis, the coefficients in an order probit model or any other maximum likelihood estimator cannot be used to gauge the magnitude of an independent variable's affect on the dependent variable.

In order to gauge magnitude or substantive impact, predicted probabilities were calculated and the results are found in Tables 15-20. When all of the variables are held at their appropriate measure of central tendency, the probability that a participant will complete all three tasks is .07. At these same values, the probability that a participant will complete none of the assigned tasks is .12. The likelihood of completing one and two tasks are .49 and .31 respectively. In order to gauge how these overall likelihoods change as a particular independent variable changes, all values except the independent variable of interest are held constant (at their respective means or medians) while the value of the independent variable is manipulated.

Table 15

Overall Probability of Task Completion

Number of Tasks	Overall Probability
0	.12
1	.49
2	.31
3	.07

The first set of hypotheses relates to several sociodemographic characteristics of the participants in the experiments; they are race, gender, and age.

3. Hypothesis: As the age of the participant increases, the likelihood that they will complete all three tasks will rise.

It is expected that the age of the participant will be positively and significantly associated with total task completion. As the age of the participant increases, the likelihood that they will complete all three tasks is expected to rise. The positive relationship between total task completion and age is due to the increases in cognitive development that comes with age. However, the catalogs being tested in this experiment are designed for children so it is expected that even five year olds should be able to complete some tasks. Table 14 indicates that age is positively and significantly associated with total task completion as hypothesized and reveals the magnitude of the association. In Table 16, the predicted probabilities as age changes are displayed.

Table 16

Effect of Age

Number of Tasks	Prob. AGE=5	Prob. AGE=6	Prob. AGE=8
0	.32	.12	.01
1	.51	.49	.13
2	.15	.31	.40
3	.02	.07	.45

A five year old has a .02 chance of completing all three tasks while an 8 year old has a .45 chance of completing all three. The odds of a five year old completing none of tasks is a startling .32. An eight year old, a child at the top of the age range for which these catalogs were tested, has a less than 50% chance of completing all three tasks. Bilal and Kirby (2002) conducted research of children's success in searching versus graduate students; their study found that children were only 50% successful versus graduate students who were 89% successful. An additional study by Borgman, Hirsh, Walter, and Gallagher (1995) with nine to twelve year olds showed that age did *not* play a significant role in children's success in searching the Science Library Catalog (SLC) or LePac but *did* play a role in their success using Orion. Bilal (2000) studied seventh grade students and found that even within the one grade range only 50% of the children tested were successful in finding their task. A study of a school OPAC found significance differences in the strategy success of first graders and sixth graders (Solomon, 1993). Borgman, Gallagher, Krieger, and Bower (1990) found for children ages ten, eleven, and twelve that there was no significant difference in success when searching. The mixed results in the current literature make it important to consider age as a factor. In the case of this study, the differences in cognitive development between a five year old and an eight year old are quite large, leading to the hypothesis that success searching should increase as age increases, unlike the studies where there is little cognitive gap between participants.

When it comes to race and gender, if the catalog designs are race and gender neutral, it is expected that there should be no statistically significant relationship between total task completion and these variables.

4. Hypothesis: It is expected that there will be no statistically significant relationship between total task completion and the participants' race.
5. Hypothesis: It is expected that there will be no statistically significant relationship between total task completion and the participants' gender.

Table 14 reveals that this is exactly what the results were produced. While the coefficients are negative and at first glance might indicate that female participants and minority participants are less likely to complete tasks, the *p*-value for race is .227 and the *p*-value for gender is .706. These values are not even marginally significant; therefore, the null hypothesis of no relationship between race and total task completion and gender and total task completion cannot be rejected. Garrison, Christakis, and the Kaiser Family Foundation (2005) reported that a "substantial racial and socio-economic divide separates those children who have ever used computers from those who have not, with Hispanic children least likely to have used a computer at these early [4 to 6 year olds] ages (23%, compared to 42% African American and 50% for White children)" (p. 33). This discrepancy in computer use by minorities did not affect the success of *these* participants; this may be due in part to the local of the study (a library with computers and a location with an average income of over $49,000 per household (Datasheer, 2007) or that the catalogs were adequately designed to be race neutral.

Although studies have shown that there are differences in the amount of experience boys and girls have using the computer and their attitudes about technology, these studies are inconclusive (Hirsh, 1996). In Walter, Borgman, and Hirsh (1996) study with children ages nine to twelve, age, gender, and computer experience was found to have no impact on children's searching effectiveness. An additional study by Borgman et al. (1995) showed that gender did not play a role in children's success in searching the Science Library, Orion, and LePac catalogs. Schacter, Chung, and Dorr (1998) also conducted research on the effect of children's gender on their style of Internet searching finding that while all children overwhelmingly used browsing as their search method boys used it significantly more; however even though boys used significantly more browsing they were not more or less successful. In a study of fifty-three 6th students, Large, Beheshti, and Rahman (2002b) studied thirty girls and twenty-three boys searching in same-sex groups on the Web for an assigned school task. Although their study looked at keyword searching and formation and not browsing, Large et al. (2002b) reported that females and males used different search strategies, which resulted in different results. Females used more complex combinations of search terms while males used more single terms. In a study by Revelle et al. (2002), researchers examined the effect of gender on efficiency in regards to searching a paper prototype versus a computer. While males' search efficiency showed no statistically significant difference on the two versions, females were more efficient on computer searching versus the paper prototype. Walter et al. (1996) reported that gender did not consistently affect children's search success in the Science Library Catalog (SLC). Schacter et al. (1998) investigated the role of gender in relation to search strategy and reported that boys browsed more than girls did.

Although research indicates that gender effect search style and efficiency, it does not indicate a great effect on searching success, which is what this study found. However, evidence of the differences between males and females computer use, attitudes and skills indicates that more in-depth research should continue (Kuiper, Vomna, & Terwel, 2005). Previous work that examines race and searching success was not found. The decision to control for race was made because it is possible that different races search in different ways and that catalogs are designed in a manner that makes searching easier for whites.

The next set of hypotheses is centered on the computer and includes the following: computer usage, ease of tasks, and catalog types.

6. Hypothesis: Familiarity with computers will increase the likelihood that a participant will complete all three tasks.

The hypothesis is that familiarity with computers should increase the likelihood that a participant will complete all three tasks. The variable measures the amount of time a participant typically spends on the computer. Table 14 reveals that the coefficient for computer usage is positive and statistically significant.

Table 14

Ordered Probit Estimates (Reprinted)

LR chi2(9) =	38.62					
Prob > chi2 =	0					
Log likelihood	-49.0515					
Pseudo R2 =	0.2825					
Number of obs =	51					
totaltask	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
gender	-0.1272	0.3370	-0.38	0.7060	-0.7877	0.5333
age	0.7522	0.1846	4.07	0.0000	0.3904	1.1141
minority	-0.4280	0.3539	-1.21	0.2270	-1.1217	0.2658
ease of use	0.4061	0.1882	2.16	0.0310	0.0372	0.7750
computer	0.3071	0.1403	2.19	0.0290	0.0320	0.5821
cat1	-0.7075	0.4405	-1.61	0.1080	-1.5708	0.1558
cat2	-0.2119	0.4311	-0.49	0.6230	-1.0568	0.6329
total paths	0.2416	0.0745	3.24	0.0010	0.0956	0.3876
time	-0.0026	0.0011	-2.50	0.0120	-0.0047	-0.0006
(Ancillary parameters)						
_cut1	4.13499	1.281747				
_cut2	5.739592	1.365894				
_cut3	7.05085	1.458363				

Table 17's predicted probabilities indicate that, in general, the participants who report that they are on the computer "once a day" are more likely to complete all three tasks than those who spend less time on the computer.

Table 17

Effect of Time Spent on Computer

Number of Tasks	Prob. Computer=0 (other)	Prob. Computer=2 (once a week)	Prob. Computer=4 (once a day)
0	.27	.12	.08
1	.53	.49	.43
2	.17	.31	.38
3	.02	.07	.12

Note: In cases with continuous data, it is common practice to use the standard deviation to figure out what values to use in order to illustrate changing probabilities. With variables such as these (both are ordinal) , it is standard practice to pick the low, middle, and high points since the point is to illustrate changes from the low to high values of the variables.

A participant who reports using a computer "less than once a month" has a .02 likelihood of completing all three tasks while a participant who reports that he/she are on the computer "once a day" has a .12 likelihood of completing all three tasks. It is interesting to note that in contrast to the Yan (2005) study that found in the five to eight age range 48% of the children had minimal (never and hardly ever) Internet experience, this study found that 53% of the participants in the same age range used the computer and Internet daily. This study was more in line with the Rideout, Hamel, and the Kaiser Family Foundation (2006) report that found 43% of children ages four to six use the computer several times during a week and that 13% of this age group use the computer daily. Bilal (2000) reported in a study involving seventh graders that children with more Internet and Web search engines experience were more successful than those with less experience. Additional studies by Nelson, Wiese and Cooper (1991) and Greenfield (1984) found that computer experience affected attitudes, perceptions, and interaction with computers. In contrast, Hirsh (1996) found experience on the computer and playing video games had no significant impact on success. In this study even though the catalog search experience was taken out of the computer environment, the participants benefited from time spent on the computer.

7. Hypothesis: Participants who think the searches are easy will complete more tasks.

The next variable, ease of use, gauges how easy the participant thought the search process and finding the assigned search task were. The hypothesis was that the participants who thought the searches were easy would be more likely to complete more tasks. Table 14 reveals that the coefficient for ease of use is positive and statistically significant. The predicted probabilities in Table 18 indicates that, on average, a participant who thought the tasks were very hard had a .01 likelihood of completing all three tasks while a participant who thought the tasks were very easy had a .14 likelihood of completing all three.

Table 18

Effect of Ease of Use

Number of Tasks	Prob. EASE=0 (very hard)	Prob. EASE=3 (easy)	Prob. EASE=4 (very easy)
0	.48	.12	.07
1	.42	.49	.40
2	.09	.31	.39
3	.01	.07	.14

Note: The ease of use variable was flipped from the survey to make the discussion of its effect more intuitive. For example, it was expected the easier the task, the more tasks completed.

In the Borgman et al. (1995) study, children reported liking all three catalogs with successful searching rates of 74% in SLC, 57% in LePac, and 69% in Orion. Even though only 50% of the children searching were successful, Bilal (2000) reported that 87% of the participants in the study had positive feelings for the Web. Fitzgerald and Galloway (2001) reported that affect acted as a mild influence on the reasoning processes of college students. In this study, the participants' feelings about how easy the search process was and how easy it was to find the assigned tasks supports that positive feelings increased their success.

The ANOVA analysis conducted earlier indicated that there was no significant difference between the three catalogs and total task completion. The results from the ordered probit confirm these results. The *p*-values for the catalog dummy variables do not reach statistical significance. There appears to be no performance advantage when it comes to a particular catalog. In the Borgman et al. (1995) study, children searched three catalogs with successful searching rates of 74% in SLC, 57% in LePac, and 69% in Orion.

The last set of hypotheses relate to perseverance. In other words, the likelihood of completing tasks is going to be affected by willingness of a particular participant to devote time to the task and to try again when a search fails.

8. Hypothesis: Participants who spend longer amounts of time on the searches are more likely to complete tasks.

    a. Additionally, participants who use multiple paths in a search attempt are more likely to complete tasks.

Table 14 indicates that the coefficient for path attempts is positive and statistically significant. The predicted probabilities in Table 19 indicate that a participant who attempted 2.77 paths had a .02 likelihood of completing all three tasks while a participant who attempted 8.99 paths had a .22 likelihood of completing all three tasks.

Table 19

Effect of Number of Paths Tried

Number of Tasks	Prob. Paths =2.77 (1sd below mean)	Prob. Paths=5.88 (mean)	Prob. Computer=8.99 (1sd above mean)
0	.31	.12	.04
1	.52	.49	.31
2	.15	.31	.43
3	.02	.07	.22

In the Bilal and Kirby (2002) study, the average number of attempts or queries tried by children was M=5.1 while graduate students had an average number of attempts or queries of M=1.66. Additionally, they reported that children had an average time of 15:79 minutes while graduate students had an average time of 6:05 minutes. Graduate students who spent less time searching and used less queries to find their answers were 39% more successful (Bilal & Kirby, 2002). In a study by Borgman et al. (1995) comparing Orion, LePac, and the Science Library Catalog, students searching the Orion catalog exhibited a significant difference in success with younger children finding fewer matches on topics. These findings reflect the findings of the study by Borgman et al. (1995) in searching the Science Library, Orion, and LePac catalogs where children who were unsuccessful spend up to twice as long on abandoned or stopped searches than on successful searches. Additionally, children in the Bilal's (2000) first Yahooligans! study still exhibited "persistence and patience" in searching even though only 50% of them successful (p. 659). In her second study, children who were partly successful had a mean search time of 8 minutes while unsuccessful children had a mean search time of 16 minutes (Bilal, 2001).

The results from the order probit in Table 14 indicate a statistically significant relationship between time spent searching but the relationship is negative, not positive as hypothesized. On average, the predicted probabilities in Table 19 indicate that the more time a participant spent searching, the less likely he or she was to complete all three tasks.

Table 20

Effect of Amount of Time Spent

Number of Tasks	Prob. Paths =286.5 (1sd below mean)	Prob. Paths=495.29 (mean)	Prob. Computer=704.68 (1sd above mean)
0	.05	.12	.26
1	.36	.49	.53
2	.42	.31	.19
3	.17	.07	.03

A participant who spent slightly more than four minutes searching had a .17 likelihood of completing all three tasks while a participant who spent just over eleven minutes had a .03 likelihood of completing all three tasks. Participants who spent more than eleven minutes searching were the most likely to complete just one task. These results seem to indicate that perseverance does not necessarily pay off. Evidently, participants who were able to complete all three tasks were likely to do so and to do so quickly. For those participants who were struggling, spending more time on the searches did not pay off.

It must be noted that a researcher's confidence in maximum likelihood estimators and the corresponding statistical significance of the estimators is dependent on the size of the sample. In the case of small sample sizes, it is necessary to discuss the risk of type one error or the rejection of the null hypothesis when it actually should not be rejected (Wonnacott & Wonnacott, 1990). Admittedly, a sample size of fifty-one is not the ideal sample size when utilizing a maximum likelihood estimator. Specifically, the concern is that the a-priori probability of rejecting the null hypothesis is nearly one leading a research to conclude an independent variable affects the dependent variable when it does not. The only perfect remedy for this concern is an increase in sample size, which cannot be done in the current research problem. It is possible to alleviate some concern about the a-priori probability of rejecting the null hypotheses by noting that four of the nine null hypotheses are *not* rejected.

In addition, it also possible to reduce this concern by using another estimation procedure that is slightly less sensitive to sample size. An ordinary least squares (OLS) regression is not the ideal estimator in this model because totaltask ranges from 0 to 3. However, an OLS regression can be estimated as a check on type one error. The regression results lead to the same rejection of null hypotheses as those in the maximum likelihood estimation; the results of the OLS regression are found in Appendix N. Another estimation procedure that will help eliminate the concern over type one error is the upcoming availability of a probit estimator in STATA®[14] is sensitive to small sample sizes.

Identification of Icons Interpreted

As stated earlier in this dissertation and defined by DeLoache (2002) a "symbol is something that someone intends to stand for or represent something other than itself" (p. 207). Children must be able to understand the intended abstract meaning and know the concrete object (dual representation). "*How* the object is represented depends on the *semantics* (intended meaning of the sign), which address the direct relationship between the representamen and the sign of the object" (Goonetilleke, Martins Shih, Kai On, & Fritsch, 2001, p. 744). There are four manners of representation. There are the representation icons that normally express real images of the object. Abstract icons try to reflect an idea or concept close to the actual image, and arbitrary icons that do not have an apparent link to the meaning they are supposed to be representing. Text is the last form of representation (Goonetilleke et al., 2001).

There are opposing viewpoints on the use of text with icons. As cited in Goonetilleke et al. (2001), researchers "such as Paivio (1971) have argued that multiple modalities enhance memorability and hence text and graphics together may be more effective than pure graphics" (p.

[14] STATA: Statistical Software for Professionals, www.stata.com

744). In Ornager (1997), Barthes' three messages – linguistic, literal, and symbolic – conveyed by photographs are detailed. Although referencing specifically photographs, these messages also have implications for icons. The linguistic or text message can be used to stress a specific meaning of the image; the literal message is the actual images and the symbolic message which is based on "individual or cultural experience and knowledge" (Ornager, 1997, p. 204).

Additionally, with browsing searching identifying the starting point is the first thing a user must do (Marchionini, 1995). Then, the user must bring their knowledge and culture to what representations the system is using and its organization of those representations (Marchionini, 1995). Kuiper et al. (2005) reported Sorapure, Inglesby, and Yatchisin's two means of gaining visual literacy as images equaling an information medium and images as contributors to the graphical user interface. "Moreover, 'reading' and understanding illustrations is a process in which knowledge and experience play a role" (Kuiper et al., 2005, p. 307). Solomon (1991) described the following situation with children searching by keyword in light of controlled vocabulary: "For instance children looking for materials might approach the OPAC and enter <u>Health</u> and receive the message <u>Record(s) Found = 0</u>. They might need to know the subject heading to access materials on this subject – <u>Hygiene</u> – because health might not appear in either the title or document summary" (p. 18). A parallel situation applicable for this study is a child looking at the subjects and icons of the browsing interface of the catalog and selecting <u>Animals</u> (a koala) for dinosaurs but not finding it because they are classified as part of <u>Nature</u> (a butterfly) instead of animals.

In this study, participants overwhelmingly (n=41 or 80%) reported using the images and the text and that the images and the text helped them when searching the paper versions of the catalogs. Eight participants, just fewer than 16%, reported using only the text when searching, and two or 4% reported using only the images. In the Holmes, Robins, Zhang, Salaba, and Byerly (2006) report on the SirsiDynix's SchoolRooms^{TM}, 53% of the participants "found the pictures and graphics to be helpful in finding things they needed" (p. 17). In a study of the SLC, Hirsh (1997) reported that children were more successful when they were browse searching in topics with which they were familiar. These results suggest the need for further research into the role of the text descriptors play in success.

Table 21 below contains the icons from the three catalogs, which were misidentified by the participants. There are several possible explanations for this misinterpretation.

Table 21

Misidentified Icons

Icons Label:	Mislabeled by Interpretant:	Catalog:
Person swimming laps (Swimming)	Shark fin	Sirsi
Mount Rushmore (United States)	Picture of George Washington; picture of presidents	Sirsi
Eclipse (Science)	Do not know (DNK); Sun; fireball crashing down; shooting star	Sirsi
Dog and cat (Animals)	Dog only; wolf	Sirsi
Woman (Poems)	DNK	Sirsi
Stone Monster (Monsters)	Dinosaur monster	Sirsi
Lava (Volcanoes and Earthquakes)	DNK	Sirsi
Dodo (Extinct Animals)	DNK	Dynix
Map of Earth (Countries)	Picture of Earth	Dynix
Chameleon (Reptiles)	Iguana; lizard	Dynix
Gorilla (Animals)	Some animal	Dynix
Monster (Monster and Creatures)	DNK	Dynix
Africa (Africa)	Picture of Gulf of Mexico	Dynix

(table continued)

Table 21 *(continued).*

Icons Label:	Mislabeled by Interpretant:	Catalog:
Scientist with Microscope (Science)	Man with a magnifying glass	Dynix
Double Helix (Life Science)	DNK	Dynix
Sunset (Nature)	DNK	Dynix
Fossil of Fish (Fossils)	Fossil of a shark; picture of a dead shark	Dynix
Marsh (Earth Science)	DNK	Dynix
Koala (Animals)	Some type of bear; monkey	iii
Eel (Sea Animals)	DNK; snake	iii
Scroll (History)	Paper	iii
Microscope (Science)	DNK; telescope	iii
Map (Places)	Picture of Earth	iii

With the Sirsi catalog interface, there were seven icons that were misidentified by participants. Table 22 shows the number of times each Sirsi icon was misidentified and the number of times that it was visited by participants. The icon for the United States was misidentified over 52% of the times it was selected. However, the participants did identify it by concepts that were related to the icon – George Washington and the presidents. They knew the people pictured but not the monument. Of the twenty participants testing the Sirsi catalog, fifteen looked in Science for answers, and the icon for Science was misidentified 40% of the time. Participants selected Animals fourteen times and misidentified the icon almost 93% of the time. The majority of the misidentification (all but one) was based on not identifying the cat that is seated next to the dog in the icon.

Table 22

Sirsi Misidentified Icons

Icon Description	Text Description	Mislabeled As	# Times Misidentified	# Times Visited
Person swimming laps	Swimming	Shark fin	1	1
Mount Rushmore	United States	Picture of George Washington	3	19
		Picture of presidents	7	
Eclipse	Science	Do not know (DNK)	1	15
		Sun	3	
		Fireball crashing down	1	
		Shooting star	1	
Dog and cat	Animals	Dog only	11	14
		Wolf	1	
Woman	Poems	DNK	1	1
Stone Monster	Monsters	Dinosaur monster	2	4
Lava	Volcanoes and Earthquakes	DNK	2	2

In the Dynix catalog, there were eleven icons misidentified by participants. In Table 23, the icons misidentified and the number of times it was viewed in a selected path are detailed.

Table 23

Dynix Misidentified Icons

Icon Description	Text Description	Mislabeled As	# Times Misidentified	# Times Visited
Dodo	Extinct Animals	DNK	2	2
Map of Earth	Countries	Picture of Earth	2	2
Chameleon	Reptiles	Iguana	2	
		Lizard	2	6
Gorilla	Animals	Some animal	1	16
Monster	Monsters and Creatures	DNK	1	4
Scientist with Microscope	Science	Man with a magnifying glass	2	11
Double Helix	Life Science	DNK	1	1
Africa	Africa	Picture of Gulf of Mexico	1	1
Sunset	Nature	DNK	1	1
Fossil of Fish	Fossils	Fossil of a shark	1	
		Picture of a dead shark	2	10
Marsh	Earth Science	DNK	1	1

The icon for Extinct Animals, a picture of the Dodo bird, was not identified either time that it was visited and selected. The participants knew what extinct animals were and that dinosaurs are extinct, but did not know or did not recognize the Dodo bird. On task 1 (dinosaurs) in the Dynix catalog, eight of the fifteen participants were unsuccessful at finding dinosaurs under animals or fossils. The icon for Reptiles was misidentified over 66% of the time it was viewed although it the misidentification was related to the actual animal depicted. There was evidence of the task coloring how the participants viewed and misidentified the icons when looking for task 2 (sharks). The Fossils icon depicts a fish was described as a fossil of a shark and picture of a dead shark by three of the ten participants who viewed it.

In the iii catalog, there were only five icons misidentified by participants. In Table 24, the icons misidentified and the number of times it was viewed in a selected path are detailed.

Table 24

iii Misidentified Icons

Icon Description	Text Description	Mislabeled As	# Times	# Times Path visited
Koala	Animals	Some type of bear	3	15
		Monkey	1	
Eel	Sea Animals	DNK	2	10
		Snake	1	
Scroll	History	Paper	1	3
Microscope	Science	DNK	3	10
		Telescope	1	
Map	Places	Picture of the Earth	2	9

The icon for Animals, a picture of the Koala bear, was not identified over 26% of the time it was visited and selected. The participants were either unfamiliar with what a Koala bear is or from the image were unable to tell that it was a bear; one participant said monkey since the animal is in a tree. Sea Animals, a necessary selection for search task 2 (sharks), was misidentified 30% of the time it was viewed. In the case of Science, one participant was unable to identify the microscope and misidentified it as a telescope, a related concept.

There are several possible reasons for the misidentification of icons by the participants. First is the relationship between the person or interpretant and their interpretation, which is based on their cultural experience or background. Figure 12 shows Nadin's visual representation of the components that relate to the interpretation of sign(s) (Goonetilleke et al., 2001). They are object (O), interpretant (I), and representamen (R).

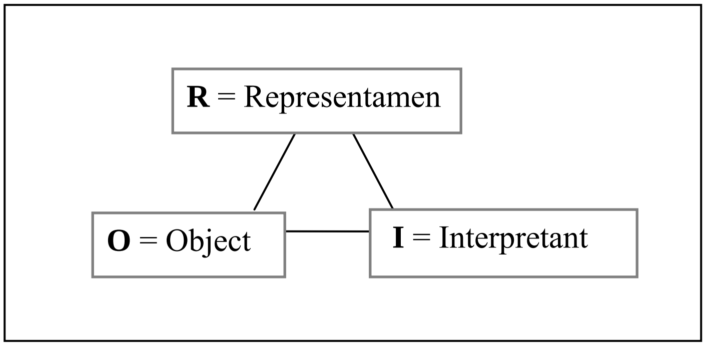


Figure 12. Nadin's components related to the interpretation of a sign(s) (Goonetilleke et al., 2001).

"*Interpretation* also called expression (R-I relationship) is the process of understanding the meaning of a sign" (Goonetilleke et al., 2001, p. 742). The icon is viewed in the context or culture of the viewer to determine the meaning, which can account for the different (a.k.a. misinterpreted or mislabeled) interpretations of the icons (Goonetilleke et al., 2001). "The function of *representation* involves emphasizing the relationship between the representamen and the object that is represented (O-R relationship). In this relationship, the effectiveness of the representation depends on what is represented and how it is represented" (Goonetilleke et al., 2001, p. 742). "From object to illustration a viewer of images will search for the features of that object or objects that illustrate its meaning to the viewer in relation to the needs of the situation" (Greisdorf & O'Connor, 2002, p. 10).

For example when looking for the Task 2: sharks, one participant saw the picture of the beach seen in Image 1 of Figure 13 representing Fun Stuff from the Sirsi catalog. He/she had been to the beach with her family in Galveston and was told that sharks come up in the waves at the beach; this was his/her context or experience for sharks. After going to A to Z → "S" Words, when participants were unable to locate sharks in the "S" words, then looked to Image 2 representing Summer and Image 3 representing Swimming in Figure 13 and in the context of knowing that sharks live in water made that choice.

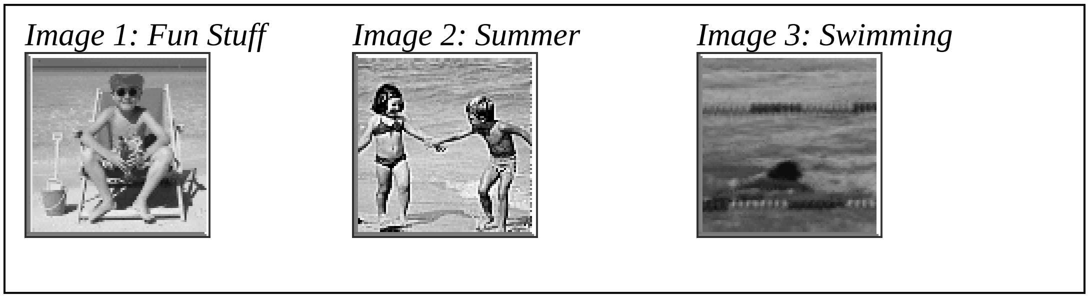


Figure 13. Icons incorrectly selected for sharks.

It is this same culture or context which the viewer or interpretant uses to determine the meaning of the icon or representamen, which affects their development of taxonomies as seen in the next section.

Second is the fact that young children obtain new category labels by ostensive definition. "That is, an adult or other teacher points to an object and labels it. It is important to consider how much can be learned by way of ostensive definition, because very young children who are learning their first language may have little else to rely on" (Markman, 1989, p. 19). "Language skills develop slowly yet dramatically during the first five to seven years, expanding and becoming refined in subsequent years. There are limits to what children under seven can convey to others using words alone" (Garbarino, Stott, & faculty of the Erikson Institute, 1992, p. 67). Halford (2002) highlights Smith's work on how children acquire new words. "Smith postulated that to learn dimension words, children must learn three kinds of mappings: between words and objects ('red' for red objects); word—word maps ('red', 'blue', etc. are associated with color), and property—property maps ('They are the same color')" (Halford, 2002, p. 571). It could be that the children at the younger age of the participant spectrum have not experienced these three types of mapping. This is supported by previous studies where children did not possess sufficient knowledge of vocabulary even when grade appropriate terminology was used (Cooper, 2002b).

A third reason that children may misidentify or fail to identify images is that they do not understand the task at hand even with an explanation of the process and examples. “Because they do not fully understand what is being asked of them, children give the best response they can come put with at the moment – which is likely to reflect their own immediate perspective. These researchers have demonstrated that when perspective-taking tasks are simplified and presented with materials, situations, and language that are more familiar, young children can give more accurate responses and hence appear much less ‘egocentric’” (Garbarino et al., 1992, p. 49).

The fourth reason may be based on cognitive economy. Studies have shown that participants when stressed or tired instead of performing at their highest capabilities opt instead to economize and use more primitive skills (Murray, 1984). “In some situations, children use less-advanced strategies to minimize the effort needed to solve a task, and on other occasions they seek to match the structure and demands of the task with their most advanced cognitive structures and operations, thereby achieving more elegant and economic solutions to the problems they face” (Murray, 1984,p. 16). There was evidence of participants systematically selecting all of the choices on a screen instead of selecting a new path or going back a screen choice.

The fifth reason is the designers may have used the same or similar representations in different context. Traditionally, icons have been used as a graphical symbol to symbolize things in a computer or objects although in recent years actions have been included (Goonetilleke et al., 2001). The icons are designed to convey significant, substantial information in the most basic way so that the icon's image has "perceptual immediacy" (Goonetilleke et al., 2001, p. 743). If the icons do not convey the perceptual immediacy for the participant, they are unsure what is being represented. "Thus, icons are meant to correspond with real objects with which users are familiar. Limitations may arise due to a lack of a direct mapping between real objects and the system objects. An even greater problem arises if designers use the same or similar metaphor in different contexts thereby causing confusions for the users" (Goonetilleke et al., 2001, p. 743). This use of same or similar representations in different context leads to ambiguity or varied meanings. This ambiguity and lack of success by the viewer is presented by Horton in Goonetilleke et al. (2001, p. 755) as:

$\text{Icon}_i + \text{context}_j + \text{viewer (or interpretant)}_k \rightarrow \text{meaning}_1 + \text{meaning}_2 + \ldots + \text{meaning}_n$.

An example of this ambiguity and use of the same icon to represent different (and in this case related) concepts can be seen in Figure 14 in the following images:

- Images 4 (Fossils) and 5 (Dinosaurs) from Sirsi
- Images 6 (Sharks) and 7 (Dangerous Fish) from Dynix
- Images 8 (Untied States) and 9 (Territories and Possessions) from Dynix
- Images 10 (Fossils) and Image 11 (Dinosaurs) from iii

Additionally in Figure 14, Image 8 has two distinct separate paths and outcomes for the United States.

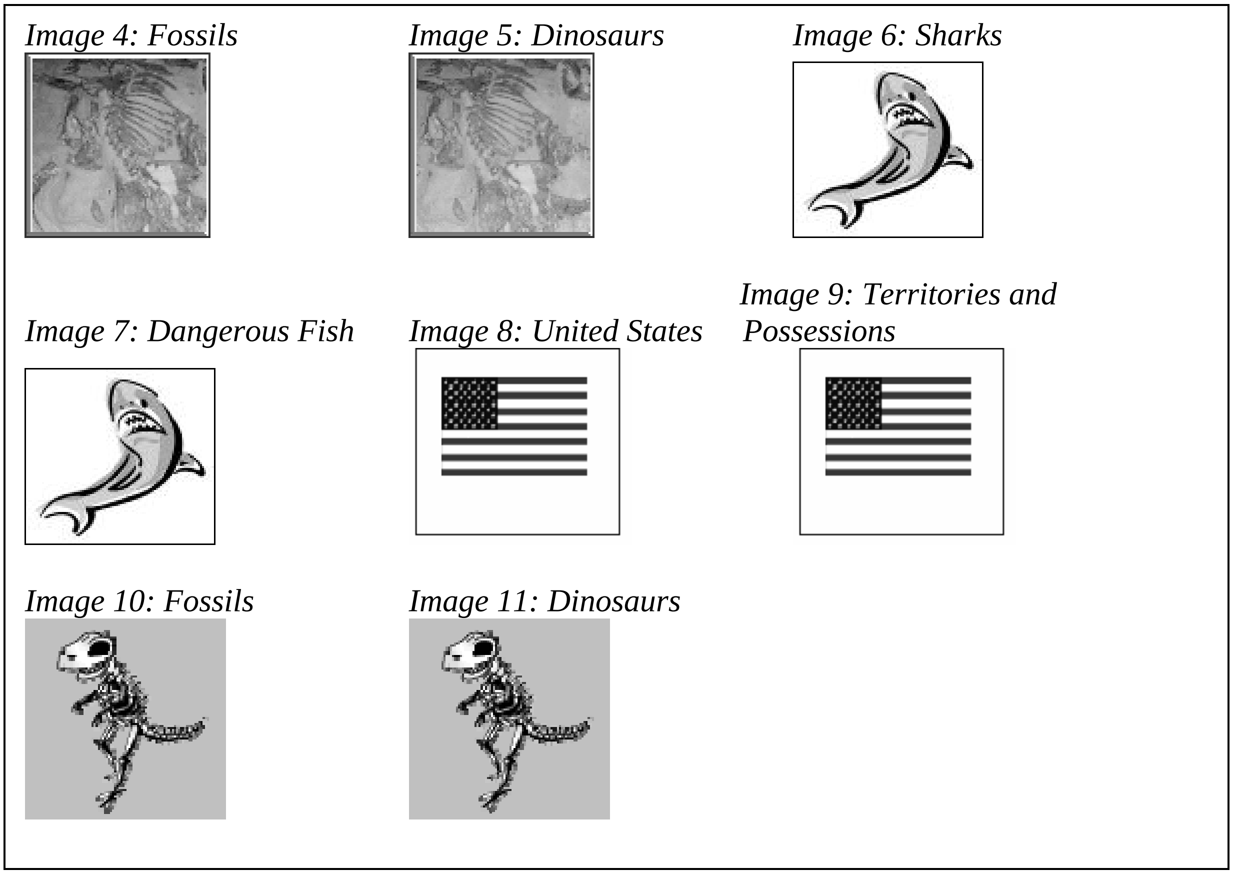


Figure 14. Dual representation icons.

From the main page, selecting United States leads to seven other choices, one of which is "States," which then leads the user to the individual states. Selecting countries from the main page leads to Americas to North America to the United States, which then ends in books about the country as a whole but not to the individual states.

However, in Figure 14 with Images 10 (Dinosaurs) and 11 (Fossils) from Dynix, the designers have more appropriately used two separate and meaningful images. Unfortunately, the participants were not successful in finding dinosaurs in Dynix, because it is located under the category of Extinct Animals with Image 12, a Dodo bird, representing it. Participants in this experiment consistently terminated after finding Fossils through several paths, and while Fossils does result in some overlapping material on dinosaurs, it does not contain fictional works on dinosaurs. This inability to know and determine that they have found the correct answer is not easy for young children to determine and vocalize (Gross, 2004). Additionally, this may be related to relevancy and the fact that participants were not then presented with a list of books and images from the actual catalog to read further and determine relevancy (Schacter et al., 1998). In Dynix, 60% of the participants selected Animals but were either unfamiliar with the text of Extinct Animals or the image of the Dodo bird used to represent it. Only two participants made their way to Image 10 in Figure 15 and only after trying several other avenues under Animals.

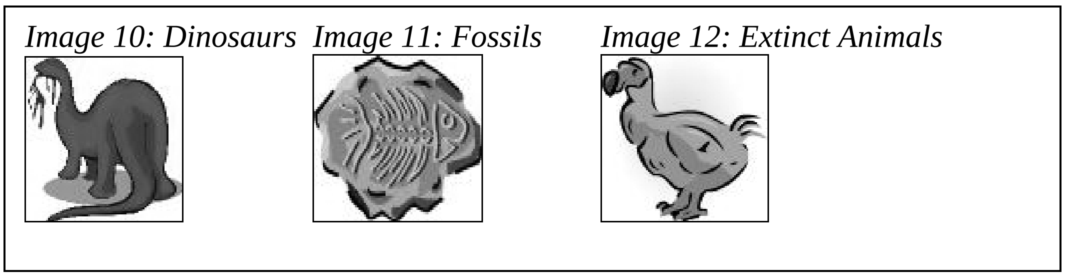


Figure 15. Dinosaur icons.

While there are many guidelines, which should be employed in the creation of icons, the following from Shneiderman & Plaisant (2004) would be especially helpful: “Represent the object or action in a familiar and recognizable manner; make each icon distinctive from every other icon” (p. 237). “To be effective a number of interdependent factors need to be considered, such as level of experience with the graphical representation, the knowledge domain and the type of task” (Scaife & Rogers, 1996, p. 186). In psychology, the word symbol has multiple meanings including the act of referring to mental representations or “the coding of experience in memory” and something created to refer, in either an abstract or realistic way, to something else (DeLoache, 2002, p. 207). The designers had clear intentions of what they wanted the icons to convey to the user; however, in some cases dual representation, context disconnect, or lack of perceptual immediacy lead to a lack of success. Although the participants’ lack of success has some basis in icons, there are additional issues with the taxonomies of the three catalogs.

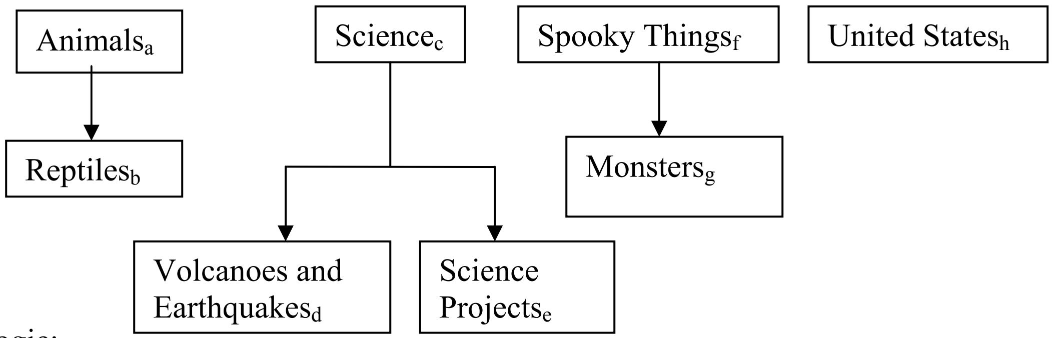
Taxonomies Interpreted

Taxonomies are used by information retrieval systems to assist in searching and to organize information and involves the practice of matching groups of items with previously defined labels but can also include the creation and arrangement of the items (Drake, 2003). An object is placed in a category based on appropriate properties, appearance, role, or behavior. "In either case, to decide whether an object is a member of a given category, it suffices to consider its relevant properties, appearance, function, or behavior. However, many external relations between objects are not captured by this internal analysis of an object's properties" (Markman, 1989, p. 21). Examples of external relations are causal relations, spatial relations, and event relations. "These various types of external relations between objects are referred to as *thematic* relations, to reflect the idea that the objects participate together in a theme or event" (Markman, 1989, p. 21). For children younger than six or seven years of age, they base their categorization on some other basis, like relationship, instead of common characteristics. "These thematic relations emphasize events rather than taxonomic similarity" (Markman, 1989, p. 23). In this study, 33% of participants (17 out of 51) were successful with inclusion understanding that dinosaurs are a subclass of reptiles under the superordinate class of animals. Almost 51% of participants (26 out of 51) demonstrated success with inclusion by understanding that sharks are a subclass of fish under the superordinate class of animals. Almost 72% of participants (37 out of 51) were successful with inclusion understanding that Texas is a subclass of the United States under the superordinate class of North America. Additionally, on task 1, almost 22% (11 out of 51) of participants were able to correctly identify the correct taxonomic path to dinosaurs on the first try. On task 2, 29% (15 out 51) of participants correctly went straight to sharks and on task 3, almost 57% of participants (29 out 51) followed the correct taxonomic path to Texas.

It was the participants' creation of thematic relationships based on events that were not accounted for within the catalogs. Examples include sharks being related to swimming, beaches, and scary things, or dinosaurs being related to scary things and places where they are found. In all three catalogs, there is evidence of participants using logic based on experience and knowledge, which while not perfect, certainly held some aspect of truth.

Repeatedly participants looked for dinosaurs under science knowing scientists study dinosaurs. In fact, dinosaurs are found in the broad category of science in Dewey, more specifically 567s Paleontology so this makes sense. In the Dynix catalog and Sirsi catalog science leads to fossils; however, the information found through the science → fossils path does not result in the same materials found under animals → dinosaurs or animals → extinct animals → dinosaurs. Additionally in the iii catalog, science does not lead to dinosaurs at all. They must go through another science category of nature → fossils → dinosaurs. Participants repeatedly looked to animals → reptiles to locate dinosaurs. In iii, there is no path to dinosaurs via the "animals" taxonomy. In Dynix and Sirsi, for participants to be successful instead of choosing reptiles must recognize images (previously discussed Images 5 and 12) that they may be unfamiliar with in order to find dinosaurs through the animals' taxonomy.

In the following taxonomies created by the participants, there are examples of the paths they attempted in locating the three tasks that even though unsuccessful had reasoning based in some logic or experience appropriate to the participants' cognitive levels. The taxonomies are pictured along with the reasoning and in each of the taxonomies, the participants' reasoning shows that they are relying on their knowledge of the subjects and their personal experiences to create taxonomies that while not perfect do contain some basis in fact.



Logic:

a. Dinosaurs were animals.
b. Dinosaurs were reptiles.
c. Dinosaurs were studied by scientists.
d. Dinosaurs were killed by volcanoes and earthquakes.
e. There are lots of projects/studies about dinosaurs.
f. Dinosaurs were scary.
g. The picture of the monster looks like a Triceratops.
h. Dinosaurs are buried in rocks in the United States. (Icon = Mount Rushmore)

Figure 16. Sirsi dinosaur taxonomies based on logic but not ending in success.

In Figure 16, dinosaurs were by fact prehistoric animals that were reptiles (logic a and b). Dinosaurs suddenly became extinct at the end of the Cretaceous period, a time of high volcanic and tectonic activity (logic d). Dinosaurs are studied by scientists and found in science studies (logic c and e). Dinosaurs certainly can appear to be scary or monstrous (logic f and g). Dinosaurs are buried in rocks in the United States (logic h). While none of these things are the best logical paths to reach dinosaurs, they certainly are based in some kernel of truth (Dinosaur, 2007). The same thing can be said about the taxonomies in Figure 17 and 18.

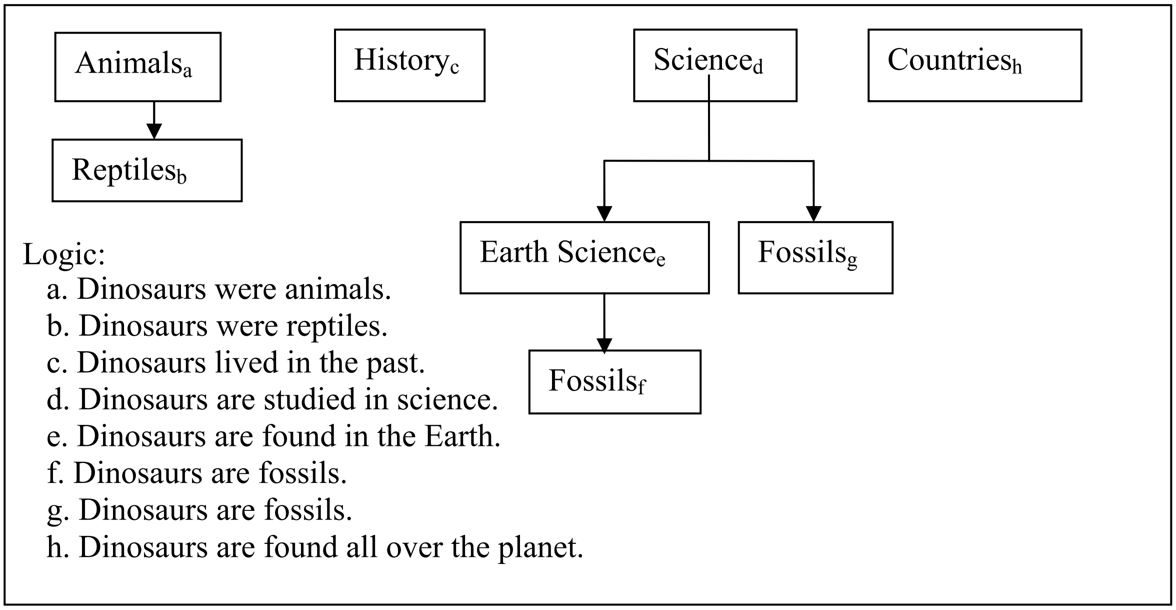
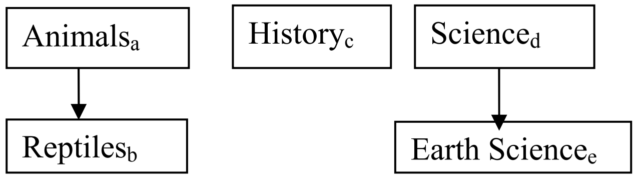


Figure 17. Dynix dinosaur taxonomies based on logic but not ending in success.

In Figure 17 (above), dinosaurs were by fact prehistoric animals that were reptiles (logic a and b). Dinosaurs lived in the past during the Mesozoic era that began about 248 million years ago and ended about 65 million years ago (logic c). Dinosaurs are studied by scientists and found in science studies (logic d). Dinosaur fossils were first discovered in the early 1800s in the Earth and have been found in many countries (logic e through h) (Dinosaur, 2007).

In Figure 18 (below), dinosaurs were by fact prehistoric animals that were reptiles (logic a and b). Dinosaurs lived in the past during the Mesozoic era that began about 248 million years ago and ended about 65 million years ago (logic c). Dinosaurs are studied by scientists and found in science studies (logic d). Dinosaur fossils are found the Earth and they suddenly became extinct at the end of the Cretaceous period, a time of high volcanic and tectonic activity (logic e). This information on dinosaurs came from a database on the computer (logic f). Once again, none of these things are the best logical paths to reach dinosaurs, they certainly are based in some kernel of truth (Dinosaur, 2007).

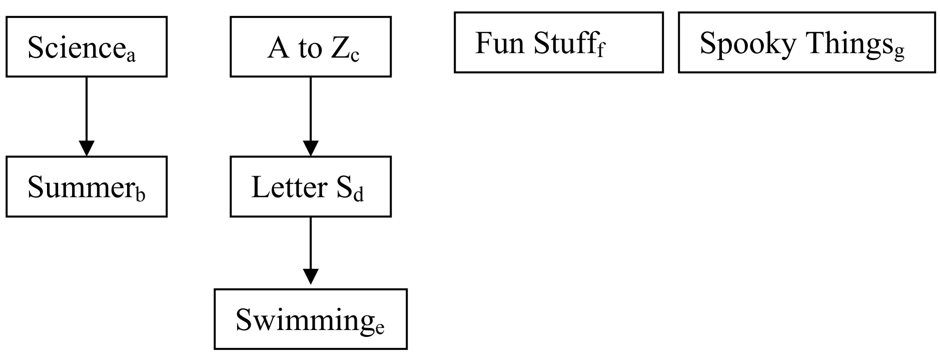


Logic:

a. Dinosaurs were animals.
b. Dinosaurs were reptiles.
c. Dinosaurs lived in the past.
d. Dinosaurs are studied in science.
e. Dinosaurs are found in the Earth and were killed by volcanoes.
f. Dinosaurs can be found by using the computer.

Figure 18. iii dinosaur taxonomies based on logic but not ending in success.

Once again in Figure 19 (below), their knowledge and experience about sharks is evident.



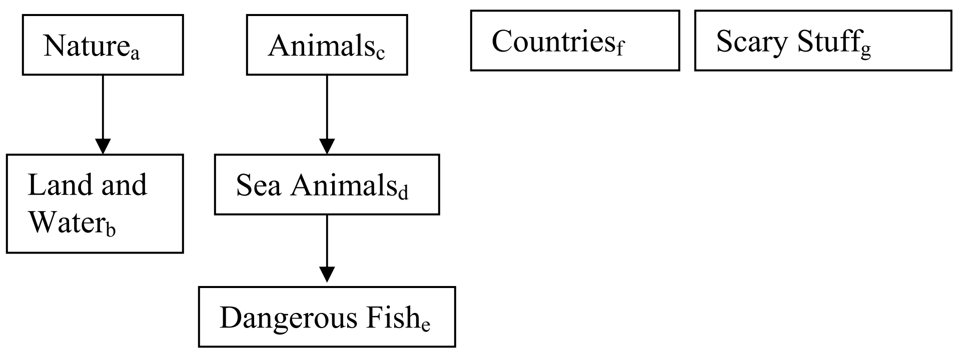
Logic:

a. Sharks are studied in science.
b. It's a picture of the beach where you swim and sometimes see sharks.
c. A to Z means has everything.
d. Sharks starts "s."
e. It's a picture of a shark's fin and sharks swim. (Icon = person swimming laps)
f. It's a picture of a beach and sharks live in salt water and come up in the waves; sharks live near beaches.
g. Sharks are scary.

Figure 19. Sirsi shark taxonomies based on logic but not ending in success.

Sharks are studied in science (logic a). Sharks certainly live in the ocean/salt water and can be seen there (logic b and f) (Shark, 2007). Additionally in Texas, sharks are active during summer months and frequently feed in the shallow waters of the Gulf of Mexico (KGBT 4, 2004).

During the summer in Texas, the incidents of shark attacks and warnings are seen on the news. The A to Z implies that it has everything; the word shark does start with the letter "s" so the selection of "s" words is sound (logic c and d). If you were unfamiliar with a pool set up for swimming laps, it certainly can be mistaken for something else (logic e). It is water and sharks do swim (logic e). Sharks are dangerous and can be scary (logic g) (Shark, 2007). In Figure 20 and 21, there is additional evidence of their logic based in some fact but not leading to success. Figure 20 details additional information based on fact or logic not ending in success.

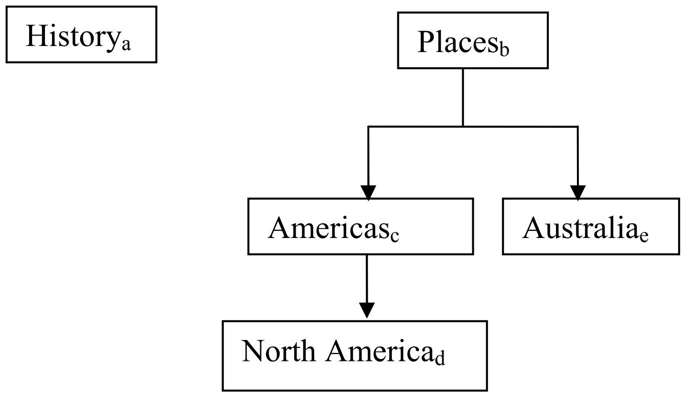


Logic:

a. Sharks are part of nature.
b. Sharks live in water.
c. Sharks are animals.
d. Sharks are fish.
e. Sharks are dangerous.
f. Map shows where the water is, and sharks live in water.
g. Sharks are scary.

Figure 20. Dynix shark taxonomies based on logic but not ending in success.

From figure 20 (above), sharks are part of nature and certainly live in the ocean/salt water (logic a, b, and f) (Shark, 2007). Sharks are animals, fish, which live in the sea and can attack humans (logic c and d). Sharks are dangerous and can be scary (logic e) (Shark, 2007).



Logic:

a. There is a shark from the past called Megalodon.
b. It's a map of places with land and water, and sharks live in water.
c. Sharks live in the water around America.
d. Sharks live around North Carolina and Florida in North America.
e. Sharks kill a lot of people around Australia.

Figure 21. iii shark taxonomies based on logic but not ending in success.

From figure 21 (above), Carcharodon megalodon's teeth have been discovered (logic a) (Bruner, 1997). Sharks certainly live in the ocean/salt water and can be found around America, Australia, and other places (logic b through e) (Shark, 2007).

In the taxonomy listed in Figure 22 (below), there is no doubt that the participants' logic is sound. Texas is in a country in the world on the continent of North America in the United States (logic a – d) (Texas, 2007).

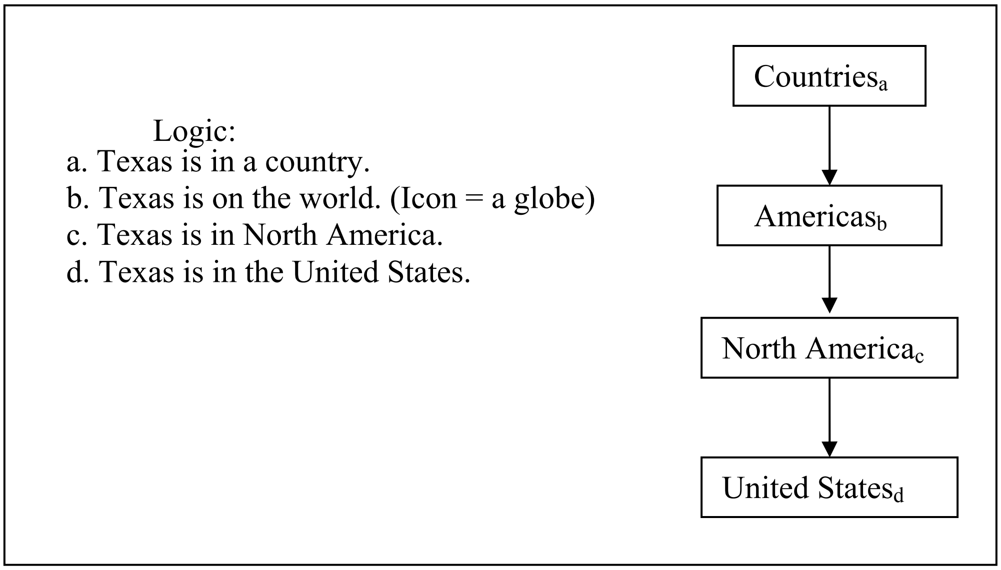


Figure 22. Dynix Texas taxonomies based on logic but not ending in success.

Pre-process Question Responses

Computer Use

The first question researchers posed to participants was:

- How often do you use the computer?
  [once a day, once a week, once a month, other:_____]

Children's computer use in relation to success has been discussed in the statistical analysis section of this paper. In simplest terms, the participants reported the following: n=27 used the computer once a day; n=10 used it once a week; n=1 used the computer once a month; and n=13 reported using the computer other (less than once a month).

The second pre-interview question was:

- What do you do on the computer?
  [play games, type, use the Internet, use the library catalog]

The participants overwhelmingly reported that their prime uses of the computer were game playing (n=35 almost 69%) and using the Internet (n=24 or 47%). The collection tool did not allow for participants to elaborate on what they were doing on the Internet (i.e. searching for school, searching for personal interests, using email, etc.). Participants selected as many uses as applicable to them. In addition to playing games and using the Internet, five participants, just under 10%, reported using the computer to type, and 6 participants, almost 12%, reported using the library catalog. In *Children's Access to and Use of Technology Evaluation* (CATE), Gross, Dresang and Holt (2004) found children's use of technology in the public library centers on games more than on educational directed research and communication, such as chat or email. Sandvig (2000) also reported the three most common uses of the Internet in San Francisco's Public Library's Electronic Discovery Centers were chatting, playing arcade-style games, and playing multi-user dungeon games. The results of this study echo their findings.

The third and final pre-process question was:

- Have you ever used this catalog?
  [show them a laptop with the catalog]

Overall, there was a surprising lack of catalog recognition from the participants especially since almost 12% reported using the catalog and one of the catalogs chosen for the study was being used by the experiment site. Only two participants "thought the catalog might be familiar" indicating the following possible explanations: 1. the six participants who reported using the catalog were randomly assigned to catalogs not used by their library system; 2. the participants were confused by the paper representation of the catalog; or 3. the participants used the keyword feature instead of the browsing feature of the catalog.

Post-Process Question Responses

Lack of Response

The participants were not able to provide quality responses to the majority of the post-process questions (i.e. What did you like about the pictures used?). They were only successful in answering the following three questions: Did you find what you were looking for? Did the pictures help you? Did you use the pictures and words, just the words or just the pictures? As cited in Garbarino et al. (1992), Brown defines metacognition as “a very basic form of self-awareness,” that of realizing “what you know and what you do not know” (p. 59). In other studies and perhaps in this one, the lack of answers may be due to young children not being aware of “their own thought processes” and having “considerable difficultly in reflecting on them” (Garbarino et al., 1992, p. 59).

Reasons for Stopping

Of the thirty-nine participants who were unsuccessful and stopped searching, 92% of them (n=36) were able to verbalize why they stopped. Participants’ two primary reasons for stopping were “just couldn’t find the information” (n=14 or just under 39%) and “too hard” (n=12 or over 33%). Other reasons for stopping were “the things I picked didn’t lead to the information” (n=6 or almost 17%), “too tricky” (n=3 or just over 8%), and “just felt done” (n=1 or almost 3%). None of the fifty-one participants asked to stop the experiment before attempting all three tasks.

Self-Reported Ease of Use

Even though 76% were unsuccessful on at least one of the three tasks, only 16% (or 8 participants) reported that the catalogs were hard or very hard to use and 25% (or 13 participants) reported that the catalogs were neither easy nor hard to use. In this study, ease of use is an affective stance. When looking at Web searching, a positive attitude is related to students’ involvement and search activities but not necessarily the quality of their results (Kuiper, Volman,

& Terwel, 2005). Bandura's Social Cognition third premise is that "Self-efficacy proposes that people generate their thoughts, behavior, and affective states and that these, in turn, affect the courses of action people choose to take, the amount of effort they put forth, their resistance to failure, and the level of accomplishment they achieve" (Miwa, 2005, p. 54). Additionally, self-efficacy has the potential to explain the various degrees of performance in information seeking (Miwa, 2005, p. 56). The competency theory also addresses some of the discrepancies found in self-reporting (Gross, 2005). The participants had some cognitive knowledge and experience with the search topics of dinosaurs, sharks, and Texas combined with basic taxonomy development skills that may have lead to over inflated sense of competency. Kuhlthau (1991; 2004) addresses the importance that emotions play in the search process. This is echoed in the results of the probit where the likelihood of completing tasks increases when a child's perception of ease of use is greatest.

CHAPTER 6

CONCLUSION AND DISCUSSION

Summary

Research shows children in an online environment often search by browsing, which relies heavily on recognition and content knowledge, so catalog systems for children must use effective symbols or pictorial representations, which correspond with children's own cognitive schema and level of recognition knowledge. The literature on previous studies as noted in Chapter 2 shows that children's cognitive and developmental stages impact search behavior and must be taken into account when a system is being designed. This study was designed to look at the success of young children (ages 5 to 8) in searching online public library catalogs designed for them by Innovative Interfaces Inc., Dynix, and Sirsi, and it focused specifically on the pictorial representations and text descriptors used in the systems' browsing hierarchy. The overriding question, seeks to answer if young children (ages 5-8) are really poor searchers because of cognitive development and lack of technology skills or is system design the major reason for poor search results and is answered by looking at the following series of questions. The overriding research question in this dissertation is:

> Do current children's online catalog designs function in a manner that is compatible with information seeking by children?

In order to answer this overriding question, the results of the following three individual questions must be examined.

1. Did the categories and labels used by libraries and library vendors assist children ages 5-8 in locating assigned tasks and did the subject categories and labels used cognitively match the level and development of children ages 5-8?

The results indicated that there is no significant difference among the searching success rates of the three catalogs; however, the probability that a participant will complete all three tasks is .07, two tasks is .31, one task is .49, and none of the assigned tasks is .12. Despite this lack of success in finding all three tasks, 80% of the participants reported using the images and the text and that the images and the text helped them when searching. Although these results can not be generalized, this study indicates that there was a disconnect between the cognitive abilities of young users and catalog design. This disconnect is further exhibited by the taxonomies created and logic behind them. The participants misidentified representations used in icons in all 3 catalogs and created taxonomies via search paths that although based in fact and matching the participants' cognitive levels did not result in search success.

2. Do individual level characteristics — age, gender, perseverance, computer usage — affect the success of children ages 5-8 in locating an assigned task?

In this study, gender and race did not affect success of the participants, but the results did indicated that age, computer experience, feelings of success, and time did result in significant differences and impact searching.

3. Therefore, are young children (ages 5-8) really poor searchers because of cognitive development and lack of technology skills or is system design the major reason for poor search results?

Even though this study was done on paper instead of on the computer and further replications and verifications are needed, there certainly are indications that system design is a major reason for lack of success.

Theoretical Basis Impacting This Study Revisited

As stated earlier, Ingwersen's (1996) explains that polyrepresentation seeks to include the user's information need and knowledge states – recall knowledge and recognition knowledge. These knowledge states and cognitive/emotional structures are "determined by the experiences gained through time in a social and historical context" (Ingwersen, 1996 p. 6). These experiences must be taken into consideration when pictorial representations are being chosen for IR systems for children. The use of redundancy is also a chief concern (Ingwersen, 1996). As applied to children, the task should be logically linked in a variety of paths. Additionally as Bilal and Wang (2005) address, "Ingwersen (1992) argues that situational classifications provide contexts, whereas categorical classifications often have the form of abstract relations. He also notes that an IR system designer who has some knowledge of the user population should tailor the classification of topics and concepts accordingly" (p. 1311). There was evidence of Ingwersen's (1996) Cognitive Information Retrieval (IR) theory being exhibited in the taxonomies created and identification of icons by participants. The catalogs' use of redundancy was flawed. There was not enough redundancy used and identical images/icons do not lead to identical results. For example, dinosaurs should be found through animals → extinct animals and animals → reptiles.

Hjorland explains that children develop a structure of signs and symbols externally in a culture (Hjorland, 2005). Though it originally develops externally, the structure of signs and symbols is internalized, which affects the information seeking process. There was some evidence that the catalogs' use of signs and symbols did not match participants' cognitive abilities; this was seen by misidentification and misapplied meaning.

Additionally, Dervin's cyclic sense-making process impacts the way in which users seek information and is especially relevant to this study. It is "based on the premise that when faced with information discontinuities or information needs, humans attempt to bridge this gap by defining and making sense of the situation and then devising appropriate information processing approaches to bridge the gap" (David, Song, Hayes, & Fredin, 2007, p. 171). "It draws attention to individual sense-making (problem solving) in varying situations, and focuses on the actor and process viewpoints rather than a systems (or traditional assumptions') viewpoint" (Ingwersen & Jarvelin, 2005, p. 62). Applying Dervin's sense-making theory is important because although catalogs are made for the populous at large, it is the individual and what he or she brings to the table, which affects the information seeking process (Tidline, 2005). This was also evident in the responses and taxonomies created by the participants.

There was evidence that the participants in the study exhibited cognitive authority in the taxonomies they created (Wilson, 1983). Wilson's cognitive authority is based on the elemental concept "that people construct knowledge in two different ways: based on their first-hand experience or on what they have learned second-hand from others" (Rieh, 2005, p. 83).

Shannon's emphasis is that communication is essentially digital (Shannon & Weaver, 1963). "The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design" (Shannon & Weaver, 1963, p. 31). In Shannon's three levels of the communication problem theory, the following problems are identified:

- "Technical or physical problems have to do with the accuracy with which the symbols of communication are transmitted" (Pao, 1989, p. 9).
- "Semantic or representational problems have to do with the precision with which the transmitted symbols convey the intended meaning" (Pao, 1989, p. 9).

- "Effectiveness or behavioral problems have to do with the success with which the information conveyed from the sender to the destination affects some desired conduct at the destination" (Pao, 1989, p. 9).

Although Shannon's definition of information as the level of change a recipient experiences after receiving a message is not applicable to this study, his 3 levels of communication theory when coupled with the Cooper and O'Connor model does have application to this study (Pao, 1989; Abbas, 2002). In applying these 3 levels to this study, the technical or physical problems have to do first with the accuracy of the symbols selected to communicate the information transmitted. The semantic or representational problems have to do with the accuracy in which the symbols used convey meaning; the focus here, unlike in Shannon's theory and the Cooper O'Connor model is not on the words used in the message or the words used to represent the materials but on the icons and their perceived meaning by the viewer.

The MLO (*M*aron, *L*evien, *O*'Connor) matrix (Table 9 revisited) represents the complexity of the user's question and the providing of the answer (O'Connor, Copeland, & Kearns, 2003). When the question is specific requiring one and only one "right" answer, there can be less ambiguity in the user's question and less complexity of the search process and the answer (B. O'Connor, personal communication, June 6, 2007). On the other side of this, there are questions where there may be various "acceptable" answers.

Table 9

MLO Matrix

	Look Up	Deductive Logic	Inductive Logic	Conversation
Articulated Query	LA	DA	IA	CA
Vague Awareness	LV	DV	IV	CV
Monitoring	LM	DM	IM	CM
Browsing	LB	DB	IB	CB
Encountering	LE	DE	IE	CE

Note. O'Connor, Copeland, & Kearns, 2003.

The patron's question state represents the MLO matrix in the Cooper and O'Connor model, and the effectiveness or behavioral problems have to do with the success of the participant finding the search task in addition to complexity of the type of question and possible answers (B. O'Connor, personal communication, June 6, 2007). On top of question complexity, user behavior, possible answers, design and representation further increase the complications. At this point in the discussion, it is important to include Abbas' (2002) modification of the Cooper and O'Connor model with her emphasis on the user's cognitive abilities.

Abbas (2002) has further adapted this model to show an emphasis on the following: "the user's developmental and cognitive state, domain and system knowledge, and indexer's knowledge of the user's intended purpose(s) for the objects, or the idea of functional representation, can affect representation and retrieval" (p. 51). She places additional emphasis on the indexer's knowledge of the user's cognitive ability when extracting descriptors of the text (Abbas, 2002). When using words to represent documents or objects in a catalog, there is the ability to generalize or to be more specific – to use antonyms or synonyms, and to define or to describe. There are built in mechanisms to make communication connections based on native elements, but this is not the case with pictures (B. O'Connor, personal communication, June 6, 2007; Wyatt & O'Connor, 2004). "Pictures are not words and words are not native elements of photographs" (Wyatt & O'Connor, 2004, p. 107). When a text document is described, it is done through an "extraction process," and when a picture is described, there are generally no words to extract (Wyatt & O'Connor, 2004). Linguistics and images are two fundamentally different ways of communicating; participants do not know how the decision was made by the designers to have (blank) represent (blank) and whether designers have taken the users' interpretation of the images into account in using them for representation and the accompanying text descriptors of the icons (B. O'Connor, personal communication, June 6, 2007). This lack of explanation of representations or rules leads participants' to have no understanding of why they were unsuccessful or the need for them to think of other search paths; there is an assumption that the designers selected the best representation for information. The assumption is that all users have the same built in code for the message.

The complexity of using images in representation is that there "is no general rule for translation of an entire picture or any of its parts into words" (Wyatt & O'Connor, 2004, p. 113). Wyatt and O'Connor (2004) use the example of the following words and pictures: sheep, elephant, and horse. These three words can easily be generalized into the superordinate taxonomic class of mammals or animals. However as images, even if parts are selected or a collage of the sheep, elephant, and horse is constructed, the user must take big cognitive leap to animals since the representation is still of a sheep, an elephant, and a horse (Wyatt & O'Connor, 2004). Icons are not part of the documents or materials being represented; they are not extracted from the text. Text representation is a direct path; icon representation is not a direct path. In the catalogs examined, users had to make the cognitive leap from the following images used to represent animals: kola (iii), dog and cat (Sirsi), and gorilla (Dynix).

The icon is viewed in the context or culture of the viewer to determine the meaning, which can account for the different (a.k.a. misinterpreted or mislabeled) interpretations of the icons (Goonetilleke, Martins Shih, Kai On, & Fritsch, 2001). "In this relationship, the effectiveness of the representation depends on what is represented and how it is represented" (Goonetilleke et al., 2001, p. 742). "Denotation is regarded as the definitional, literal, obvious or commonsense meaning of a sign" (Yoon, 2006, p. 17). In general, this means that a sign should be readily recognized by the recipient no matter what the context or cultural background; this is especially important when looking at children as users since they may not yet have the cultural or social background necessary to interpret the sign (Yoon, 2006). In contrast to denotation, connotation signs likely have multiple meanings and are based on the socio-cultural and individuality of the recipient (Yoon, 2006). Signs are interpreted within a code, or framework, used to make sense of the signs (Yoon, 2006). "Signs address receivers within particular codes, and a producer of signs may assume that receivers would read signs within the same codes with him/her or at least some intended codes" (Yoon, 2006, p. 20). In the case of the catalog designs, participants did not always exhibit using the same code as the designers as exhibited by their misinterpretation of icons and the subjects they were representing.

For the purposes of this study, the Cooper and O'Connor model can be even further modified to include an emphasis on the selection of icons and their text descriptors and subjects selected by the designer as in Figure 23. The information loss is resulting on multiple levels: loss in text descriptors, loss by icon choice, and loss through cognitive mismatch between the user and the system. In the case of this study, the indexing or tagging of documents is less of an emphasis because of the hierarchical subject browsing design being studied instead of the keyword retrieval.   However, participants in the study took reasonable steps to find the tasks but were unsuccessful in part because of this loss of information.

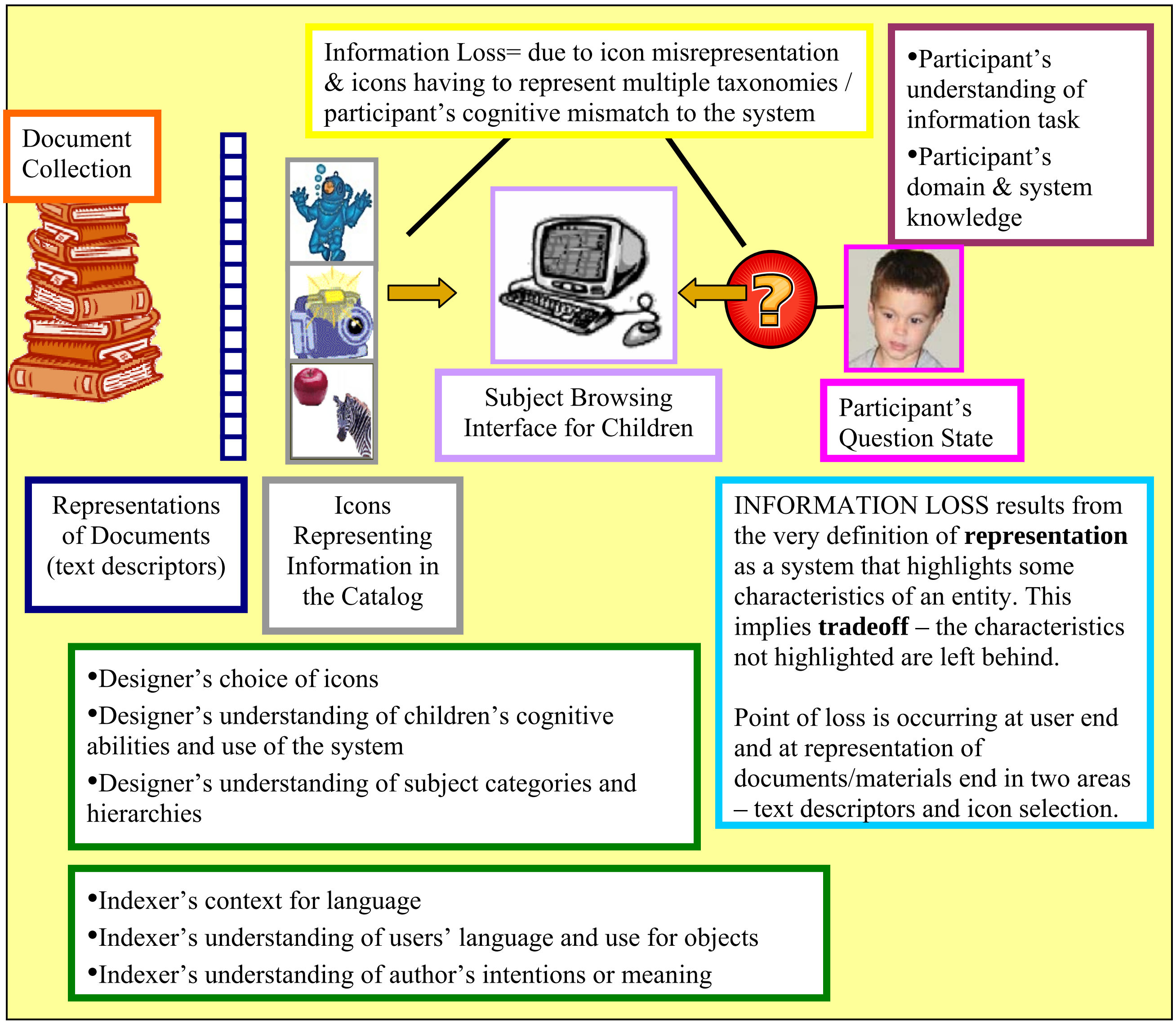


Figure 23. Further modification of the Cooper and O'Connor model.

Judgment involves making a qualitative assessment; decision-making involves assessing conflicting judgments and terminates in an action (Fitzgerald & Galloway, 2001). Participants were called to assess a set of choices and then make a decision as to where to find the task. Satisficing in information seeking involves making a decision about information being "good enough" to meet their needs while not necessarily considering all possible, or known, options (Bates, 2005a). Satisficing traditionally has been applied to people with limited time and resources making the best decision at the time, "truncating the deliberation process at a point where a reasonable but not necessarily definitive decision seems possible" (Fitzgerald & Galloway, 2001, p. 992; Simon, 1956). "Evidently, organisms adapt well enough to "satisfice"; they do not, in general, "optimize" (Simon, 1956, p. 129). Satisficing is dependent on user characteristics, including cognitive development, as well as the mechanics, or the structure, of the searching environment (Simon, 1956).

Additionally, there is a model from the field of psychology that must be mentioned. Strategy Choice and Discovery Simulation (SCADS) is a computer simulation by Siegler and Araya (2005) that solves mathematical problems. SCADS is able to select the correct strategy or create a strategy to solve a problem with the most speed and accuracy (Siegler & Araya, 2005). SCADS was modeled on children's use of adaptive strategies when solving addition problems and the discovery of new shortcut strategies. "The choices are adaptive in the sense that children use the fastest and least effortful strategy consistent with their achieving a high degree of accuracy on the particular problem" (Siegler & Araya, 2005, p. 4).

Building on all of the above-mentioned theories, models, and processes and on the results of this study, the following proposed model – Creel's second best choice (SBC) – was developed. In this dissertation, a model is "a set of propositions or equations describing in simplified form some aspects of our experience. Every model is based upon a theory, but the theory may not be stated in concise form" (Umpleby, 2003). Additionally, a model is an "object or process which shares crucial properties of an original, modeled object or process, but is easier to manipulate or understand" (Arbib, 2003).

The emphasis of the SBC model is two-fold. First, there is a heavy emphasis on interface design of the system used to represent the information, which heavily influences the choices children make when seeking information. Second, the emphasis in the SBC model is that when children are faced with an organizational/structural gap they select another "second best" logical route to the solution even though they know what the best choice would be. They are making a *forced* good enough or next logical choice/decision due to the task not being readily available or solvable because of system design; this is an important distinction. The satisficing is not true satisficing, since it is being forced; they are picking the second best option of all options available for consideration. The SBC model places the emphasis, not on the hows as with the Sense-Making theory, but on the whys of their selection and the outside influence of the design of the catalog.

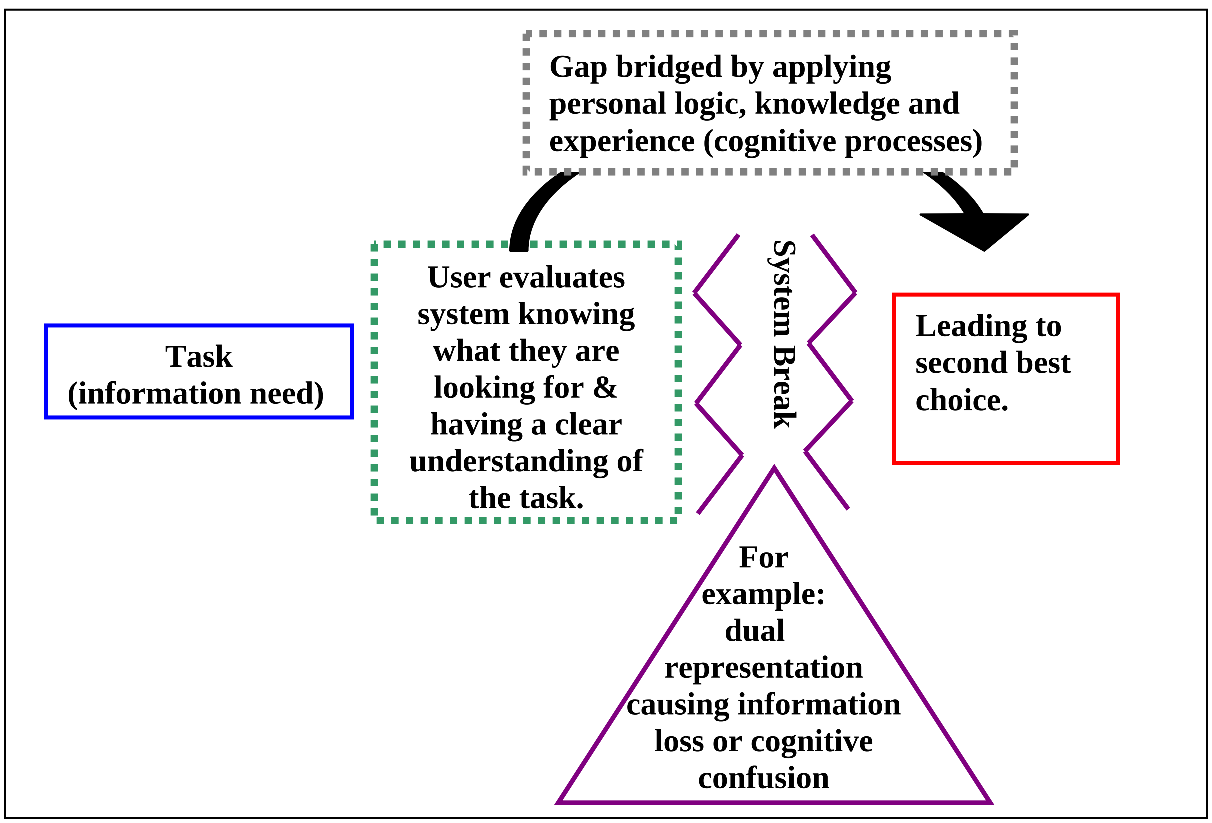
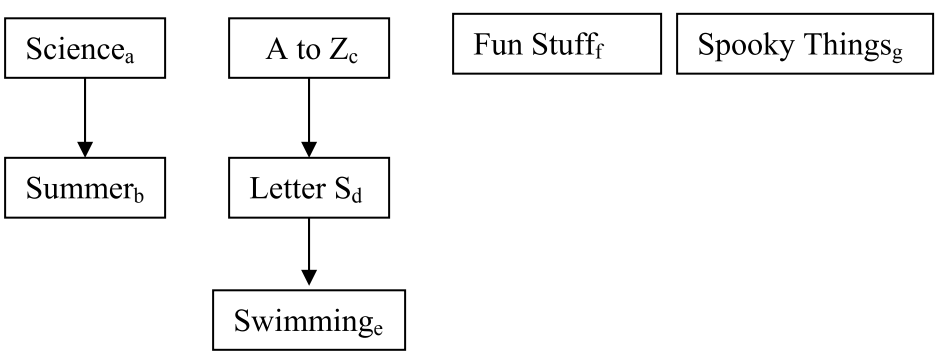


Figure 24. Creel's second best choice model (SBC).

In this study, the **tasks** were dinosaurs, sharks, and Texas. They were the 3 most repeated topics in the reference statistics and were selected to help battle low motivation. Participants' knew what they were looking for, and researchers tested their **domain knowledge** by use of task cards. Examples of the **system break** are information loss that comes from poor icon choice, dual representation, or cognitive logic based on experience but not accounted for in the catalog. The participants then **bridge the gap** in the system by applying personal logic, experience, and cognitive knowledge to the make the next, or **second, best choice**.

Examples of the participants in this study making second best choices are found in the taxonomies created when searching for the tasks. The best option, of course, would be the path to the task simply and straightforwardly identified. For example, previously seen Figure 19 represents some of the logical choices that participants of the study made when searching for sharks.



Logic:
a. Sharks are studied in science.
b. It's a picture of the beach where you swim and sometimes see sharks.
c. A to Z means has everything.
d. Sharks starts "s."
e. It's a picture of a shark's fin and sharks swim. (Icon = person swimming laps)
f. It's a picture of a beach and sharks live in salt water and come up in the waves; sharks live near beaches.
g. Sharks are scary.

Figure 19. Shark taxonomies based on logic not ending in success for Sirsi.

When *sharks* was not readily available from the home page screen shot, they looked for logically related images and text descriptors. The icon for summer is a picture of the beach with the ocean in the background. Participants know sharks live in the ocean. The icon for swimming, which is a person swimming laps, is not clear. Participants know sharks swim and that the fin sticks up out of the water. They clearly knew what a shark was and understood what they were looking for, but the system break came from the icons selected to represent information and the lack of use of system tools like verbal mouse over forcing them to make the "bad" second best choices to find their information.

Limitations of the Study

While it is anticipated that this study will be valuable in providing information on the cognitive impact of children searching and the design of catalogs for children in the public library setting, it is necessary to point out the limitations of the study. First, due to the small sample of participants (51 children in only 1 location), the work described here cannot provide definitive answers as to the flaws of the design of the 3 online browsing catalogs for children used in a public library setting matching the cognitive needs of children ages five to eight. However, this study does seem to indicate that children's lack of skills is not solely to blame and further investigation is warranted.

Second, although the data collection procedures and instruments are IRB approved and are understood to be valid, the consistency of data collection was dependent on two individuals collecting data. Time was spent by both individuals observing one another on how the study should be and was conducted. Both of the individuals have over ten years of experience working with and engaging children in school and library environments. Their training in dealing with and engaging children can impact the way the participants perceived the processes and their willingness to try multiple paths when searching for tasks. An additional validity issue is dependent on the candor of the participants and their desire to provide the “right” answer and please the interviewers (Gross, 2006; Gabarino, Stott, & faculty of the Erikson Institute, 1992).

The validity of a study can also be influenced by testing effects or changes the participants experience via going through the process (Singleton, Straits, & Straits, 1993). “Through browsing, the individual becomes aware of unforeseeable, useful information that may lead to a change of the individual’s state of knowledge and subsequently influences or, more specifically clarifies, her original information need” (Rice, McCreadie, & Chang, 2001, p. 182). “Typically, people will score better or give more socially desirable or psychologically healthier responses the second time a test or scale is administered to them” (Singleton et al., 1993, p. 215). As Hirsh (1996) indicates, testing effects or incidental learning, although not specifically tested for, has been seen in studies by Borgman, Hirsh, Walter, and Gallagher (1995) and Liebscher and Marchionini (1988). In this study, however, the ANOVAs indicated that the task completion is the same when it comes to completion rates regardless of the task performed and regardless of the catalog; there was no statistical difference in completion rates of the three tasks – dinosaurs, sharks, and Texas – across the various catalogs.

Internal validity is also dependent on selection of participants (Singleton et al., 1993). Although every effort was made to recruit diverse participants reflective of the population at large, the study was dependent on children willing to volunteer in a public library setting. In an effort to increase validity among the participants, they were randomly assigned to the catalog they tested.

Finally, extraneous, or uncontrolled, variables may also affect the internal validity of the study (Singleton et al., 1993). For example, some participants may not be familiar with the catalog they tested but could be familiar with similar catalogs; another example would be if a participant received training at school or using a catalog. It also could be something non-technology or library related, such as a trip to the pool promised after the library visit, which could cause the participant to rush through the experiment.

Discussion

"Catalogs and online resource sharing capabilities in libraries needs to improve, which is something that was a hot button topic in the library blog world last year" (Mercado, 2007). It is interesting to note that both SirsiDynix and Innovative Interfaces, Inc. have heard the call to improve library catalogs and are currently revamping their interfaces for children's online catalogs.

SirsiDynix has created SchoolRooms™ "a comprehensive and integrated multimedia online discovery portal for K-12 schools" (SirsiDynix, 2006). Although SchoolRooms is described as a product for K-12 schools, the reported testing so far has focused on children ages 8 to 18 (Holmes, Robins, Zhang, Salaba, & Byerly, 2006); while the interfaces contains text and images, it is moving away from icon driven browsing hierarchies. This movement away from icons is in contrast to what Cooper (2005) reports as helpful for young children searching and what participants in this study reported about using the icons. "Use of icons in conjunction with or instead of alphabetic symbols support children who cannot read or read well, have trouble scanning text on a computer screen, or have trouble with the concept that an alphabetic citation stands for a book that they want" (Cooper, 2005, p. 292). Additional research by Borgman, Gallagher, Hirsh, & Walter (1995) also indicates that browsing interfaces assist children in searching. "As to the computer interface, Tuori (1987) suggests that a system is more browsable if it does not create a great demand on users for specification of intention, knowledge of organizational (file) structure, and the language used to communicate with the system as well as modality of interaction" (Rice, McCreadie, & Change, 2001, p. 231). Testing on how this affects the youngest users, the budding reader, will need to be investigated. SirsiDynix plans on public libraries and schools collaborating to use and teach their new interface.

Figure 25. SirsiDynix's SchoolRooms.

As seen in Figure 26, a version of iii's new interface has already made an appearance. This newer version has maintained an icon driven browsing interface for users as research has indicated is an important feature but has changed from cartoon style images to photographic images. Additionally it has increased the number of subjects found on the home screen from fifteen to twenty-four.

Figure 26. iii's new interface for children.

Significant Contributions and Recommendations

The first contribution to information seeking behavior of children and the field of library information science is the further modification of the Cooper and O'Connor model to include the second layer of information representation, which children must "go through" and understand to retrieve information. In keyword searching, children must use the appropriate search terms that system designers have selected to represent (or not represent) the documents, materials, items, etc.; the controlled vocabulary is extracted through established mechanisms. With icons selected by designers or librarians, there is no established mechanism of extraction; children must figure out the representations used in the icons of the interface selected to represent those same materials and items. The information loss is resulting on multiple levels: loss in text descriptors, loss by icon choice, and loss through cognitive mismatch between the user and the system. This additional layer emphasizes the additional cognitive challenges placed on children by the system.

The second significant contribution, and perhaps the most personally exciting part of the study, is the *preliminary* design of the SBC model that developed out of the results and observations of this study.   Of course, it is recommended that the model be further tested to see if it remains true in the following cases:

- Searching on additional tasks in the new and any previous versions still available of the catalogs
- Searching in other online environments, for example databases for children and the Web
- Searching done by different children in increased numbers
- Searching for information in other environments – physical libraries and print materials

The emphasis of the SBC model is on the interface design of the system used to represent the information and the cognitive challenge placed on children making decisions. In this study, when children were faced with an organizational/structural gap, they selected another forced "second best" logical route to the solution. The participants exhibited knowledge about the tasks – dinosaurs, sharks, and Texas – through their reasons supplied for their choice of path.

Cognitively, the tasks match the participants but the system forced them to make "second best" choices, or choices of peripherally related to the topic, due to the following:

- By not providing structuring (categorizations) that matched their personal cognitive experiences
- By not using multiple logical paths to subjects
- By using identical icons to represent different and related topics (ambiguity)
- By using icons that did not match their knowledge

Finally, this study is significant since it fills a gap in the literature on the youngest readers in a public library using catalogs designed for children and public libraries. It confirms what previous research in the literature on children seeking information in online catalogs and in online environments has reported and emphasizes that the failures children experience when using subject browsing catalogs designed for them are not just about lack of technology skills or low domain knowledge. There is a disconnect between the design of the catalog, the lack of assistance features, and the children.

Future Studies

Although outside the scope of this study, there are plans to analyze the video tapes in the future to study the body language and movements of the participants of the study. As reported in Druckman, Rozelle, and Baxter (1982), Dittmann and Llewellyn found that there are physical manifestations related to cognitive activity including head nods, hand and feet movements, and postural shifts. Additionally, posture and body movement (kinesics) and gazing away can represent other emotions such as inattention, anxiety, and boredom. The body language and movements should supply additional insight to how the participants perceived the process of this study. This study also should be replicated using the computer instead of the paper version to see if there are significant differences for time spent searching, number of paths attempted, success in task completion, or taxonomies constructed.

The participants' likes and dislikes of the interface of the catalogs investigated were not gathered. It would be interesting to look at the participants' preferences for the visual design, color, style of icons and more in light of their feelings of success. In light of information reported by Nesset and Large (2004), it might also provide significant insight into the catalogs if the children were to redesign them.

In a study by Miralpeix (1994), 31% to 46% of participants ages eight to thirteen reported they were able to find the materials physically on the shelf after finding them in the catalog. As younger children gain more computer experience and confidence using the computer, a study focusing not only on their ability to use these catalog interfaces on the computer but subsequently find the desired materials should be conducted.

There are currently many methods available to improve catalogs for children and adults. Investigations into using auditory icons, which are defined as "familiar sounds," and earcons, which are defined as "abstract sounds whose meanings must be learned," need to take place (Shneiderman & Plaisant, 2004, p. 383). Studies on using auditory icons with children to test if they reinforce "the visual metaphors in a graphical user interface" need to be explored (Shneiderman & Plaisant, 2004, p. 383). Additionally, the testing and implementation of other auditory-interface tools should be explored like verbal mouse overs which do more than just reiterate the icon text but go beyond that to provide insight into the subcategories. Other tools like zooms to allow users to move and see different levels of representation should also be investigated (Marchionini, 1995).

Although speech recognition was originally created for adults, there are certainly implications for use with children. Bruckman and Bandlow (2002) reported on a study by Nix, Fairweather and Adams that showed that adult software could be modified for use with children ages 5 to 7 with a success rate of 95% by including common mispronunciations and children's predilection for using multiple words instead of one-word responses. These results certainly merit investigation into speech recognition software for use in catalog systems for children.

Another area of potential research is the use of user-assigned tags to content as seen in Web applications like flickr®[15], del.icio.us®[16], and Wikepedia®[17]. Integration of a search option that allows users to search by system tags, adult user tags, and children user tags could greatly enhance bridging the gap between what designers deem as cognitively appropriate controlled vocabulary and what users actually use.

Children are being exposed to computers before they are able to read (Appendix O); in some cases, they may be exposed to technology before books (Cooper, 2005). "Whereas the child of the recent past may have needed an introduction to computers and digital information upon beginning formal schooling, these things have very likely been a part of life for today's child from the beginning" (Cooper, 2005, p. 286). As they grow and learn in this computer environment, they will expect to make a seamless transition into using online catalogs. In order to make this seamless transition, they need to learn information seeking skills. In addition to their learning, catalog systems that are appropriate for even our youngest beginning readers need to be designed. A catalog that provides adequate help, feedback and support scaffolding is necessary. This scaffolding may end up coming in many different forms; including some of the features

[15]flickr, www.flickr.com
[16]del.icio.us, del.icio.us
[17]Wikepedia, www.wikipedia.org

discussed under future studies like verbal mouse over and auditory clues. Perhaps now is the time to heed Tennant (2005) and attempt to create a system that does not need to be taught.

I wish I had known that the solution for needing to teach our users how to search our catalog was to create a system that didn't need to be taught—and that we would spend years asking vendors for systems that solved our problems but did little to serve our users

-- Roy Tennant from "What I wish I had Known" in *Library Journal*

APPENDIX A

CLASSIFICATION OF OPAC BREAKDOWNS

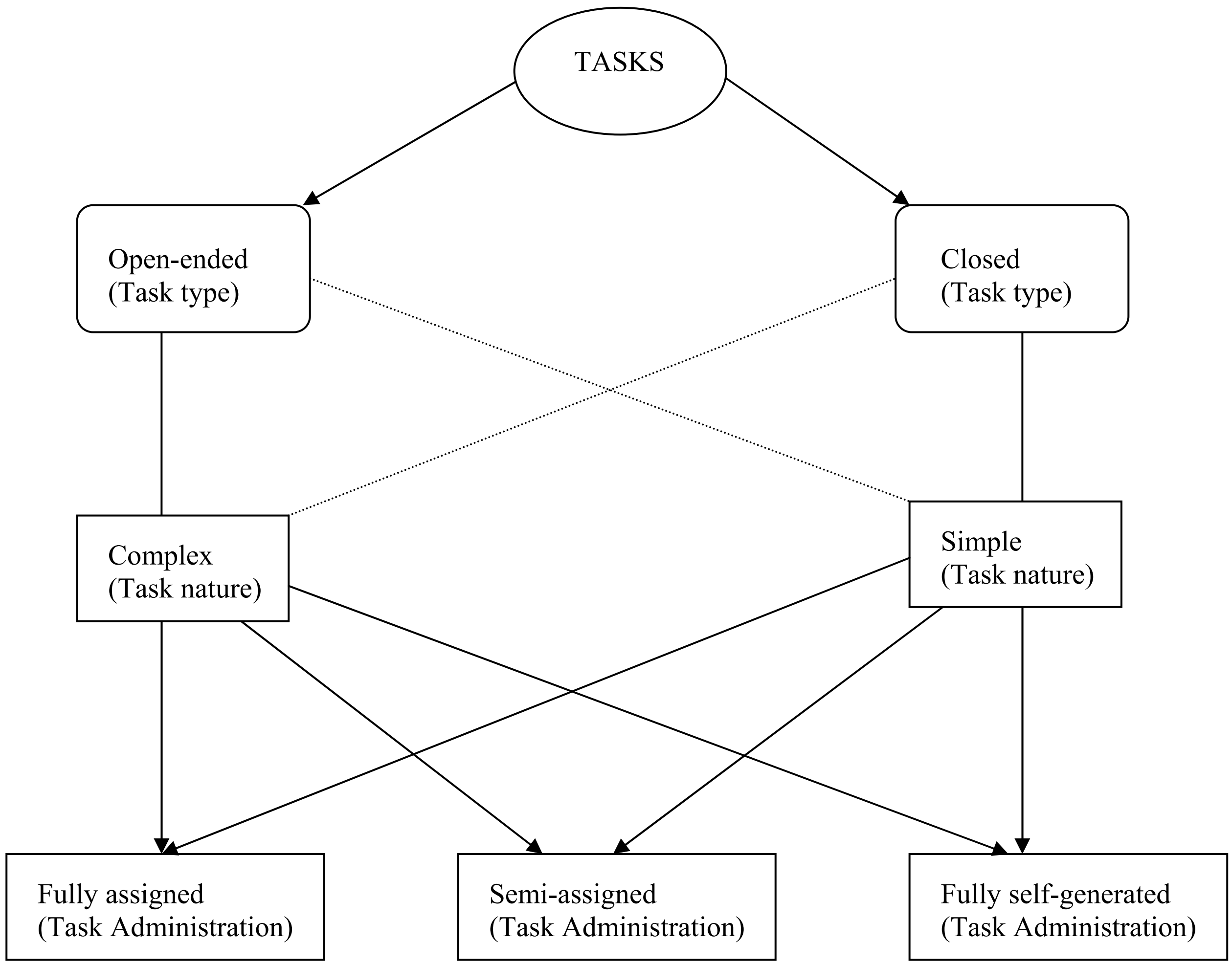
Classification of OPAC Breakdowns

	User Requirements	Occurrence	Design implications
Knowledge			
Conditional	Monitor OPAC response; take action if appropriate.	Low in first grade and increases; most prevalent following spelling	Point out ambiguous queries (e.g., bat: animal or object?, whale or Wales?)
Processing	Follow-up action is user's responsibility.	Low in lower grades to high in upper grades.	Offer strategy options
Content	Content knowledge in area of interest or need.	Uniform for all grades; character varies with grade.	Access tools tailored to curriculum and interests.
Rules			
Syntax	Know form requirements: no extra spaces or punctuation.	All grades. Conflict with emphasis on punctuation.	Ignore extra spaces and punctuation in query parsing.
Query Form	Know requirements of well-formed queries (e.g., nouns, plural form).	All grades with greater frequency in upper grades.	Display word forms in use; ignore terms not in use.
Focus	Evaluate focus of query: author, subject, title.	All grades.	Follow failed query with test on other foci.
Skills			
OPAC	Understanding of OPAC uses and products.	Primarily in first grade with lesser prevalence in second, third and fifth.	Learning aides, context sensitive help, OPAC response to action/inaction.
Reading	Able to read words associated with interests.	First grade for titles; all grades for some words in summaries.	Users initiated voice synthesis feature.
Spelling/ Keying	Able to locate keys, spell and review term entry.	All grades; most prevalent breakdown.	Spelling checker, new interface options (e.g., point and shoot).

Note: (Solomon, 1993)

APPENDIX B

TAXONOMY OF TASKS



Taxonomy of tasks (Bilal, 2002).

APPENDIX C

DESIGN INTERFACE COMPONENT SUGGESTIONS

Design interface component suggestions composed from Large, Beheshti, & Rahman. (2002a)

Design Component	Design implications
Name	Fun; attention getting; prominent, related to the task.
Color	Colorful backgrounds; bold, colorful foregrounds; avoid white
Font	Larger font
Graphics	Popular; represented as characters
Animation	Popular; want more
Icons	Should obviously match the concept they represent
Characterization	Characters should appear throughout site; should change with context; immediately recognizable; age appropriate
Vocabulary	Age appropriate
Layout	Clear layout; information easily identified
Advertisements	Not desired for inclusion

APPENDIX D

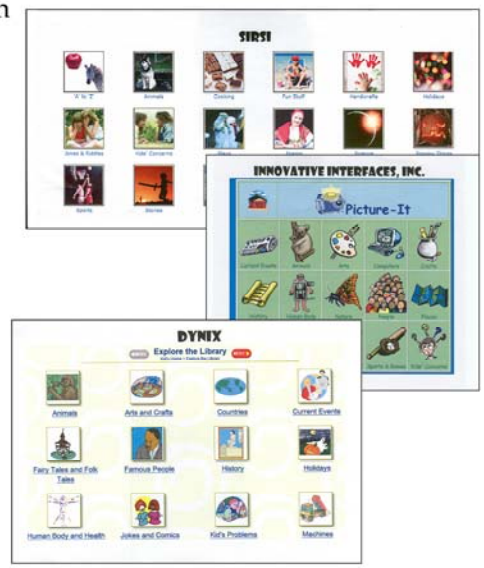
POSTER PRESENTED FROM PILOT STUDY

Online Web Catalogs for Children

Just Another Sexy Product?

Purpose: A Preliminary Study of Representation

Research shows children often search by browsing, which relies heavily on recognition and content knowledge. Catalog systems for children must use effective symbols or pictorial representations which correspond with children's own cognitive schema and level of recognition knowledge. This study hopes to determine if these systems make children more successful searchers or if they are merely a "sexy" product sold to libraries.



Methodology:

- Quasi-experimental
- Quantitative = success/failure, pictorial representation vs. text descriptions, etc.
- Qualitative = affective states, behavior, etc.
- Looking at pictorial representations
- Removing the "known issues" & focusing on the design
- Working with children ages 5-8
- Using semi-assigned search tasks
- Using card representations of the catalog
- Conducting interviews during & after
- Videotaping for analysis

Variables:

<u>Independent variables:</u> gender, domain knowledge, computer experience, and age.
<u>Dependent variables:</u> success in searching, attitude toward searching, search time.

Theories to investigate:

Cognitive Information Retrieval Theory
Dual Coding Theory
Information Processing Theory
External Cognition Theory
Cognitive Development Theory

UNIVERSITY OF NORTH TEXAS

Problems existing when children search in an online environment

- Typing / Keyboarding
- Spelling
- Adequate Vocabulary
- Search Strategy Formulation
- Boolean Operators
- Search Refinement
- Domain Knowledge
- Controlled Vocabulary
- Reading
- Alphabetizing

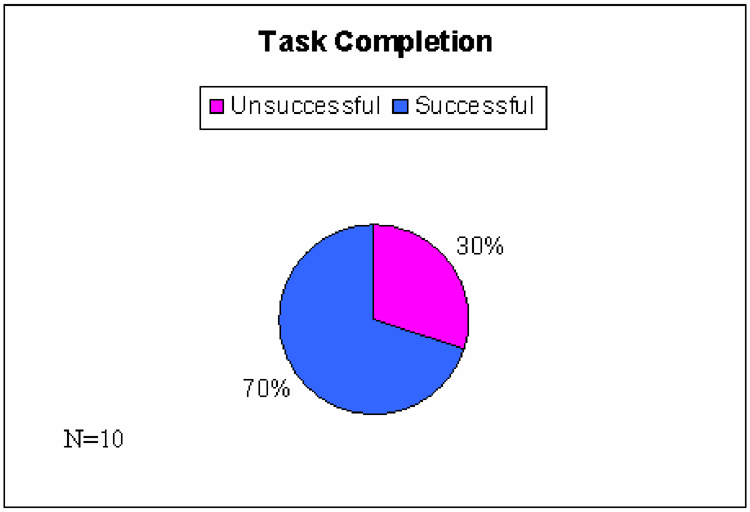
Three studies involving children searching online catalogs

- Approximately 500 first through sixth grade school students (Solomon, 1993; 1994). Researchers observed and interviewed.
- 131 children ages 9 through 12 (Borgman et al., 1995; Walter, Borgman & Hirsh, 1996). Researchers observed and interviewed during four different experiments using the Science Library Catalog (SLC).
- 64 fifth grade students (Hirsh, 1997). Researchers observed and interviewed during two search sessions of the SLC.

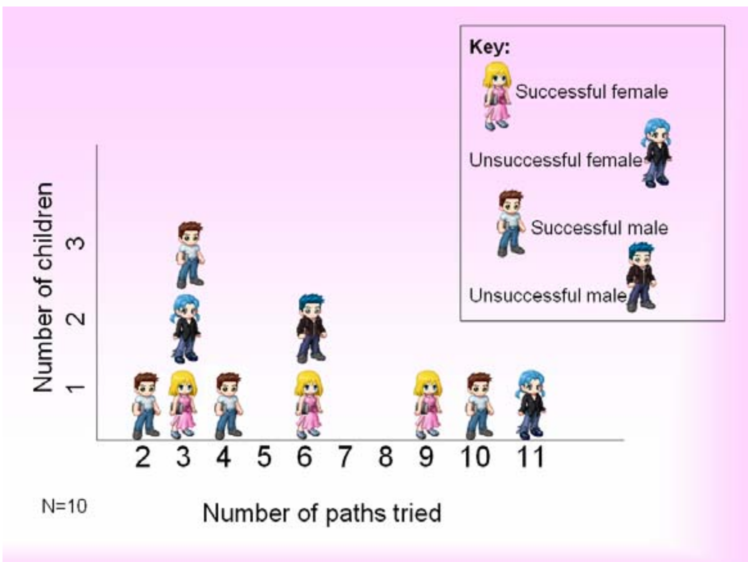
Stacy L. Creel
Stacy.L.Creel@nhmccd.edu

APPENDIX E

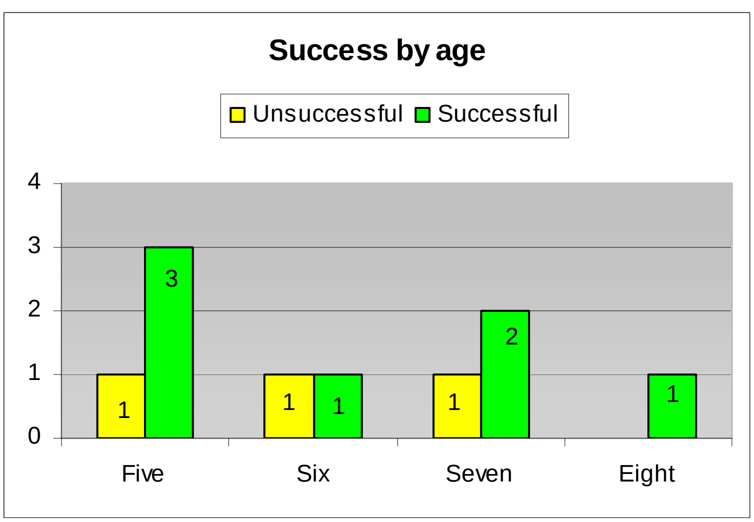
PARTIAL RESULTS OF PILOT STUDY



Task Completion
Unsuccessful
Successful
30%
70%
N=10



Key:
Successful female
Unsuccessful female
Successful male
Unsuccessful male
Number of children
1
2
3
2
3
4
5
6
7
8
9
10
11
N=10
Number of paths tried



Success by age
Unsuccessful
Successful
0
1
2
3
4
1
3
1
1
1
2
1
Five
Six
Seven
Eight

APPENDIX F

III HEIRARCHIAL SUBJECT BROWSING CATALOG FOR CHILDREN

iii's hierarchical subject browsing catalog for children.

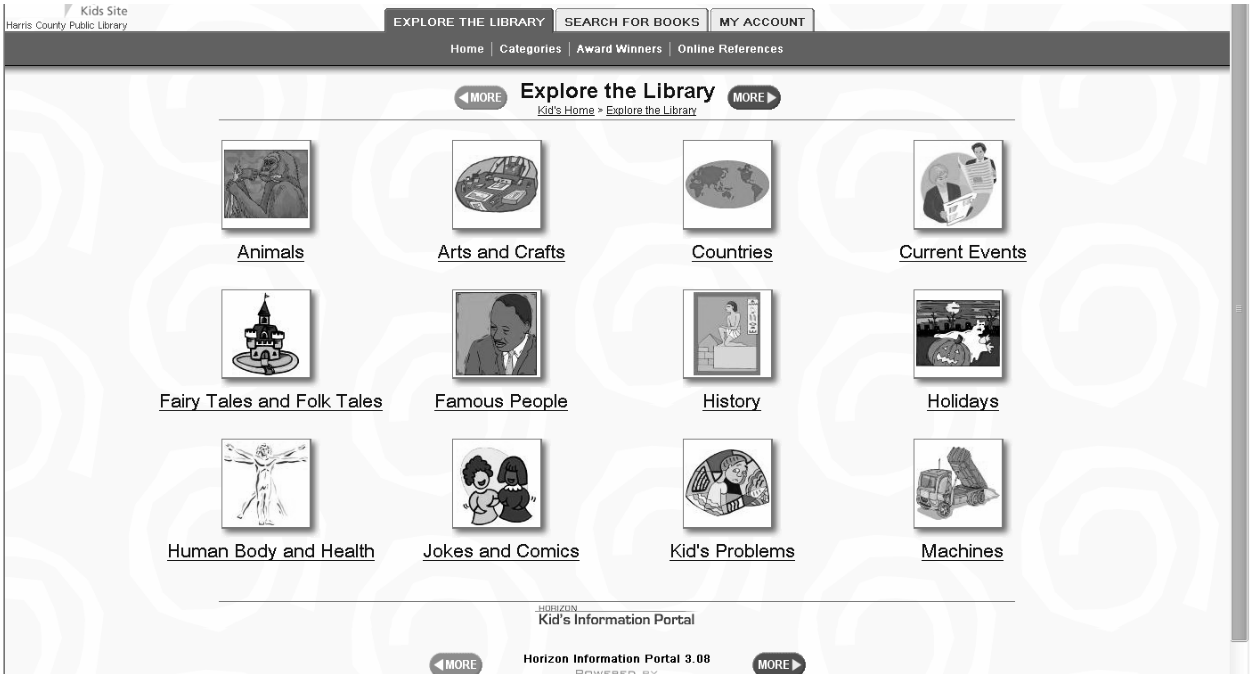
APPENDIX G

SIRSI HEIRARCHIAL SUBJECT BROWSING CATALOG FOR CHILDREN

Sirsi's hierarchical subject browsing catalog for children.

APPENDIX H

DYNIX HEIRARCHIAL SUBJECT BROWSING CATALOG FOR CHILDREN

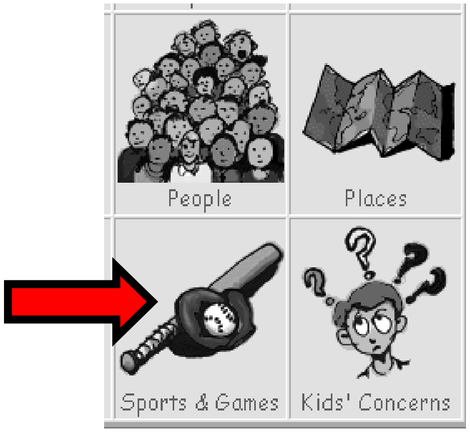


Dynix's hierarchical subject browsing catalog for children, screen 1.

Dynix's hierarchical subject browsing catalog for children, screen 2.

APPENDIX I

EXAMPLE OF PROCESS OF SEARCHING ON CARDS



Looking for baseball, select "Sports & Games."

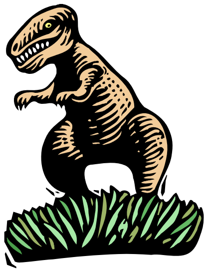
From the next screen, select "Team Sports."

From the next screen, select "Baseball."

APPENDIX J

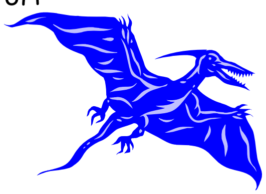
TASKS EXAMPLES

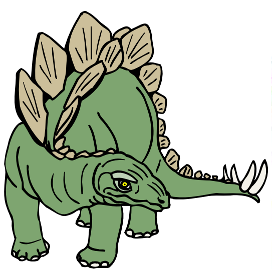
Dinosaurs



5H

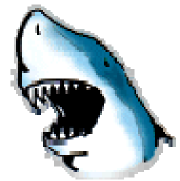
6H

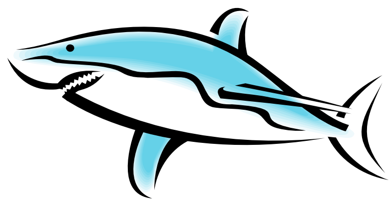


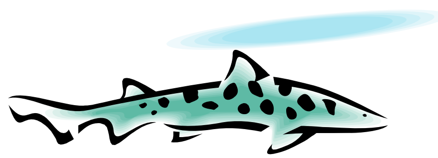


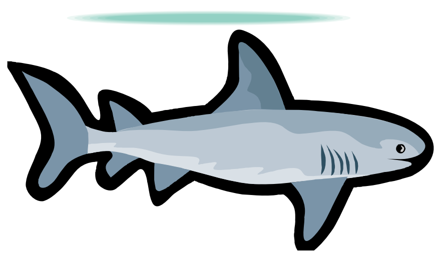
Sharks

4H

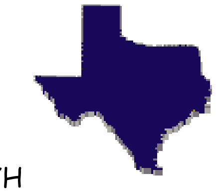






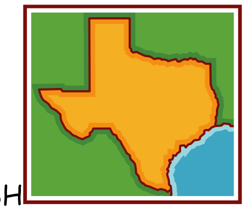


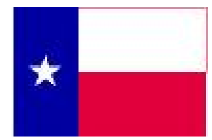
Texas



7H

8H





Images from catalogs and Microsoft Word® 2003 Clipart

APPENDIX K

EXAMPLES OF ADVERTISEMENTS

Newspaper Press Release:

Calling All Readers Ages 5-8

Does your child have basic reading skills?
Do you want to influence how library online catalogs for children look?

Here's your chance to participate in a study conducted by a UNT research team looking at the pictorial representations chosen by libraries and online library catalog companies!

Benefits:

- Provide vendors with insight into creating more child-friendly online library catalogs.
- Provide valuable information to improve how we teach the online library catalogs to children.

For FUN your child will get a certificate of participation and something from the treasure chest!

Confidentiality and anonymity guaranteed!

For more information, please call Stacy at ###.###.#### or ###.###.#### or send an email to (edited out)@hotmail.com with study in the subject line.

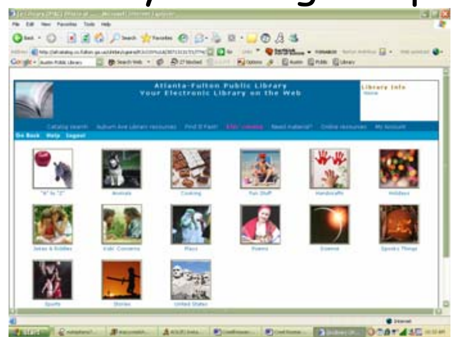
Posters (11X17 color) & Flyers (8 ½ X 11):

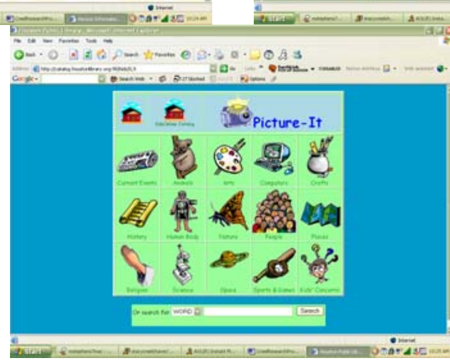
Calling All Readers Ages 5-8

Does your child have basic reading skills?

Do you want to influence how library online catalogs for children look?

Here's your chance to participate in a study conducted by a UNT research team looking at the pictorial representations chosen by libraries and online library catalog companies!





Benefits:

- Provide insight into creating more child-friendly online library catalogs.
- Provide valuable information to improve how we teach the online library catalogs to children.

For FUN your child will get a certificate of participation and something from the treasure chest/prize box!

Confidentiality and anonymity guaranteed!

For more information, please call Stacy at ###.###.### or ###.###.####
or send an email to (edited out)@hotmail.com with study in the subject line.

APPENDIX L

COLLECTION INSTRUMENT

University of North Texas
Institutional Review Board
Data Collection Instrument

These questions will be asked by a facilitator and video recorded.

Pre-process search process questions to be asked of the child:

How often do you use the computer?

[once a day, once a week, once a month, other:_____]

What do you do on the computer?

[play games, type, use the Internet, use the library catalog]

Have you ever used this catalog?

[show them a laptop with the catalog]

During the search process questions to be asked of the child:

Which picture do you want to pick to find information on dinosaurs?

What is it a picture of?

Why did you pick it?

Early termination of the searching process questions:

Why did you stop?

Did you find what you were looking for?

Final ending the search process questions:

Finding the information on dinosaurs was:

Very Easy	Easy	Not Easy or Hard	Hard	Very Hard
☺ ☺ ☺	☺ ☺	😐	☹ ☹	☹ ☹ ☹
1	2	3	4	5

Did you find what you were looking for?

What did you like about the pictures used?

What didn't you like about the pictures?

Did the pictures help you?

What would you change?

Can you tell me about pictures that might be better to help kids?

Did you use the pictures and words, just the words or just the pictures?

Is there anything else you would like to tell me today about what you did here today?

Do you have any questions for me?

APPENDIX M

CERTIFICATE OF APPRECIATION

Certificate of Appreciation

This certificate is awarded to

____

in recognition of valuable participation in the
University of North Texas'
School of Library & Information Sciences
study of online children's catalogs.

________________________ __________

Stacy L. Creel, Assistant Director
NAME of Library

Date

APPENDIX N

RESULTS OF ORDINARY LEAST SQUARES (OLS) REGRESSION

. regress totaltask gender age minority easeofus computer cat1 cat2 totpath time

Source	SS	df	MS		
Model	26.932499	9	2.99249989	Number of obs =	51
Residual	22.7145598	41	.554013655	F(9, 41) =	5.40
Total	49.6470588	50	.992941176	Prob > F =	0.0001
				R-squared =	0.5425
				Adj R-squared =	0.4420
				Root MSE =	.74432

totaltask	Coef.	Std. Err.	t	P>|t|		
gender	-.0704877	.2154482	-0.33	0.745	-.5055942	.3646188
age	.470975	.1085636	4.34	0.000	.2517263	.6902237
minority	-.2272321	.2266063	-1.00	0.322	-.6848729	.2304087
easeofus	.2313035	.1172553	1.97	0.055	-.0054984	.4681053
computer	.1925391	.0900591	2.14	0.039	.010661	.3744172
cat1	-.3962722	.2795682	-1.42	0.164	-.9608717	.1683272
cat2	-.1213803	.2748633	-0.44	0.661	-.6764779	.4337174
totpath	.1469776	.0439469	3.34	0.002	.0582251	.2357301
time	-.0015464	.0006287	-2.46	0.018	-.002816	-.0002768
_cons	-2.070211	.7762173	-2.67	0.011	-3.637814	-.5026089

APPENDIX O

VERY YOUNG CHILD INTERACTING WITH COMPUTER

Customer and her child trying out a sample Early Literacy Station.

GLOSSARY OF TERMS

Term	Definition	Chapter(s)
Browsing	in an online environment, it involves seeking information by "going through an index by clicking on topics" (Kuiper, Volman & Terwel, 2005, p. 289). By definition, it involves seeking information in a way in which there is no set pattern and progression to the pattern; it is random (Drake, 2003). Browsing "in essence is an examination of unknown items of potential interest by scanning or moving through an information space in order to judge the utility of the items, to learn about something of interest in the item, or to satisfy curiosity about something" (Chang, 2005, p. 73). Additionally, browsing acts as a visual process since the browser plans to locate items of potential use by glancing through items and moving on to other items when said item is unable to hold the browser's attention (Chang, 2005).	1, 2, 5, & 6
Categorization	"is a means of simplifying the environment, of reducing the load on memory, and of helping us to store and retrieve information efficiently" (Markman, 1989, p. 11).	2 & 5
Children	are persons ages birth through fourteen as delineated by The Association for Library Service to Children (ALSC) of the American Library Association (American Library Association, 2006b).	1, 2, 3, 4, 5, & 5
Icons	are important communication components of the graphical user interface; they are used to convey or represent something or some idea to the viewer (Goonetilleke, Martins Shih, Kai On, & Fritsch, 2001).	2, 3, 4, 5, & 6

Term	Definition	Chapter(s)
Interface	is a "communication channel between a user and a machine" (Marchionini, 1995, p. 41). The interface is made of several components and one of importance for this study is the representational structure, which is the way the information is organized and the physical components necessary to manipulate the structure (Marchionini, 1995). It is this part of the interface that is heavily influenced by domain specialists who help decide how the content is structured in order to meet the demands of the users (Marchionini, 1995).	1, 2, 3, 4, 5, & 6
Internet	is a "worldwide system of interconnected computer networks, communicating by means of TCP/IP and associated protocols" (McGraw-Hill Dictionary of Scientific and Technical Terms, 2003).	1, 2, 3, 4, & 5
Online catalog	is a current and complete record of a library's holdings that are accessible through a computer terminal (Keenan & Johnston, 2000, p. 182).	1, 2, 3, 4, 5, & 6
Online Public Access Catalog (OPAC)	a catalog system in which "information is stored on a database loaded in a computer which can be used directly by a user via a remote terminal" (Keenan & Johnston, 2000, p. 182).	1, 2, & 5
Representation	"is a surrogate for the thing itself. Representation converts the intangible into the tangible" (Rice et al., 2001, p. 228).	1, 2, 3, 5, & 6
Search browsing	is goal – or purpose – based browsing; also known as directed browsing or browsing with a specific goal is "a closely directed and structured activity where the desired product or goal is known" (Rice, McCreadie, & Chang, 2001, p. 179).	1
task	is "whatever an individual or a computer is set to do" (Keenan & Johnston, 2000, p. 234)	1, 2, 3, 4, 5, & 6
World Wide Web	is "a part of the Internet that contains linked text, image, sound, and video documents" (McGraw-Hill Dictionary of Scientific and Technical Terms, 2003).	1, 2, 4, 5, & 6

ACRONYMS

Acronym	Meaning	Chapter
AACR2	Anglo-American Cataloguing Rules, Second Edition	2
ADL	Artemis Digital Library	2
ALA	American Library Association	2
ALISE	Association of Library and Information Science Educators	3
ALSC	Association for Library Services to Children	2
ANOVA	Analysis of Variance	4 & 5
BPL	Boston Public Library	2
DNK	Do not know	5
ICDL	International Children's Digital Library	2
IR	Information retrieval	2 & 6
IRB	Institutional Review Board	3 & 4
ISP	Information Search Process	2
MARC	MAchine-Readable Cataloging	2
NLP	Natural language processor	2
OCLC	Online Computer Library Center	2
OPAC	Online Public Access Catalog	1, 2, & 5
OLS	Ordinary least squares	5
SBC	Second best choice model	1 & 6
SLC	Science Library Catalog	1, 2, & 5
UNT	University of North Texas	3 & 4

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