

Children's Search Roles at Home: Implications for Designers, Researchers, Educators, and Parents

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Abstract

This paper presents the results of a large-scale, qualitative study conducted in the homes of children aged 7, 9, and 11 investigating Internet searching processes on Google. Seven search roles, representing distinct behavior patterns displayed by children when interacting with the Google search engine are described, including Developing Searchers, Domain-specific Searchers, Power Searchers, Non-motivated Searchers, Distracted Searchers, Rule-bound Searchers, and Visual Searchers. Other trends are described and selected to present a view of the whole child searcher. These roles and trends are used to make recommendations to designers, researchers, educators, and parents about the directions to take when considering how to best aid children to become search literate.

Introduction

Internet access for children continues to increase over time, with 84% of children age 8-18 in the U.S. having home Internet access (Rideout, Foehr, & Roberts, 2010). However, this ubiquity of home use does not preclude difficulties with online searching in young children. Children encounter well-documented barriers completing assigned search tasks (Bilal, 2000) and typing and spelling (Druin, Foss, Hatley, Golub, Guha, Fails, & Hutchinson, 2009). They are also less successful with keyword search than

with browsing (Bilal, 2002), and they have difficulty formulating queries (Bilal, 2002; Large, Beheshti, & Breuleux, 1998). Difficulties with result selection are common (Jochmann-Mannak, Huibers, Lentz, Sander, 2010; Torres, Hiemstra & Serdyukov, 2010), as are problems with reading comprehension (De Belder & Moens, 2010).

Designing a search engine that caters to the skills and needs of each child is not a scalable solution – children often prefer to use the same search tools as adults (Jochmann-Mannak, et al., 2010), the diversity of skills is too broad, and users rarely set up customizations. Children also generally share computers with family members, so methods used by search engines to personalize search, such as web history, will be influenced by other users. Additionally, differentiating between individual children is not easily executed on a computer with multiple users, such as in classrooms. However, if we observe patterns in search behavior that allow us to group children, we might be able to scope the problem to a smaller set of typical behavior patterns that parents, educators, and search engine designers can all consider when helping children learn to search more effectively.

One approach to observing patterns has been to collect problems, such as query formulation or spelling, and then attempt to provide a solution, such as autocomplete or spelling correction, for that type of problem. For example, De Belder and Moens (2010) describe a method to take text intended to be read by adults and simplify it for children. In contrast, we have attempted to arrive at a broader understanding of the whole searcher by observing affect, uncovering searching rules, and noting the people who influence search. This has allowed us to develop profiles of child users, or “search roles”, which aggregate the behaviors, challenges, and strengths of a group of searchers. This view is of the whole searcher, instead of pieces of the search that can go wrong. Previous research by Bilal (2005) has discussed the need to factor affect as a determinant of search behavior. Our study extends Bilal’s work by attempting to include more factors in understanding search, and then operationalizing these factors for positive change. By using our search roles, we are able to make recommendations to designers of

search tools, to researchers who will conduct further studies, to educators who can to better prepare children to be search literate, and to parents wanting to accommodate the needs of their children.

Need for Research

Basic search literacy is a necessary skill for children to be successful in school, as they are asked to complete homework and in-class assignments that hinge on search ability. However, Rideout et al. (2010) report that 57% of Internet searching by children is done at home. The home environment presents a different search picture. Children have freer access to the computer and encounter a wider and more incidental array of search topics, as opposed to constrained topics and access to computers in the school. Better understanding of children's needs while searching at home is thus one area where more research is necessary, as previous studies on searching have been conducted outside the classroom (e.g. Agosto, 2002; Poddar & Ruthven, 2010; Slone, 2003) in laboratory, work, or library settings, but not the home. To help address this need, our research focuses on children searching at home.

Creating search tools for children, whether at home or at school, is a challenge. It is infeasible to deeply assess each child prior to their computer use to pinpoint their skills and needs, and search engine companies are unlikely to create numerous versions to accommodate multiple user types. Additionally, users rarely do much customization of computer software, and children do not report enjoying using tools intended just for children. While some problems such as spelling and typing can be fixed easily with software, less obvious (to a computer) problems like the ability to formulate a query or differentiate good from bad search results remain a challenge and are unlikely to be addressed by interfaces alone. To address these more complex problems, we decided to start with research that takes a more complex view of searchers in the hopes that this more holistic picture could be used not only by search engine designers, but also by parents and educators.

The Search Landscape for Children

The areas explored in the search literature and presented here reflect the major trends observed within our data. The breadth of the areas we examined afforded us a snapshot of the child as a whole searcher, but it also has presented us with a wide array of literature to tie together. We looked at *triggers* as search initiators or motivators and *result selection criteria* from the search results page, as both of these are prominent for children when searching on the Internet. *The visual context* examines how children use pictures and video during searching. *Search stoppers* are typical stumbling points during a search. Other focal points for young searchers are the people who *influence* search, the *affect* or emotions of the searcher, self-imposed or household *rules* governing searching behavior, and how the searcher approaches *complex or multi-step queries*.

Triggers

The concept of triggers or motivators for search has existed in the literature for some time. Bilal (2005) found that children ages 11 to 13 reported four major reasons for using the computer for search: an increase in self-confidence, for the challenge of using the Web, for discovery of information, and for convenience. This work does not extend to in-home search use, and additionally does not consider search motivators for younger children. Kuhlthau (1991) describes triggers as search initiators, arising due to a lack of knowledge or understanding. However, while this characterization of information needs does fit many situations for children, we found during our study that children express a wider range of reasons for initiating search sessions (such as a desire for social interaction while searching). Slone (2003) found in her study of public library users that younger users, age 7-12, were more likely to use computers recreationally, and were less goal- or topic-motivated when searching than older age groups.

Result Selection Criteria

Many researchers have established the difficulty children have when selecting a result from the list presented after entering a query. A comparison of Google to other search interfaces with differences

such as menu structure and density of information (Jochmann-Mannak et al., 2010) found that children 8 to 12 years old encountered difficulty selecting results. In Google, the children had trouble deciding which sources were related to their search task, and in other interfaces they could not discern that results were clickable. Large et al. (1998) found in their study of 11 and 12 year olds that children were able to discern which information source was best when choosing between several CDROMs. However, this study relied on closed databases rather than allowing children to explore the open Internet, and does not reflect the current search landscape. .

Torres et al. (2010) did examine open Internet logs from AOL and found that less relevant results were selected for queries that appeared to be child-generated or related. Torres et al. also found that searchers of child-related queries were not clicking past the first page of results, reflecting the findings of Druin et al. (2009) observing child searchers. While the findings of Torres et al. suggest that result selection is challenging for children, the researchers do not explore why. Hirsh (1999) suggests in her findings that some difficulty with result selection arises due to the developmental preference in children to have results that exactly match their queries.

The Visual Context

Large et al. (1998) found that children using CDROM searching tools did not rely heavily on visual information as a primary source, as they infrequently took advantage of multimedia aspects of their programs, preferring instead to read text. However, our prior research found that there are some searchers who prefer to search entirely within a visual context (Druin, Foss, Hutchinson, Golub, & Hatley, 2010). Slone (2003) found that children age 7-12 were very interested in visual information and would wait for web pages to load graphics, even irrelevant graphics, before continuing with searches. Other recent work has begun to find that images disambiguate confusing results pages for children (Jochmann-Mannak et al., 2010). There is also growing interest in creating visual search interfaces for

children (Gyllstrom & Moens, 2010), although other studies have shown that kids prefer to use the same interfaces as adults (Bilal, 2002; Jochmann-Mannak et al., 2010).

Search Stoppers

Examining reasons for stopping searches can allow us to develop methods to help searchers complete searches successfully. Agosto (2000) explored the concept of search termination in her study with female adolescents aged 14-16. These participants reported stopping their searching for reasons such as finding a website that is acceptable, having physical discomfort related to sitting and searching, boredom, or repetitive information. Although they did not examine search stopping directly, but rather how to predict search engine switching behavior in adults, White and Dumais (2009) found that the top three reasons for switching to another search engine were dissatisfaction, expecting better results, and curiosity. Frustration was the fourth highest reason for switching. Feild, Allen, and Jones (2010) note that even when successful when searching, adult users can become frustrated. Kuhlthau (1993) notes that adult users are less willing to continue to interact with a system if they are experiencing high levels of uncertainty prior to formulating a query. Little research has been done with children about reasons to terminate a search.

Influencers

Spavold (1990) found that when children 9 to 11 are learning how to navigate an unfamiliar database, they rely heavily on peers whom they perceive to have mastery over the system. This was confirmed by the 11 and 12 year olds in Large et al.'s (1998) study, who cooperated by allowing one child to search while others offered suggestions. However, research about other likely influencers (e.g. parents, siblings) is not well documented in the literature. Hirsh found in her 1999 study of fifth graders in an elementary school that her participants did not mention parents as influencers. She also found that children included information in their schoolwork based on their perceptions of what their peers

would find interesting. This study does not extend into home environments, or further examine the role of peer influence.

Affect

Some researchers have also considered the role of affect, or emotional reaction, in the information seeking process. Kuhlthau (1991) notes that the affect of the searcher can change throughout the search process, with the searcher experiencing optimism, frustration, and possibly disappointment at an unsuccessful search. Burdick (1996) includes a discussion of the feelings of high school age searchers at different points during the information seeking process. Her participants verified many of the emotions from Kuhlthau's work.

Poddar and Ruthven (2010) examined how search tasks in research studies impacted emotional response in adult participants. They included one self-generated task and three imposed searches: a simple fact-finding task, a complex search task, and an exploratory learning task requiring the participants to gather information to respond. Participants had little emotional change over the course of the three imposed searches; successfully completing an imposed search task did not lead to more positive emotions. However, on the self-generated search task, the participants displayed high levels of positive emotion and low uncertainty levels both before and after searching. The authors propose that the participants felt a sense of ownership of the searching task, as it was self-generated, and this led to more confidence.

Bilal (2005) considered the role of affect in information seeking, and in children rather than in adults. She proposes that factors such as motivation, engagement, frustration, confusion, persistence, patience, and preferences should be studied in relation to children and search, and may be the inroad to better interface design for children. Bilal terms this method of viewing not only behavior but also thoughts and feelings the "affective paradigm."

Rules

Parents who impose rules on home media use (all media, not just computers) have children who use media less often (Rideout et al., 2010). Examples of these rules are restrictions relating to time or television content, with content being more frequent. In general, children who are heavy media users earn lower grades (Rideout et al., 2010), indicating that limited media use in children by parents is a positive step. However, we are not aware of research documenting the effect of household rules on just computer use.

Complex Searches

It is important to differentiate between complex search and advanced search. There are many definitions for advanced search offered in the literature, but this term generally refers to the use of Boolean or other operators, such as quotation marks or the wildcard (asterisk). In this paper, we refer instead to *complex search*. This is the name we give to a search task that is designed to be complex in nature, requiring the searcher to break the task into smaller pieces that the search engine could process. However, each of these smaller pieces could themselves be a simple search, not requiring advanced query formation techniques. The final search task in our study falls into this category. Our reasons for this approach were that we were initially more interested in the cognitive processes of how children parse difficult tasks and what search paths they choose given a wide array of possible successful moves and less interested in more rote skills that are more easily taught, such as how to use Boolean operators.

A variety of research studies have looked at how adults search for difficult queries and have described characteristics of more successful users. Aula, Khan, and Guan (2010) found that successful adults spent less time on the results page, formulated their longest query at the end of their search, used advanced search operators, and formulated queries as questions. White and Morris (2007) defined

advanced users as those who used advanced operators (e.g., +, -, ", site:), and looked for additional behaviors distinctive to this group. They found that advanced users were more likely to click on results farther down the page, revisit pages less, spend less time viewing irrelevant documents, and deviate from the search path less often. Other researchers have identified patterns in searches conducted by expert researchers and compared their patterns to children and general web users (Fang, Somasundaram, Si, Ko, & Mathur, 2011). Expert searchers in this study use fewer words per query than children or regular web users, and the authors propose that the ability to formulate a query with fewer words indicates a more clearly articulated information need, as well as a less complex query (Fang et al., 2010).

Methods

Our methods were qualitative interviews conducted in the home with parents and children, as well as observations of the children conducting self-generated searches followed by imposed searches on Google. As our study was exploratory in nature, we do not have explicit research questions (Strauss & Corbin, 2008). We designed our protocol to encompass a wide range of topics with both parents and children in the hope that the trends that emerged would direct us towards useful solutions to helping children expand their search knowledge. We have additionally conducted this study in the homes of the participants and on the open web.

Participants

Participants in this study were 83 children from urban areas in Maryland, Virginia, Delaware, and Pennsylvania. 28 children were aged 7, 29 were age 9, and 26 were aged 11. 41 children were female and 42 children were male. Most of these children attended public school, although a small number were homeschooled or attended private school. We recruited participants via parent-teacher associations, personal networks of researchers and of existing participants, and through posting flyers.

We did not collect data on the socio-economic status of the families in this study, and no compensation was provided for participation.

Our parent participants were mainly mothers by themselves (77% of parents), with fewer fathers by themselves (15%) and some interviews were with both parents present (8%). Parents had a wide range of occupations. For mothers, careers in education and research were prominent, while for fathers there were a high number in government positions (probably a factor of the geographical area of the study, near Washington, DC).

Data Collection and Search Tasks

Data collection took place within the homes of the participants, with 2 researchers visiting each family once for about 1-2 hours in total. This time was spent explaining the study, acquiring consent for participation and video and audio recording, setting up equipment, and then conducting both child and parent interviews. Researchers first interviewed parents, asking about computer rules, their child's experience level, searching habits, and areas of frustration. These interviews were audiotaped and researchers took detailed notes. On average, the parent interviews lasted 11 minutes, and ranged between 5 and 23 minutes.

Following parent interviews, the children were interviewed while sitting in front of the home computer they use most frequently, whether this computer was in a public area of the home or in the child's bedroom. Interviews began with general questions such as frequency of computer use and reasons for search, and then progressed into five search tasks. Two search tasks were open ended and self-generated: "Can you show me and explain how you usually search for information on the computer?" and "If you were searching for your own interest, what would you search for? Can you show me?" Two searches were simple, one-step searches: "Can you search for information on dolphins?" and "Can you search for information on what dolphins eat?" The final search task was the multi-step search,

“Which day of the week will the Vice President’s birthday be on next year?” For each of these tasks, researchers asked the child if they had succeeded and why they clicked each link. The tasks began open ended to allow researchers to observe children using the computer in as natural a way as possible, prior to directing children to use Google. We included simple tasks to establish general computer and searching ability for each child. The multi-step task was used in an attempt to discover an upper threshold of ability for children when searching, and was intentionally difficult.

Child interviews on average lasted 25 minutes, ranging from 15 to 43 minutes and were video recorded and documented with researcher notes. The wide range of time was due to researchers allowing children as much or as little time to complete each search as the child preferred; short interviews occurred when children declined to complete searches or had more developed skills, and long interviews occurred with children who were slow typers, persistent in searching, or gave long answers when answering researcher questions. Children chose to use Google almost exclusively on the self-generated searches. Later in the interview, children were directed to use Google so searches could be compared between participants. We asked children if they used search engines other than Google, and tallied mentions or uses of any other search tools. Most common was Yahoo!, reported by 15 children, followed by Ask.com with 8 mentions or uses.

Data Analysis

For this analysis, we used transcripts of the child interviews and the parent interviews, video recordings to observe search behaviors, affect, and tone, and researcher notes to ensure that details such as what the children typed were not overlooked. Researchers who conducted the interviews transcribed approximately 50% of the transcripts, while the rest were transcribed by a local transcription service. In the analysis, we focused on identifying differences between groups of children when viewing their behavior through the lens of roles, in order to make design and educational recommendations.

Our approach has been to identify categories, or trends, from the transcripts and to derive roles, or patterns of behavior, from video observations. Each of these approaches is derived from qualitative research literature: trend analysis from Strauss and Corbin (2008), and role analysis from Beyer and Holtzblatt (1998).

We analyzed the interview transcripts in an inductive, qualitative process outlined by Strauss and Corbin (2008) using the qualitative data analysis software QSR NVivo 9 (NVivo qualitative data analysis software, 2010). Open coding of the transcripts by one researcher led to the identification of categories among participants. No preconceived categories were used during the analysis, but we were interested in expanding our ideas about triggers for search and influencers, or people affecting search behaviors from prior analyses (Druin et al., 2009; 2010). To bring this to light during analysis, we focused on identifying successful searching strategies used rather than on established problems encountered by children such as typing or spelling. Other trends, such as common reasons for search frustration, emerged by comparing responses to specific interview questions for all participants and through meetings of the research team.

All child transcripts were coded three times by one researcher. At the point where it was felt that saturation of coding had been reached, the code book containing the definitions and examples of each trend and 20% of the transcripts were passed to another researcher, who verified the initial coding. The few differences between the coders occurred due to the second researcher identifying a new trend and identifying relevant data missed by the first researcher. All transcripts were again coded using the code book by the first researcher to ensure no data was overlooked.

Following this open coding of the data, we began axial coding (Strauss & Corbin, 2008). During this stage, we further refined our categories to ensure that they were well-defined. We then began selective coding, where we combined and separated categories as needed. These decisions were made

through group meetings with three of the researchers. At the conclusion of this coding process, we felt that no new categories would emerge from the data. From this analysis process, we were able to identify the following major trends: triggers, result selection criteria, visual context, search stoppers, influencers, affect, rules, and complex search.

In addition to identifying trends, we applied the ideas behind Beyer and Holtzblatt's Contextual Inquiry (1998) (*flow, sequence, artifact, and culture*) in order to aid in the identification of behaviors distinguishing roles from one another. This approach reminded us to consistently shift our perspective, and has provided us with a more complete profile of each type of child searcher, as we viewed each searcher in the same manner. *Flow* provides focus on the communication style of the child such as how the child communicated with the interface and with his or her search influencers. *Sequence* reminds us to think about the process of search and what event triggers another, as well as what events act as barriers to search processes. Thinking of *artifact* places emphasis on the layout of the web page and on the tools used by the child. Finally, *culture* allows us to focus on the context of the searching and factors such as the home environment.

Parent Data Analysis

The process for deriving trends from parent data was the same as for child data. Due to data loss, only 75 transcripts were analyzed. We conducted trend analysis as described above following Strauss and Corbin (2008), resulting in trends such as household rules surrounding computers, reports of frustration in children when searching, methods of helping children to search, descriptions of the home setting, and frequency of computer use. These trends were used to verify findings from the children, such as for reports of length of searching sessions, and to add an additional perspective in areas such as child frustration and home environment.

Limitations

It is possible that the presence of one or more researcher influenced the behavior of the children in this study. We interviewed children as they searched, as while we tried to wait until completion of incremental search tasks, it is a possibility that we caused more reflection than normal on the search process. We also asked the children to relate their search decisions verbally to us, and this likewise could have interrupted their searching.

Our study was conducted with what is likely a limited economic group, although we did not specifically collect information relating to income level. All of our participants had home internet access and at least one home computer.

Lastly, we collected general computer experience data on the minutes per week children spend on the computer as well as the number of years they have been using the computer. These data points do not show an easily described relationship with our roles. We are aware that computer experience does not equate with searching experience, but we feel that searching experience is difficult to quantify as an isolate, as search is merely one of a myriad of activities children engage in on the computer. Any type of computer experience likely has an effect on searching ability, but using the data on general computer experience, the strongest relationship we observed was that children in the Non-motivated role were more likely to report never having searched before.

The Development of Search Roles

Our roles are defined by the characteristics of behaviors, triggers, barriers encountered, and by influencers, or people who have influenced searching behavior. In order to identify search roles, we observed the children as they performed the five search tasks in the interview and noted these characteristics. This resulted in the seven roles we present here. An individual child could exhibit the characteristics of more than one role during the course of the interview. For example, a child could use a particular search strategy on a self-generated search task, and then switch strategies during a different

search task, resulting in inclusion in more than one search role. See Table 2 for the distribution of children by age and by gender into the seven roles.

Definition of Roles

Developing Searchers are the most frequently observed type of searcher. They are very willing to search, and are excited by the computer. Their willingness to search is the defining characteristic of the Developing Searcher, and was not observed in all other roles. One 7 year old girl explained her eagerness, “Basically, if we’re lucky we can raise our hand [at school] fast enough we can get on the computer, ‘cause there’s only four computers.” Developing Searchers have some search and computer skills, such as typing and mouse abilities, but often there are notable difficulties with basic skills, as well as with more complex abilities such as keyword query formulation. Other characteristics in this role are varied, partially because Developing Searchers range in age.

Domain-specific Searchers make up the second largest group in our study. These searchers use their searching ability to gather information around a specific topic of interest, for example, images of cartoon characters. They have developed skills and source knowledge around their particular domain, but have not necessarily learned to apply this knowledge in a broader searching context.

Power Searchers use keywords when searching, are able to verbalize their search process when asked, and are reflective, demonstrating an understanding of how the search engine works and the features of the search engine. They often have a high typing and spelling skill level when compared to other searchers, and they display confidence when searching. Power Searchers uniquely have the ability to appropriately approach multi-step queries, breaking the query into parts that the search engine is capable of handling, in comparison to children in other roles who type long queries with many phrases or unrelated parts. They also understand the tools offered by the search engine, as demonstrated by an 11 year old boy, who explains as he searches for apple pie, “And then there’s another link down here.

And on it it'll say the title which has the link, below it there's a little snippet of text that and anything that contains, uh, your keywords are in boldface. And then below that in green is the um, URL and then it looks like how many um, like kilobytes, of information it is, and then cached which means I guess old versions of that site. And some more pages which is some more pages." If a child displayed Power Searcher skills, he or she was not coded as a Developing Searcher; these two roles are mutually exclusive.

Non-motivated searchers are compliant with directions to search, but do not choose searching or computer use as an activity of their own accord. This disinterest is the hallmark of the Non-motivated Searcher. As one 7 year old girl told us when asked to search for her own interest, "I have no interest in Google." These searchers have hours comparable to children in other roles logged on their home computers, indicating that their lack of enthusiasm is not due solely to inexperience. They are aware of the fewest number of features of the search engine, such as the autocomplete or image search. When considering affect, Non-motivated Searchers do not show a sense of excitement towards the affordances of the Internet or Web searching in the way that we observed in many of their peers. If these disinterested behaviors are merely due to factors such as interview tasks or the rapport with the researcher, our inclusion of both imposed and self-generated tasks should have allowed them to display at least some enjoyment or involvement comparable to children in other roles. Additionally, researchers took time at the beginning of each interview to talk with each participant to establish a level of comfort.

Similar to Developing Searchers, Distracted Searchers are willing to search, and are often excited by searching. However, Distracted Searchers begin searching, become distracted by other things, and are not be able to resume their original task, even with prompting. Distracted Searchers encounter information quite easily by using minimal computer skills such as typing ability, mouse control, and how to access the browser. One searcher, a 9 year old Developing and Distracted girl, while searching for

[what dolphins eat], encountered information on Martin Luther King Jr., environmental stewardship, and sea turtles. Although she did not successfully answer the search task, she learned some valuable information of more personal interest. It is important to note that this type of search pattern is considered distracted only when the child is unable to redirect his or her attention to the original task.

Children characterized into the role of Visual Searcher display and verbalize a desire to retrieve information from visual sources such as pictures or videos. This preference for visual information is not incidental; these searchers begin searches with the intention of looking in visual sources, and do not merely opportunistically click on visual search results. However, they frequently inappropriately apply this preference for visual information. For example, one 7 year old boy began watching a news broadcast on cnn.com while searching for the Vice President's birthday rather than reading the text containing the answer on the same page. Visual Searchers are much more likely to refer to images or video verbally than were children in other roles.

Rule-bound Searchers display constrained searching patterns, such as repeating the same steps for every search and frequenting (or not) particular sites. They verbalize and follow rules about searching or computer use frequently. These rules fall into a number of categories, and while children in all roles have rules that they verbalize, Rule-bound Searchers are more constrained and unwilling to deviate from their search pattern. These children are perhaps more heavily influenced by parents, with parents of Rule-bound Searchers reporting that they search while sitting with their child at higher rates than for children in any other role. Rule-bound Searchers are also most certainly heavily influenced by teachers and librarians at school, as all of them report influence by school. Additionally, it is possible that Rule-bound Searchers are confident in their abilities and do not deviate from their search patterns because they believe they possess a high skill level that will allowed them to access information.

Results

The results presented below are based on 80 transcripts of the interviews with children. Although we had 83 participants and retain researcher notes for all interviews, one participant declined to be videotaped, one interview suffered from audio recording malfunction, and one was lost during data transfer. In the sections below, we present the most significant findings for each trend. For a full summary of the data for each trend, please refer to the associated tables in Appendix A.

Triggers

Triggers are motivators or initiators for children to begin information seeking on the Internet. We asked children directly, “What makes you look for information?” Children responded with reasons such as school, personal interest, playing games, because they were referred by a friend, or due to a daily activity or event in their lives (e.g. Halloween).

For 7 and 9 year olds, the most common response to researchers questioning their motivation was a personal interest (39% and 54% respectively). This is similar to findings where the majority of children under 13 in a public library were recreationally using the computers (Slone, 2003). For 11 year olds, school was the most common trigger (63%). School was second-most important to 9 year olds with 43% mentioning it, and of lower importance to 7 year olds, only mentioned by 11%. This attribute, showing school as a trigger rising in importance with age, highlights the need for children to attain good search skills as they grow older; when they are 7 and 9, computer activities seem to be focused more recreationally, but at age 11 searching is more often the result of school assignments. Boys are much more likely to report games as a trigger (32% vs. 3% for girls). By role, children in most roles report personal interest as a major trigger, with the exception of Power Searchers and Rule-bound Searchers, who report school as their top-ranked trigger. See Table 2 for more detail on reported triggers.

Result Selection Criteria

Children cited a number of reasons for selecting one website over another from the results page on Google. The most frequently reported selection criterion for children for all ages was the summary, or snippet, provided by Google. Use of the snippet increases with age, possibly due to increasing reading ability; older children are more able to read the summary, and are therefore more likely to use it as a reason to select a particular result from a list of similar results. This method of source evaluation is not new, as other research found that elementary aged children were likely to select print sources to retrieve based on descriptions of the source (Hirsh, 1999).

Choosing sites due to recognition or familiarity also increased with age; nearly half of 11 year olds reported revisiting sites to satisfy the search tasks in the interview, while this was only the case for a small percentage of 7 year olds. 29% of 11 year olds also discuss a desire to choose websites that are kid friendly. Kid friendly websites, such as those with simple text and many pictures, or aimed specifically at children, were only mentioned by one other child, a 7 year old (4%). Site recognition was indicated verbally by the children with unprompted statements such as “I’ve been on the site before so I know this is one with a lots and lots of information” (11 year old girl) or “I’ve already looked at this site before, there’s nothing new” (9 year old boy) or in response to researcher questions when it appeared the child had familiarity navigating within a particular site.

In most roles, site recognition strongly affects result selection, with 20% of all children reporting this reason for picking websites. For Non-motivated and Distracted Searchers, the summary, or snippet, and site recognition are the only mentioned selection criteria. Power Searchers had higher percentages than other roles when reporting all the reasons for selecting websites; they were surer of their searching decisions and provided clear reasoning behind their choices. Children in other roles more frequently reported that they did not know why they selected a particular website, or did not select a site at all. Refer to Table 3 for more information on the numbers of children reporting each reason for selecting a

website, presented by age, gender, and role. These numbers are a compilation from the entire interview; one child could report multiple reasons for selecting a website.

The Visual Context

Nine year olds were slightly more likely than 7 or 11 year olds to discuss images or video with researchers during the interview. Boys are more likely to use YouTube, with 10 boys reporting use compared to 4 girls. However, when references to static images are considered as well as use of video, there is no gender difference, with 26 children of each gender referring to images.

All Visual Searchers discussed images and video, as well as 80% of Power Searchers and 70% of Distracted Searchers. Visual Searchers also repeatedly mentioned images, with 3.29 mentions per searcher. The next-highest role is Power Searchers, with 2.17 mentions of video or images per searcher, followed by Domain-specific Searchers with 1.94. Of all the roles, Non-motivated Searchers most infrequently referred to images and video. Table 4 contains a count of children who discussed images or video during the interviews, presented by age, gender, and role.

Search Stoppers

Researchers asked the children “What makes you stop searching?” The verbal responses to this question ranged from engaging in an activity off the computer, boredom, finding the answer, gathering enough information, because a parent limits their use, or encountering wrong and unexpected information. Children differentiated between finding the answer and finding enough information about the answer. See Table 5 for the frequencies of these categories by age, gender, and role.

Seven year olds almost never discuss stopping searching due to finding the answer or gathering sufficient information, which is consistent with their low overall search success rate (33% for all tasks, compared to 71% for 9 year olds and 81% for 11 year olds). Nine year olds are more likely to discuss

stopping searching due to finding the answer, in comparison with 11 year olds who report gathering enough information. There are differences when comparing reasons for search stopping by gender as well as by age; girls (23%) report stopping searching due to boredom nearly twice as often as boys (12%). Girls also report stopping due to finding the information more frequently: 28% of girls compared to 17% of boys.

Rule-bound Searchers report boredom more often as a reason for search stopping (tied with gathering enough information). It is possible that since Rule-bound Searchers also report doing the majority of their searching for school related tasks, boredom is a predictable outcome, and that given more opportunities for search for personal interest, these searchers would report more engagement.

Influencers

Drawn from any point during the interview, influencers are people mentioned by the children as having an effect on their searching or computer use. For each mention of an influencer, we identified how that person influenced the child based on the child's comment. See Table 6 for all types of influencers (e.g. parents, siblings) and for frequencies of mentioning each type of person by age, gender, and role.

Younger children are most influenced by their parents as a unit (46% of 7 year olds, 54% of 9 year olds), and as they grow older this evolves into stronger influence by school, as 46% of 11 year olds mention school most often, compared with 29% and 11% for 9 and 7 year olds respectively. Girls reported more influencing overall than boys, with girls reporting 1.9 influencers on average per child and boys reporting .8 influencers per child. Although fathers were infrequently mentioned as influencers (by only seven children) compared to mothers (by 26 children), the children who did mention fathers had varied enough search patterns that they fit the profile for more than one search role. Given this and the high impact of influence from mothers, it is possible that having two parents providing influence can

give a child a broader search profile. However, it is also the case that more mothers than fathers were present during the interviews. The more frequent mentions of mothers as influencers may be related to their presence at the time of the interview rather than actual influence.

Power and Visual Searchers show somewhat lower rates of reporting influence by comparison to children in other roles with just over one mention of an influencer per Power Searcher on average and .5 mentions per Visual Searcher. The highest incidence per searcher is for Rule-bound Searchers, with three mentions of an influencer per searcher.

Processes of influence.

There are several strong age trends when examining the children's reports of how their influencers impact their searching. Older children more frequently report that their influencers answer their questions, encourage them to use the computer, make rules for them about their computer use, or show them new websites. Younger children more frequently describe their influencers searching with them at the computer and learning from watching their influencers search. This indicates that influencers of younger children are much more hands-on and involved with the search, while influencers of older children are more likely to allow the searcher to be independent, while still offering support by answer questions and providing encouragement. These processes are detailed in Table 7, where the methods of helping are presented with tallies of children reporting each.

Affect

Gauging the emotional state of the children during the searches in this study is difficult, as we have largely inferred emotional reactions from verbal and behavioral cues. However, a few factors can be considered as indicators for negative emotional reaction to searching. Indicating uncertainty, stating "I don't know" could lead to stopping the search process, as Kuhlthau found in her 1993 work. We

coded for this statement, as well as phrases such as “I have no idea” and “I’m not sure.” We also examined the children’s responses to the interview question, “Is there anything frustrating about searching on the computer?” Additionally, we have data from parent’s responses to “Does anything frustrate your child when it comes to searching?” Using these three measures, we can further examine how affect may alter search behavior.

Uncertainty. During the interviews, researchers asked children questions such as why they made choices to follow a particular link, why they began or ended a search, or their opinions on results pages within Google, in addition to the search tasks. Children’s responses of “I don’t know” were tallied from all points during the interview where the child stated “I don’t know” or “I’m not really sure” and then did not provide another answer or explanation. The majority of children, 70%, expressed these uncertainties.

Younger children made more uncertainty statements than older children. Seven year olds stated they did not know or were not sure on average 4 times per child, compared with 2 times per 9 year old and 1.5 times per 11 year old. Girls and boys stated they did not know equally; boys had 103 statements similar to “I don’t know” while girls had 102. Although uncertainty statements are occasionally in response to non-critical questions (such as “Why did you click on that?”), the higher counts of uncertainty for younger children and the equal counts by gender indicates that this measure may accurately show uncertainty, as these are the results that would be expected.

Frustration. Frustration was extremely common, with almost every child reporting frustration of some kind when researchers inquired whether there was anything frustrating about searching, although we did not use any other measurements of frustration. When expressing their frustrations to us, children discussed the frustrations as stemming from sources such as not being able to find the information, errors with software, slowness of the internet, having too many results, or not having

enough information. Additionally, developmental limitations such as spelling, typing, and low reading ability caused frustration for 28% of the children. Only 20% of all the children used Google's autocomplete feature (query suggestion), and only 21% used the "Did you mean" spelling suggestion from the results page, indicating that while spelling and typing are problems, the children are not all using the most readily available assistance. Table 8 has frequency reports of frustration from the children by age, gender, and role.

Parents report that 61% of their children verbalize frustration, compared with 20% who become physical when frustrated. For example, one mother of a 9 year old boy said, "He bangs the mouse on the table. Or he presses the buttons really hard!" Poddar and Ruthven (2010) report physical reactions to searching in the form of sighs, and fingernail-biting. According to the parents in this study, sources of frustration are spelling (25%), the speed of the computer (18%), or not finding the information (12%). Refer to Table 9 for a full frequency report of parents reporting their children's frustrations.

Rules

In explaining their actions while searching, some searchers dogmatically verbalize guidelines about how they should search. These guidelines range widely; some of the rules are aids to the children in their searching, and some are explanations by the children for their search behavior. The children do not necessarily adhere to these rules, but do verbalize them. Table 10 shows the number of children following each rule.

Predictably, Rule-bound Searchers stand apart from other roles when discussing search guidelines. As a group, Rule-bound Searchers state that they follow every rule, while children in other roles adhere much less broadly, only following some of the 10 rules we found. These 10 rules are (in order of increasing occurrence) are: rules about spelling, search the [school] databases first, no inappropriate sites, do not use Wikipedia, go through the results in order, use specific keywords, rules

about the URL or other site info, results get worse farther down the page, choose the first result, and use Wikipedia.

For all parents, the most common rule imposed on children is a restriction on the length of time the child is allowed on the computer, reported by 58% of parents. This is in contrast to the finding of the Kaiser Family Foundation study with a wider age range of children, which found that rules about length of time for use of the computer were less common than rules about permissible content and activities (Rideout et al., 2010). We found in this research that there are also frequently household rules about specific websites (reported by 30% of parents), for example not allowing children to use YouTube.

Complex Search

For this research, we were more interested in the early stages of query formulation that involve how to approach and break down a problem than the later stages where knowledge of search engine tools or perhaps using operators is more important. The latter are simple skills that can be taught, whereas the former requires more cognitive skill. We tested many search questions in seeking one that would most completely reveal the highest level of a child's searching abilities. Choosing unrelated topics and linking them within a search task ensures that children will have to deconstruct the task into smaller parts, as they would not be able to accidentally solve the task by quoting the researcher; there will be no web pages broadcasting the answer. We selected the task, "Which day of the week will the current Vice President's birthday be on next year?" with the topics of Vice President, birthday, and calendars. There are three stages to this task: The first stage requires searching for the name of the Vice President, since most of the children did not previously have this knowledge. The second stage is finding the birthdate of the Vice President. Finally, the last stage requires searching for a calendar to find the day of the week. It is possible to accomplish the overall task while using natural language within each stage, but searchers must recognize the need to approach the task overall in smaller parts rather than by

typing the researcher's statement verbatim. This task proved to be extremely difficult for the searchers to complete.

Overall, 10 children refused to try this search task. The majority of children who attempted the task but failed experienced breakdowns due to an inability to break apart the search task. Children were extremely likely to type the question as stated (or close to as stated) by the researcher. This natural language, verbatim approach does not generally provide access to the answer. Another common reason for search failure, in addition to using natural language, was simply the children misunderstanding the question. Children found birthdates for President Obama and Michelle Obama, and would also frequently stop searching after correctly identifying Joe Biden and his date of birth, not realizing they had not completed the search task.

Boys were more likely decline to search altogether (7 boys vs. 3 for girls). When summarizing overall gender trends, it is notable that boys have slightly broader strategies than girls do, as they are more likely to make varied search moves (such as switching from keywords to natural language syntax or varying the composition of the query from early to more advanced stages of search without first finding the solution to the early stage) while working towards an answer. This does not mean boys are more successful, but perhaps indicates that they are less restrained in their computer use. Large, Beheshti, and Rahman (2002) found similar results of broad strategy use, with boys in their study on gender differences clicking more links and typing fewer keywords than girls. The authors propose that by typing fewer keywords, boys could be expressing a preference to have more results to explore, similar to their exploratory behavior on the complex search task.

Of the 10 children declining to search, nine were age 7, and one was age 9. None of the 7 year olds who did attempt the search task knew the name of the Vice President. One 7 year old was able to

find the answer, as were six 9 year olds and thirteen 11 year olds, as measured by arriving at the correct day of the week via any search path.

When examining the approach to the complex task from the perspective of roles, the more successful Power, Rule-bound, and Visual Searchers displayed less varied strategies within their groups, making similar search choices (to use keywords, for example). Developing Searchers displayed many different strategies as a group, as well as in individual children, switching between keyword and natural language queries, and changing the content of their queries from verbatim quotes of the researcher to spontaneous question-queries. Although part of the diversity of strategy in Developing Searchers is due to the large number of searchers falling into the role, it is also evidence that more guiding search tools would not be unwelcome, as many developing searchers are unsuccessful.

Parent Perspectives

Parents describe themselves as helping their children search in three distinct styles. Parents who are *fixers* help their children by taking over the task the child needs help with. For example, the mother of an 11 year old said, "I'm at the computer all day so I will do the search for her. And then direct her from there." 30% of parents are fixers. A second type of parental help is in the form of *demonstrators*. These parents help the child search by sitting with them and demonstrating techniques for searching. 20% of parents are demonstrators. As one parent explained, "When she was having some issues, we tried it together." Finally, 30% of parents describe how they *mentor* their children when searching: "I will go through them with her and explain to her why I think certain ones may be what she is looking for." These parents more often offer guidance to their children.

Regardless of their helping style, parents have a number of processes by which they actually aid their children. Parents report helping their children with spelling and suggest keywords. Parents also suggest links from the results page or websites to visit. Other methods of help were reading the results

to the child, helping to narrow the search by adding search terms, and suggesting new ways to find information, such as using tools in Google.

Implications

Using our findings from the analysis of the parent and child interviews presented above, we have determined recommendations for adult stakeholders in children's search. These stakeholders include the designers of search tools, researchers investigating search, educators in the field of information literacy, and parents of young children. Our hope is that by extending our findings into recommendations for broad groups of adults, we can influence the search landscape from a variety of perspectives, and that this will translate into improved search literacy for children.

For designers of search tools

The willingness of children in the seven search roles to allow others to influence their search behavior indicates that they may also be open to learning how to search more effectively from the interface itself. With that in mind, designers of search tools could help children by attempting to duplicate or scaffold the successful skills demonstrated by the Power Searchers.

One of the major successes for Power Searchers is their ability with typing and spelling. To pass this ability to all searchers, interface designers are on the right track with features such as auto-complete and "Did you mean?" Children are becoming more aware of and adept with these features, as is apparent when comparing the findings of Druin et al. (2009), where children did not use auto-complete, and the findings of Jochmann-Mannak et al. (2010) who found children quite willing to use auto-complete when using Google.

Power Searchers have the ability to complete complex search tasks by breaking them apart into smaller tasks. An interface that encourages users to identify that their question contains multiple steps

and to perform each step separately would be beneficial to searchers. The appearance of long, complicated, natural language queries might be a good time to trigger this tool.

Power Searchers also seem to be aware of sources before searching. An interface designed to support this skill might enable users to choose to see already viewed sites higher on the results page. We also found that Power Searchers follow the rule choose the first result and rules about useful URLs and other site information. An interface that presented fewer results or one result at a time, while visually emphasizing the URL and other indicators of reliability, might better support teaching other searchers to follow these rules as well.

Power Searchers are the only one of the roles we found who fact-checked their information, were much more aware of the vastness of the Internet, and seemed to be encouraged more to try new websites. Designing a method to encourage children to look for alternative sources could increase their trust in information they find on the Internet, as well their success. Many search engines offer “related” or “similar” cross links to search results. Presenting these options more prominently might encourage more fact-checking.

Influencers of younger children were very involved with searching, while older children seemed to have fewer influencers overall, but more influence from their friends. Although the causes for this shift in influence are unclear, perhaps supporting younger children in forming friendships around search interests would aid in the sharing of skills and strategies. Additionally, search tools such as ClassSearch (Moraveji, Morris, M.R., Morris, D., Czerwinski, & Riche, 2011) provide transparency of the search paths of others in the school environment. Adapting tools such as these for home might prove to be beneficial.

Although there are many possibilities for designing tools, children in some roles may respond better to some tools than to others. An interface crowded with tools designed for all searchers is not an

ideal solution. An interface that identified roles would provide a way to selectively present tools specific to the needs of each searcher.

For Researchers

A major distinction of this research study from others is that it was conducted in the homes of the participants, and that we examined search behaviors separately from school assignments. The broad findings in this study indicate that research on informal search settings can yield rich and productive results, and that research in a variety of settings should continue to be conducted.

We have established search roles, and have opened a path for other researchers to test our theory in other studies. We feel that while all of our roles may not exist in all populations, it will be interesting to discover what roles remain consistent despite age and other demographic factors. Other areas for further research include detailed gender studies such as those completed by Burdick (1996) and Large et al. (2002) to confirm the lack of major differences, and studies across geographical regions, and with distinct socio-economic classes.

We found the children during this study were able to bypass stages during multi-stage question we presented to them, despite our best efforts to force them into a staged search pattern. For example, some children already knew who the vice president was, and some children knew that if a birthday was on a Tuesday this year, it would likely be on a Wednesday next year. Researchers should be aware that complex search is difficult to characterize and define. The alternate search paths developed by the children are a rich area for continued research. Studying these paths could help to develop insight into whether children use taught skills, coincidence, or experience as their main guide to successful searching.

Although the design of this study produced a framework of roles for viewing children's search behaviors, it is possible that a structured quantitative analysis would also be useful. Other researchers have used quantitative measures to provide definitive areas of interest and user competence (e.g. Bilal, 2001; Large et al., 2002; White and Morris, 2007). Applying quantitative methods to further refine or explore observed role differences in similar areas as previous research, such as for complex searching strategies, would strengthen the body of literature on children's search, as well as the results found here.

Finally, a consideration of emerging technologies such as cloud-based information storage and retrieval and the proliferation of mobile devices has the potential to dramatically shift the search landscape. It will be of interest to determine whether search skills on desktop computers with full-sized screens and keyboards translate to mobile devices and for cross-platform searching. Additionally, we wonder as families begin to own multiple devices, many with differing search functionality and operating systems, if children's roles will become broader to reflect the number of technologies they use, or if perhaps the distribution of children in each role will fluctuate.

For Information Literacy Educators

Information literacy educators were reported frequently as influencers for the children in this study. We can use this influence to engage children and approach search education in new ways to create more effective and successful searchers, and to reinforce basic search lessons.

Children in less skilled roles are triggered to search more often for information that is for personal interest. When creating assignments, educators could attempt to allow children to self-select topics as much as possible as this may engender more engagement in searching (Poddar & Ruthven, 2010). Teaching children to deconstruct search tasks is likewise important. In our study, large numbers

of children were unable to break apart a long search task. Educators do not need to focus on use of keywords, but rather on separating combined search ideas into separate queries.

Power Searchers are aware of many sources for information, and know which sites to visit on the Internet when they encounter a results page. Educators can aid children in other roles with the difficulty they encounter with result selection criteria by expanding the number of sources of which children are aware. Presenting children with a variety of appropriate pages and discussing why they are desirable would help to build source knowledge.

Other basic search lessons could be established surrounding visual search. Given that some children are Visual Searchers and seek information largely in visual form, there is a need for educators to cater to their alternate learning needs. Additionally, visual search is highly important to all children regardless of role. Educators could ensure that they include discussions of image search and when using image search is not helpful.

Children and parents in this study mentioned frequently that typing is a source of frustration. However, schoolwork often requires that children type information. We anecdotally note that many children were unaware of the cut and paste functions, and recommend that this be taught as a method of frustration reduction for typing. Additionally, educators can pair children when typing, allowing children to take turns and possibly relieve frustration as well. This should additionally facilitate the peer transfer of search knowledge.

The roles displaying more searching skills, those of Power and Rule-bound, tend to adhere to rules more firmly than do other roles. Rules provide children with enough of a guide about how to proceed with searching that they are able to avoid common pitfalls. However, with rigidity, rules can become more of a hindrance. Finding a balance of what messages to teach in the rule format without limiting successful strategies is important. As an example, one child described how, "All these websites,

they're the big sea, the ocean. And you have to get a cup of sea water.” This rule, reminding the child to narrow her search, is a useful guide without causing the child to become stuck.

For Parents

Parents are major influencers to searchers when they are young, but they are eclipsed by school as an influencer as the searchers grow older. Parents should be aware that their period of influence is short-lived, and exists largely before age 9. Although this is a short window, children are extremely aware of what their parents are doing during these years, enabling parents to impart search skills that are long-lasting.

Parents are in a unique position to observe and alleviate frustration in their children and are able to describe what difficulties cause frustration and how their child will respond. Given the parents' ability to foresee the change in affect, and armed with knowledge of what computer searching presents as challenges, perhaps they can prepare children to handle computer difficulties more productively. Teaching children to overcome their frustrations is important, as this remains a barrier even for highly skilled searchers.

Some children shared rules with us about searching, such as prohibitions on collaborative online encyclopedias, but would disregard their own rule to find an answer, or worse, would miss an answer due to their refusal to consider breaking the rule. Coordinating house rules with rules taught at school could provide consistent messages for children learning searching skills. It is important that parents communicate each year with the school to determine what the information literacy educator is planning on sharing with their child.

Future Work

We intend to determine whether these seven roles are static in children or whether they change over time. To accomplish this, we intend to revisit children from this study, re-interview them, and assess the amount of change in search patterns over time. We predict that children are able to shift between roles as they grow in age but that some traits, such as Visual Searchers' preference for information in pictures or Non-motivated Searchers' aversion to computers, may be lasting qualities. If this proves to be true, that only some search traits are alterable, it becomes all the more important for designers, researchers, educators, and parents to provide a more appropriate searching environment for all roles and to better prepare children to interact with that environment.

We have just completed a pilot study with 11 adolescents 16 years old, duplicating the methods used here. We will shortly begin data analysis to explore whether our identified roles remain stable in older children. For example, we have already noticed how much more social the adolescents are than young children, as they discuss using Facebook, completing homework via Skype, or sharing photos on Flickr. It is possible that these social adolescents are searching together or using social applications in unexpected ways.

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References

- Agosto, D.E. (2002). Bounded rationality and satisficing in young people's web-based decision making. *Journal of the American Society for Information Science and Technology*, 53(1), 16-27.
- Aula, A., Khan, R.M., and Guan, Z. (2010). How does search behavior change as search becomes more difficult? In *Proceedings of the 28th International Conference on Human Factors in Computing Systems* (pp. 35-44). New York: ACM Press.
- Beyer, K., and Holtzblatt, H. (1998). *Contextual Design: Defining Customer Centered Systems*. USA: Morgan Kaufmann Publishers.
- Bilal, D. (2000). Children's use of the Yahoooligans! web search engine: I. Cognitive, physical, and affective behaviors on fact-based search tasks. *Journal of the American Society for Information Science*, 51(7), 646-665.
- Bilal, D. (2002). Children's use of the Yahoooligans! web search engine. III. Cognitive and physical behaviors on fully self-generated search tasks. *Journal of the American Society for Information Science and Technology*, 53(13), 1170-1183.
- Bilal, D. (2005). Children's information seeking and the design of digital interfaces in the affective paradigm. *Library Trends*, 54(2), 197-208.
- Burdick, T.A. (1996). Success and diversity in information seeking: Gender and the information search styles model. *School Library Media Quarterly*, 25(1), 19-26.
- Claypool, M., Le, P., Wased, M., and Brown, D. (2001). Implicit interest indicators. In *Proceedings of the 6th International Conference on Intelligent User Interfaces* (pp. 33-40). New York: ACM Press.
- De Belder, J., and Moens, M. (2010). Text simplification for children. In *Proceedings of the SIGIR Workshop on Accessible Search Systems* (pp. 19-26). New York: ACM Press

- Druin, A., Foss, E., Hatley, L., Golub, E., Guha, M.L., Fails, J., and Hutchinson, H. (2009). How children search the Internet with keyword interfaces. In Proceeding of the 9th International Conference on Interaction Design and Children (pp. 89-96). New York: ACM Press.
- Druin, A., Foss, E., Hutchinson, H., Golub, E., and Hatley, L. (2010). Children's roles using keyword search interfaces at home. In Proceedings of the 28th International Conference on Human Factors in Computing Systems (pp. 413-422). New York: ACM Press.
- Fang, Y., Somasundaram, N., Si, L., Ko, J., and Mathur, A.P. (2011). Analysis of an expert search query log. In Proceedings of the 34th International ACM SIGIR Conference on Research and Development in Information (pp. 1189-1190). New York: ACM Press.
- Feild, H., Allan, J., and Jones, R. (2010). Predicting searcher frustration. In Proceeding of the 33rd International ACM SIGIR Conference on Research and Development in Information Retrieval (pp. 34-41). New York: ACM Press.
- Gyllstrom, K. and Moens, M. (2010). A picture is worth a thousand search results: Finding child-oriented multimedia results with collAge. In Proceeding of the 33rd International ACM SIGIR Conference on Research and Development in Information Retrieval (pp. 731-732). New York: ACM Press.
- Hirsh, S.G. (1999). Children's relevance criteria and information seeking on electronic resources. *Journal of the American Society for Information Science*, 50(14), 1265-1283.
- Jochmann-Mannak, H., Huibers, T., Lentz, L., and Sanders, T. (2010). Children searching information on the Internet: Performance on children's interfaces compared to Google. In Proceedings of the SIGIR workshop on accessible search systems (pp. 27-35). New York: ACM Press.
- Kuhlthau, C.C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science*, 42(5), 361-371.

- Kuhlthau, C.C. (1993). A principle of uncertainty for information seeking. *Journal of Documentation*, 49(4), 339-355.
- Large, A., Beheshti, J., and Breuleux, A. (1998). Information seeking in a multimedia environment by primary school students. *Library and Information Science Research*, 20(4), 343-376.
- Large, A., Beheshti, J., and Rahman, T. (2002). Gender differences in collaborative Web searching behavior: An elementary school study. *Information Processing and Management*, 38, 427-443.
- Moraveji, N., Morris, M.R., Morris, D., Czerwinski, M., and Riche, N. (2011). ClassSearch: Facilitating the development of web search skills through social learning. In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems* (pp. 1797-1806). New York: ACM Press.
- NVivo qualitative data analysis software; QSR International Pty Ltd. Version 9, 2010.
- Poddar, A., and Ruthven, I. (2010). The emotional impact of search tasks. In *Proceeding of the 3rd Symposium on Information Interaction in Context* (pp. 35-44). New York: ACM Press.
- Rideout, V.J., Foehr, U.G., and Roberts, D.F. (2010). *Generation M2: Media in the lives of 8-18 year olds. A Kaiser Family Foundation Study*. Menlo Park, CA: Henry J. Kaiser Family Foundation.
<http://www.kff.org/entmedia/upload/8010.pdf>
- Slone, D.J. (2003). Internet search approaches: The influence of age, search goals, and experience. *Library and Information Science Research*, 25, 403-418.
- Spavold, J. (1990). The child as naïve user: A study of database use with young children. *International Journal of Man-Machine Studies*, 32(6), 603-625.
- Strauss, A.L., and Corbin, J. (2008). *Basics of qualitative research: techniques and procedures for developing grounded theory*. Third edition. Thousand Oaks, CA: Sage Publications.

Torres, S.D., Hiemstra, D., and Serdyukov, P. (2010). Query log analysis in the context of information retrieval for children. In Proceeding of the 33rd International ACM SIGIR Conference on Research and Development in Information Retrieval (pp. 847-848). New York: ACM Press.

White, R. and Morris, D. (2007). Investigating the searching and browsing behaviors of advanced search engine users. In Proceeding of the 30th International ACM SIGIR Conference on Research and Development in Information Retrieval (pp. 255-262). New York: ACM Press.