

Children's Roles Using Keyword Search Interfaces at Home

Allison Druin¹, Elizabeth Foss¹, Hilary Hutchinson², Evan Golub¹, Leshell Hatley¹

¹Human-Computer Interaction Lab, University of Maryland, College Park, MD 20742 USA

²Google Inc., 1600 Amphitheatre Parkway, Mountain View, CA 94043 USA

allisond@umiacs.umd.edu, hhutchinson@google.com

ABSTRACT

Children want to find information about their world, but there are barriers to finding what they seek. Young people have varying abilities to formulate multi-step queries and comprehend search results. Challenges in understanding where to type, confusion about what tools are available, and frustration with how to parse the results page all have led to a lack of perceived search success for children 7-11 years old. In this paper, we describe seven *search roles* children display as information seekers using Internet keyword interfaces, based on a home study of 83 children ages 7, 9, and 11. These roles are defined not only by the children's search actions, but also by who influences their searching, their perceived success, and trends in age and gender. These roles suggest a need for new interfaces that expand the notion of keywords, scaffold results, and develop a search culture among children.

Author Keywords

Children, Internet, search, search engine, query formulation, typing, search results

ACM Classification Keywords

H.3.3. Information Search and Retrieval; H.5.2 User Interfaces: Graphical user interfaces (GUI) and User-centered design.

General Terms

Human Factors

INTRODUCTION

A 7-year old child is searching for dolphins. "...I don't know how to spell it....[Types the letters: 'd-o'] There's no dolphin...[Places chin in left hand] I don't know." ...[Then the boy types an 'l' in the text box. After staring at the screen for about 45 seconds] Still no dolphin! [The boy adds an 'F' to the text box, clicks on search and looks through the results page for 10 more seconds....The child places his left hand under his chin and mumbles through it while looking down at the keyboard. He says quietly:] I don't know what to do now..." (Quinn, July 2009; documented through video and researcher notes).

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Figure 1. A 7-year old child searching online

Traditionally, researchers have portrayed information-seeking as systematic, orderly, and procedural, with such well-established models as *The Big Six* [8] and *Kuhlthau's Information Search Process* [11]. But as this child shows, seeking information using a keyword search interface on the Internet can lead to uncertainty and confusion, with a search process that can be repetitive, complex and at times end in frustration [4, 7, 9, 11, 13, 14].

This is a child we have come to call a *Developing Searcher*, (Figure 1). He has challenges with spelling, typing, query formulation and results interpretation. Over the last year, our work with 83 children (41 females/42 males), ages 7, 9, and 11, has shown that these young people demonstrate seven distinctive *search roles*, sometimes with multiple roles present during any given information-seeking experience. To define these roles we examined their behavioral patterns by age and gender with particular interest in what triggered searching and what the barriers were. We also sought to understand who influenced children as searchers and how children perceived themselves in the information seeking process. In the sections that follow, this work will be situated in the research landscape among studies that have also sought to characterize or describe the information seeking process for children. This paper goes on to describe our own methods and results, and offers suggested design directions for future Internet search interfaces for children.

The Need for Research

Children want to find information about their world not just in the classroom. It does not take a homework assignment for children to want to learn why ice freezes, or to be

curious how birds build nests. Yet, most studies that have focused on how children seek information do this research in the context of schools and public libraries [5, 6, 13, 14]. School assignments that ask children to look for information in books, library catalogues/databases, educational CD-ROMS, even digital libraries, have been the norm [10, 13].

There is also a need to understand the home context when a librarian is not available, a teacher is not around to structure queries, and a parent is not always able to rescue what seems to be lost on the computer or what should not be found. What do children do on their own to find the information they seek? A more general understanding of children's information seeking behavior is needed, especially considering the prominence of the Internet and the growing number of children who search the Web at home [5,7].

The majority of frameworks or models concerned with children's information seeking have not been created with technology interface development in mind. These models tend to describe the stages or phases of the process, with an expected outcome that if students are taught this model, they will be successful at finding what they need [14]. Such models as *Information Skills* [16], *The Big Six* [8] and the *Information Search Process* [11] describe children's information searching in a linear, straightforward way.

By contrast, *Burdick's Information Search Styles* [4] offers a matrix of search styles seen in children 9-15 years old that are classified by the searcher's ability to focus and the amount of involvement or motivation. They range from a "Reluctant Lost" where there is little focus or involvement in the information-seeking experience to "Involved Navigator," where there is a high degree of involvement with a clear focus. He suggests from his study of 103 9-15 year olds that it is the focus more than motivation that makes a person successful in their information seeking. However this work does not offer reflections on developmental differences for children by year and it is unclear whether it also applies to younger children.

Other researchers have since begun to explore what happens when there are search failures or barriers to information-seeking. Shenton and Dixon [14] suggested that there are three behaviors that may account for unsuccessful information seeking. They found "redirections", when searchers wandered off to new search paths, "recursions", where children circled back in the process sometimes repeatedly, and "short circuits", when searchers skipped one of the typical information-seeking stages such as Kulthau's [11] "topic selection," which can lead to difficulty later on in "focus formulation."

Shenton went on to expand upon these barriers in his later analysis [13] that suggested there were five categories of failures. The category of "Psychological Barriers", where searchers' are overwhelmed by the number of results or don't think the results they want are present, seems most

relevant to online search. . The "Need/Source Mismatch" Category, in which children looked in the wrong place for information, is also probably relevant.

In addition to considering what leads to failure, researchers have begun to consider that understanding information-seeking should not only consider behaviors, but affect [3, 11]. The need to expand our definitions of what matters to information-seeking is important to consider. Kulthau's model, while somewhat linear, does offer a holistic view of what the searcher may be feeling while in a particular stage. For example, in the "task initiation" stage, children may feel uncertain or even apprehensive about whether they will find what they are looking for. On the other hand, during the "information collection" stage, children may feel confident in their ability to find what they have. These same emotions were suggested by Bilal [3] in her theoretical summary looking at children's information behavior as it relates to new technologies and child development issues. She points out that we often forget that children are very different beings just a few years apart. Few models consider how age can change a framework for information-seeking.

An emerging community of researchers (e.g., [2, 3, 7, 12, 17]) has begun to focus on children's online search experiences, which are very different from searching the finite and pre-determined content found in the CD-ROM applications, online digital libraries, and library databases. They have begun to document the many challenges children have with seeking information online. Young people struggle with complex motor and visual interactions between mouse, keyboard, and screen. Children must also decide what to search for, type it (while spelling it reasonably accurately), and then read and make decisions about the utility of the results delivered. Even children's inclination for browsing rather than planned or guided searches online [12], can lead to limited success in finding what is needed.

In summary, there is much to learn from the literature of this emerging area of children's information-seeking behaviors. However, there is still a critical need for research to support:

- A better understanding of children's experiences at *home*, with informal information-seeking experiences;
- The complexities of children's whole self in searching for information, which include *curiosity*, *failure*, and developmental differences by *age*;
- A better understanding of the now ubiquitous Internet-based keyword search interfaces that can explore a *vast information space*.

Given these research needs, we completed a study to better understand why children search on the Internet the way they do at home, what influences their searches, and what circumstances change their roles as searchers.

STUDY METHODS

Between September 2008 and July 2009, we undertook a qualitative study to better understand how children search for information on the Internet. We realized that both the interfaces that children use to search and the content returned are subject to change on a daily basis, making quantitative analysis a challenge. We did not want to circumvent this challenge by constraining children only to fixed tasks, interfaces, and results, as this would subvert our goal of observing their natural behavior. Consequently, we chose to begin data collection by letting children search freely and then moving into more targeted tasks. We then used a rigorous qualitative approach, described below, to structure our analysis. Our data collection methods were based on a pilot study we conducted in summer 2008 with 12 children ages 7, 9, and 11 [7]. Our data analysis methods were heavily influenced by the Contextual Inquiry methods of Beyer and Holtzblatt [1].

Participants

We worked with 83 children from the Washington DC metro area: 42 boys and 41 girls, 28 age seven, 29 age nine, and 26 age 11. We interviewed a total of 68 families, including 14 sets of siblings. We chose these ages based on previous research suggesting we might see differences between them [7, 10]. The children and at least one of their parents were self-selected to participate in the study through a variety of recruitment avenues: parent-teacher associations, online networking via Facebook, and personal networks through our friends and colleagues. Parents signed a consent form and no compensation was provided.

The sampling was largely convenience-based, necessitated by our desire to travel locally and interview children and their parents in their homes. We focused on getting diversity in age and gender, but not socio-economic status. However, colleagues at Sesame Workshop's Joan Ganz Cooney Center used our protocols with low-income children in an after-school setting. We are currently comparing our results with theirs to better understand whether socio-economic status correlates with searching differences and, if so, how to better support low-income children with their information-seeking needs.

All the participants in our study had computers and an Internet connection in their homes. Parents reported an average of 3 home computers, 39 rated their own skill level as "expert", 37 said they were "comfortable", 6 said they were "beginning to learn." For the children, 31 self-reported their computer skill level as "really good", 38 reported that they were "ok" and 14 reported that they were "still learning." All but 12 of the children used computers regularly both at home and school. We collected data on the amount of time children used computers at home from both parents and children, but use this data only when it agreed since there were discrepancies between the reports. In this study, we did not ask about time spent searching, but given the discrepancies between parent reports and child reports on the broader question about computer use, we

need to develop strategies for collecting more reliable information about computer and search experience in the future.

Data collection methods

We conducted qualitative, in-home interviews with at least one parent and each child. The interviews with the children also included using the computer for both directed and free searching tasks.

For the first 30% of the data collected, two members of our team were present at each interview. This enabled the researchers to learn and refine the data collection methods together, so that they would be consistent while collecting data separately. Each session began with the researcher interviewing the parent, captured with audio recording. Parent interviews were typically short, lasting just over 11 minutes on average, ranging from 5-23 minutes. (See [18] for detailed parent and child interview protocols).

After interviewing the parent, we interviewed the child, taking notes and video recording the child's keyboard and screen actions. Parents were allowed to watch but were asked not to assist their child to avoid biasing the results in any way. The length of the child interviews, including search tasks, ranged from 10 minutes to 45 minutes, and on average lasted 25 minutes.

Tasks

We adapted our interview questions from Google user experience research protocols. We did not mention any search engines or tools by name in the interviews until either the child mentioned them or had searched on their own several times. The final interview questions were refined through a pilot study [7] to support data collection with child participants.

The interview questions for the children began with general questions on how they used the computer, followed by a searching activities. All children used the home computer that they reported using most often.

We began with open-ended questions to see what search tools children used, and how they approached searching for their own pleasure: "Can you show me and explain how you usually look for something on the computer?" From this open-ended exploration, we moved to a more task-oriented set of questions: "How would you look for information on dolphins? Can you show me on the computer? How would you look for information on what dolphins eat? Can you show me on the computer?" Next, we asked a more personal but targeted question: "If you were searching on Google for your own interest, what would you look for? Can you show me?" Finally, we asked a complex, multi-step question with only one right answer: "Which day of the week will the vice president's birthday be on next year?"

We started with an open-ended question and included a free-search question to understand children's motivation for searching. We included targeted questions so that we could

make direct comparisons easily. We ended with a complex, multi-step question to better expose breakdowns for the most sophisticated searchers. These questions obviously don't capture the entire space of online search, nor are they particularly revealing in isolation. Analyzed collectively though, they begin to reveal interesting behavioral differences. For this reason, we chose to analyze the questions collectively rather than individually.

Data

We gathered a total of 31.5 hours of video of the children, 12 hours of audio recordings of the parents, and over 1500 pages of researcher notes.

Data Analysis Methods

We used qualitative methods to understand the process and outcomes of the children's search experiences. Given the amount of data collected, the ideas behind Beyer and Holtzblatt's Contextual Inquiry - *flow*, *sequence*, *artifact*, and *culture* [1] - were extremely helpful in focusing our analysis on key aspects of the search process. Examining *flow* suggests exploring user actions and communications in context. Focusing on *sequence* helps to look at the steps in the process and to question what the triggers and barriers might be. Including ideas about *artifact* reminds us to look not only at the structure of what tools the children are using, but the content they want to find. And attempting to understand *culture* emphasizes that these search experiences take place in a context with certain values, expectations, and rules.

To identify these aspects, we used the data coding research methods described by Strauss [15]. Specific categories for analysis were first developed using "open coding" methods of sorting, comparing, and categorizing data. We then used "axial coding" [15] to further refine specific areas of the data. Using these techniques, we found that one useful way to consolidate the rich qualitative data to reveal the larger trends, strengths, and challenges of the search process was to describe the children as having *search roles*. Using roles added both deeper dimension and understanding of our data than we had found in our preliminary pilot study [7].

Our initial analysis began with a daylong meeting by four of our team, to question, speculate, and explore emerging trends in the data. Through this work, the initial idea of roles emerged. For example, a trend that emerged was that a small group of children demonstrated strong search expertise. This trend was further refined through successive sessions of video analysis, which developed into the role of *Power Searcher*.

After identifying the major trends in the data, the final definitions for seven search roles were developed through open coding of the data: successive watching of the videos, listening to the audio, and analyzing the researcher notes. Categorizing, sorting, and comparing were done by two of the researchers and their results were discussed with a third researcher for consistency and to further refine and develop the role definitions. This iterative refining of the data by

comparing, contrasting and sorting is a typical approach to rigorous qualitative analysis.

Following open-coding analysis, we used axial coding to make explicit what *characteristics* each role could be defined by. Selective analysis was then conducted for certain roles that had multiple *criteria* that needed to be further defined. For example, each of the roles could be defined by the characteristic of *influencers*. What we found was there were various ways people influenced children as searchers. So, we examined the data further just in this area to define what these people did. Ultimately, through continual iterations of analysis these influencers were defined to be *demonstrators*, *mentors*, or *fixers* (defined in subsequent sections). Our sorting, comparing and contrasting of the data was done until "saturated," or no new criteria were needed to define the role characteristics. We kept an audit trail in paper journals to maintain rigor and accountability of the analysis process. From this process, the following characteristics emerged as the framework for defining each distinctive search role:

Age: 7, 9, or 11 year old child

Gender: male or female

Frequency of computer use: the average minutes per week of computer use

Search success: the belief by children that they had a successful search experience, independent of an adult's perceived notion of success. These two notions of success were compared.

Influencers: included parents, teachers, librarians, peers, and older siblings. We focused on parents for this study as they self-reported being *demonstrators*, *mentors*, or *fixers* of the search process.

Behavioral trends: included a wide variety of actions demonstrated during searching tasks which emerged due to a child's computer skill level, motivation to search, focus on the searching task, or barriers in the software.

Search breakdowns: these were behavioral trends that were causes for ending a search prematurely or for making search processes more difficult. Breakdowns included typing, spelling, and reading, as well as less anticipated barriers such as focusing on content like games, sports, or shopping to the exclusion of the searching task.

Search triggers: these were behavioral trends that were incentives for initiating a search experience. Triggers reported by the children were coded into categories such as school, specific interest, or knowledge seeking.

Frequency of role: how often these roles were seen in total and by age and by gender.

Based on these characteristics for each of the defined roles, the children were initially labeled as displaying one or more of seven roles using the observable characteristics: *behavioral trends*, *search breakdowns*, and *search triggers*

as guidelines. The researchers then performed incremental revisions of the role definitions by reviewing the video of 18 participants (three children from each of the six possible gender/age combinations). During these revisions, characteristics such as age, gender, or influencers were added to the definitions.

With all of the characteristics of the seven roles firmly defined, two researchers each independently analyzed 12 new videos of children (two children in each gender/age combination) to determine which children displayed various roles. The results of the analysis were compared and a 96% inter-rater reliability was achieved. The two researchers then divided the remaining recordings to complete the coding of the data. Once we had analyzed all the data, 3 researchers completed a meta-analysis to look for trends and differences or similarities between child participants.

SEARCH ROLES DEFINED

Based on this data analysis, seven search roles were ultimately defined. They are described below in order of how frequent these roles were found in the study, with the most frequent discussed first. A summary these role definitions with example behaviors, triggers, breakdowns, and influencers can be found in Table 1.

Developing Searcher

The role of *Developing Searcher* is the most common role children ages 7, 9, and 11 years old exhibit. The defining behavior for the developing searcher is *willingness*, but not consistently successful, ability to search. *Developing Searchers* tend to search by using natural language syntax as opposed to keywords. Quite frequently they will by-pass a search engine and go directly to a website. Although they may be new to searching, they often display knowledge of some helpful features of search tools such as auto-complete text or spelling corrections. Unsurprisingly, developing searchers are able to complete simple queries but experience challenges during multiple-step queries (e.g., the vice president's birthday question), skipping one of the typical information-seeking stages. In the literature this trend has been called "short circuits" [14]. Barriers to searching include an inability to type, spell, or read, and a lack of understanding of query formulation.

Domain-specific Searcher

Domain-specific Searchers are children who typically limit their searches to finding specific content of personal interest, which can include online games, sports scores, shopping, and videos. These searchers continually return to a small number of specific websites, and therefore, are limited in their knowledge of how to use a search engine to find new content. *Domain-specific Searchers* feel an ownership towards the content they search for and use; for them, searching helps to define their personal identity. This feeling of content ownership can act as a trigger for searching. However, content can also be a barrier to learning how to formulate queries for anything beyond what is familiar. There is often a "Need/Source Mismatch" [13],

where the information children are looking for is not there, because they are looking in the wrong place.

Power Searcher

Power Searchers possess sophisticated searching skills. A defining characteristic of this group is their ability to understand and use keywords while searching. They are also reflective during the searching process, and can explain their searching strategies if asked. *Power Searchers* approach searching using tips or rules that are helpful to searching which they have learned from experience or from others. *Power Searchers* frequently express confidence that information is available on the web, and additionally, they are confident that they will be able to find the information. Children in this role rarely run into difficulties they cannot overcome. Interestingly, neither they nor their parents report that they spend more time on computers than children in other roles. *Power Searchers* tend to look for information due to school assignments or personal learning. It is less for entertainment than with *Domain-specific Searchers*.

Non-motivated Searcher

Unlike *Developing Searchers*, *Non-motivated Searchers* lack the *will* to search. *Non-motivated Searchers* are also not persistent when searching; they may attempt to find an answer briefly, and then give up or offer an alternative solution – e.g. "I'd ask my sister." They usually do not ask for help, admit their difficulty, or try something new. When confronted with multi-step queries, many *Non-motivated Searchers* simply guess the answer, even when sitting in front of a computer. When these children actually perform a search, they tend to click on the first result or simply read content from the results summary and never go to the associated web page.

Distracted Searcher

The role of *Distracted Searcher* is defined by children going off-task easily and wandering off on new search paths. In the literature this has been called "redirection" [14]. *Distracted Searchers* are difficult to get back on task, requiring multiple verbal prompts. Visual movement such as animation, blinking text, or videos within the searching interface or on linked websites is often distracting. In addition, the child's immediate environment can also be a distraction for these searchers. We noted that the activities of siblings, pets, music, and television nearby were often barriers to searching. *Distracted Searchers* are not excited by the search process, but can become motivated to search when searching for topics of personal interest. As these children are easily distracted, breakdowns in their searching occur when they encounter search results with videos, pictures, ads that contain audio, or games. Surprisingly, few children were found to exhibit in this role, despite the news media's frequent reporting of this kind of computer use.

Visual Searcher

Visual Searchers are characterized by their desire to search within a visual context and have search results presented either as images or as videos. *Visual Searchers* do not

simply click on an image or video result; they intentionally narrow their search results down in the visual format. For example, when looking for information on what dolphins eat, *Visual Searchers* will select the “image search” option in a search engine, look for videos of dolphins, and watch until they see dolphins eating. These searchers frequently are able to effectively use search tools such as Google Images, YouTube, and Google Video. Breakdowns in searching can occur for these children when their preference for visual results limits their ability to find the content because it is in text form. Parents of *Visual Searchers* reported that these children spent more time at using computers than any of the other roles. We speculate that the combination of the browsing nature of this strategy, and its use for tasks not appropriate to the search goal, is the reason.

Rule-bound Searcher

The least common, but clearly defined role for children in this study is that of the *Rule-bound Searcher*. As the name implies, these searchers seek information online according to an inflexible set of rules that they have learned through experience or other people, such as teachers or parents. These children are not able to adjust their rules to adapt to different types of searches. Yet, despite their frustration, they display persistence in their searching. *Rule-bound Searchers* are able to verbalize their rules, often without prompting. Example rules followed by these searchers include: “Use Grolier’s before going to Google” (child, age 11). “Always click on or read through the first result” (child, age 7). *Rule-bound Searchers* do not display a great deal of confidence in their ability to find information, but they are confident that the information is on the web, which triggers them to continue searching. Common barriers for *Rule-bound Searchers* include the rules themselves and not knowing when to apply their rules.

ANALYSIS USING SEARCH ROLES

Once the search roles emerged, we analyzed the children’s searching by looking at trends in *age, gender, frequency of role, search success, influencers, and search breakdowns.*

Frequency of Roles by Age and Gender

The most frequent role seen was that of *Developing Searcher*, seen in 58 children (see Table 1). This role was equally split between boys and girls, and was most frequently seen in 7 and 9-year olds. This was also the role most frequently seen in combination with other roles such as *Rule-bound, Domain-specific* and *Distracted*. *Domain-specific Searcher* was exhibited the second most frequently, by 28 children. Gender was not a factor with this role, but age was: most of these children were 7-years old. This suggests that children at this age could be more captivated by their personal interests when searching. The least frequent role was that of *Rule-bound Searcher*; predominantly, these were girls.

Multiple Roles in Children

We found that most children exhibited multiple search roles, and there were clear trends by what roles were seen together. Most children in this study exhibited from 1 to 4 roles with an average of less than 2 roles per child. The 7-year olds exhibited the most roles per child, and the 11-year olds the fewest. This suggests that as these children get older, their search roles become more consistent.

Figure 2 shows the seven roles as nodes, connected by line edges of varying width. The size of the node represents the number of children in this role. The width of the edge represents the number of children who exhibited both of the nodes the edge connects. Only connections where three or more children displayed the same overlap between roles are displayed. The most obvious features of this visualization are the thick edges connecting the role of *Developing Searcher* to *Domain-specific Searcher*, and from *Domain-specific Searcher* to *Non-motivated searcher*. These connections suggest that both domain and type of search are often tied to search success – children are able to complete searches that are about topics they are interested in. They revert to *Developing Searcher* or *Non-motivated Searcher* when presented with more challenging tasks or unfamiliar/uninteresting topics, but display other roles when they have open-ended or easier tasks. *Power Searchers*, who by definition do not overlap with either *Rule-bound* or *Developing Searchers*, show less overlap than other roles. This could be due to their consistent understanding of how to search in diverse contexts, leading them to demonstrate directed, goal-driven searches with little error or variance. Other less strong connections are exhibited by *Rule-bound* and *Visual Searchers*. Both of these roles lend themselves well to a set of behaviors that are unlikely to vary. *Visual Searchers* prefer visual results, and *Rule-bound Searchers* follow an inflexible set of rules that guide their searches.

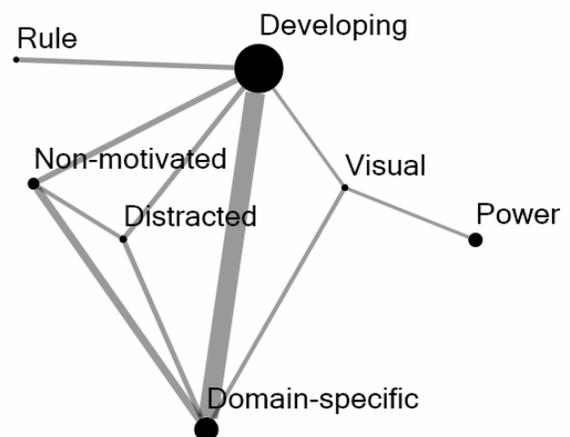


Figure 2. Vertex size = number of children who exhibit that role. Edge width = number of children who exhibit both connecting role nodes.

Role	Age:	Gender:	Behaviors	Triggers	Breakdowns	Influencer Type and Parent Quote
Developing Total: 58			<ul style="list-style-type: none"> Willing to search Limited use of search tools Tend to use natural language 	<ul style="list-style-type: none"> Specific interests, school, or were new searchers "Because I'm interested in the subject." 	<ul style="list-style-type: none"> Queries in natural language Spelling Typing Reading "What do dolphins eat?" 	<ul style="list-style-type: none"> Parents are fixers "I'll go over and type it in myself and see if I can do a better search."
Domain-specific Total: 28			<ul style="list-style-type: none"> Main use of computer is related to content of interest Site returning Excitement about computer use related to domain 	<ul style="list-style-type: none"> Specific interest. "Mostly a lot of stuff- I'm interested in Japanese manga. And singers." 	<ul style="list-style-type: none"> New searchers Query formulation "I know where some good games are, and I think I can find some things in the background maybe " 	<ul style="list-style-type: none"> Parents are generally fixers. "Help with getting to 'new' websites"
Power Total: 16			<ul style="list-style-type: none"> Search using keywords Able to approach complex queries Reflective 	<ul style="list-style-type: none"> School and knowledge seeking. "Research projects...when I want to learn something" 	<ul style="list-style-type: none"> Discriminatory "I'm trying to find a website that I kinda like." 	<ul style="list-style-type: none"> Parents are mentors "Now I really encourage him to find it on his own, I like the independence." "A lot of times she's by herself."
Non-motivated Total: 13			<ul style="list-style-type: none"> Not interested in searching Not persistent when searching Offer alternatives to or avoid searching Compliant if explicitly prompted 	<ul style="list-style-type: none"> New to searching, or school "My teacher, parents, or projects that are more than one day." 	<ul style="list-style-type: none"> Dislike searching Lack of experience "I don't feel like typing" "I don't want to do this, it looks so boring." 	<ul style="list-style-type: none"> Parents are mentors, demonstrators, and fixers. "Sometimes I sit with her and search, sometimes I give her ideas for keywords."
Distractions Total: 8			<ul style="list-style-type: none"> Easily distracted while searching Hard to get back on task 	<ul style="list-style-type: none"> Knowledge seeking, specific interest, school, or prompting. "Interesting question from math class, to play games, or even homework." 	<ul style="list-style-type: none"> Images, movies, games Environment "...the official website and I go to products. Hey, wait a minute, what's this?" 	<ul style="list-style-type: none"> Parents are fixers or mentors "He was looking through results and I was telling him... not that one. They were ads, I could tell that they were, but he couldn't."
Visual Total: 7			<ul style="list-style-type: none"> Often choose visual interface for searching Images are desired as results Seek information in pictures over text 	<ul style="list-style-type: none"> Knowledge seeking, specific interest, surfing "Find new stuff and look up different things on websites." 	<ul style="list-style-type: none"> Interface does not support visual input Inappropriately apply preference for visual searching. 	<ul style="list-style-type: none"> Parents are demonstrators "He's good at having us search for images."
Rule-Based Total: 6			<ul style="list-style-type: none"> Searches are bound by rules Inflexible search patterns Can verbalize rules Persistent searchers 	<ul style="list-style-type: none"> School and specific interest "School projects, or cartoon network." 	<ul style="list-style-type: none"> 2-step queries. "current vice president of the USA's next birthday" "pick a site that looks reliable, and isn't a blog or a wiki, like .net or .gov." 	<ul style="list-style-type: none"> Parents are present for searches. "Usually I like to be around...I just kinda stand there and watch."

Table 1. Overview Summary of Children's Search Roles

Information Seeking Success by Role

Children had varying abilities to understand whether they had found what they were seeking, due to a wide variety of barriers. Not surprisingly, we also found very few children were successful in formulating multi-step queries. We also found that among all of the search roles, children were more successful when they looked for information of personal interest, due to motivation, past experience, or both. This is an interesting contrast to the findings of Burdick [4], who found in his work with 9-15 year olds that focus more than motivation made a person successful in their information seeking.

Power Searchers were the most successful at not only accessing the information they were looking for, but also at determining whether they had found what they were seeking. *Power Searchers* were also able to state that they did not find the information they were looking for when that was the case. *Power Searchers* also displayed a tendency to be critical of the information they found when searching. They frequently discussed whether the information was good, or if it didn't include "enough."

Visual Searchers and *Rule-bound Searchers* were also able to accurately state whether they found what they were looking for, and all were successful when searching for topics of their own interest. However, they were not successful in finding the information they needed on multi-step queries, due to the limitations of their strategies. With *Visual Searchers*, the content they could find was limited due to both tools and content. For *Rule-bound Searchers* their rules limited what they found.

The most challenged searchers were *Distracted*, *Domain-specific*, *Non-motivated*, and *Developing Searchers*. The children that displayed these roles had a difficult time understanding if they had been successful when conducting multi-step queries and had difficulty completing their searches. They sometimes showed an inability to know what information was even available to them, an example of Shenton's "psychological barriers" to search [13]. Like other groups, these searchers were more successful in both actual and perceived success when looking for information of personal interest.

Domain-specific Searchers were the most inaccurate of any of the search roles when it came to perceived success. Their strong self-confidence despite their unsuccessful results might have come out of their truly successful ability to find information of their own interest. When it came to simple queries - for example, searches for dolphins - all of these searchers were able to find web pages containing dolphin information, but often these searchers did not read the page, verify the information, or undergo any critical evaluation of the page at all. For example, one 7-year old boy was quite confident he had found information about dolphins and what they eat from www.MiamiDolphins.com, a website for a professional football team whose mascot is a dolphin.

The Influencers of Search

We found that there are various ways parents influence children as information seekers on the Internet. Keeping in mind Beyer & Holtzblatt's concept of *culture* [1], we have confirmed that the values, expectations, and rules of parents heavily influenced the study's children at all ages. We were able to categorize all but 11 parents in our sample into three types: *fixers*, *demonstrators*, or *mentors*. *Fixers* are adults who take over searching tasks for the child. *Demonstrators* are adults who sit with the child at the computer and show them how to do a task, yet still let the child search independently. *Mentors* are adults who try to support their children with advice but don't sit at the computer with them. The parents that we did not categorize either had children who were new enough to searching that they did not yet have a clear pattern of providing assistance, or had children who they felt did not need help.

The most influenced in their search by adults were *Non-motivated Searchers*. Parents of these searchers were fairly involved as *demonstrators*, *fixers*, and *mentors*. As one parent said, "I clarify goals and find out what's wrong. I also give suggestions to try, and [I] might move to typing for him." For *Domain-specific Searchers*, more parents were *fixers*, possibly due to the children's lack of search experience. *Visual Searchers* tended to be most influenced by parents as *demonstrators*. Searching within image or video corpora is a less well known feature, so we suspect that these children were taught by their parents. The role least influenced by parents were *Power Searchers*. Some parents of *Power Searchers* discussed being *fixers* even though they admitted that they didn't think their child needed help. Several parents suggested that their children didn't need any assistance because they felt that the child was more fluent in search than they were.

Search Breakdowns

For search breakdowns or times when the search process didn't yield results, we found strong behavioral differences by age, and interesting differences by gender. The strong gender finding surprisingly cut across all ages and was one of the few trends to do so. We also found that all roles had some search breakdowns.

The girls at all ages in this study tended to offer their concerns when faced with challenges, while the males would suggest a way to fix the situation. For example, one 9-year old girl said, "Oh, oh, I'm looking for the wrong thing. I'm not good at math, I don't know." An 11-year old girl said, "I can't find it. I don't know what to search for, it's a difficult search." On the other hand, the boys would explain a new path forward. For example, a 9-year old boy suggested, "I could just get off the computer and look at a calendar." Another 7-year old boy suggested, "I know where some good games are, and I think I can find some things in the background maybe." This gender-trend is consistent with Burdick's findings [4] that teenage girls were more doubtful and concerned at the end of a research project as opposed to boys.

In looking at search breakdowns by age, not surprisingly, at 7 years old, the children in this study had challenges with spelling, typing, keyword selection, and query formulation, confirming the literature in this area [7]. For the oldest children who still had challenges, their query formulation, knowledge of the tools, and conceptual understanding of what could be found was lacking. We heard from a number of 11-year olds, “[The information] isn’t there.”

In looking at search breakdowns by role, we found that while *Power Searchers* experienced the fewest barriers, they still had challenges realizing what tools should be used for what purposes. For example, one 11-year old thought the search box auto-complete feature would give him the “answer” to his question, rather than suggest a query.

Rule-bound Searchers experienced search breakdowns from their rules for searching. One 9-year old had a rule to stop looking for the information she sought if it wasn’t on the first results page. Another 9-year old had a rule that all results should lead to websites with simple information and few words. There were some searchers who were *Rule-bound* due to their parents’ filtering system, and information just couldn’t be found. This was the case with three sisters who each tried to look for the Vice President’s birthday and were blocked from the information.

For *Developing Searchers*, their search breakdowns were the most varied, ranging from a lack of knowledge of the tools, to a lack of understanding of what could be found. In addition, these searchers had the expected challenges of spelling, typing, and query formulation. There were a lot of these children who gave up on searching or chose not to start. We heard such things as: “I don’t think I can find it.” “I don’t know what I’d do.” “I don’t know where it is.”

Distracted Searchers had search breakdowns when distracted by what was on the screen or in the physical surroundings. *Domain-specific Searchers* had challenges because of their desire to remain in the content or sites they knew. One child looked for both dolphins and information about the Vice President of the United States in the *SpongeBob SquarePants* website. This was also the case for *Visual Searchers*, who were limited by their need to use only visual search methods or to find visual results. Not surprisingly, *Non-motivated Searchers* were inhibited early in the search process by what they thought was possible.

DESIGNING FUTURE SEARCH INTERFACES

Based on the search roles that emerged from our research, and the trends within these roles, we suggest the following *design directions* for developing new search interfaces.

Recognize motivation and domain interests

Children can exhibit multiple search roles depending on search task and context. Success in any role depends on a variety of factors, but motivation about a particular topic or interest in a particular domain were often both important, sometimes helping and sometimes hindering the process. Educators and search engines might develop teaching tools

targeted at *Non-motivated* and *Domain-specific searchers* that use open-ended topic exploration to allow children to learn on domains of interest, and then focus on the dead-ends that result when this strategy is exhausted.

Learn from Power Searchers

Power Searchers are the most consistent and successful in their searches. Yet, these searchers don’t report spending more time at computers than other children. Understanding through more empirical study why they have fewer barriers and are reflective, critical consumers of information may help with design to support other search roles.

Scaffold known challenges

Environmental distractions, rigid search rules, and lack of confidence, the latter particularly with girls, can all lead to search breakdowns. Designs that anticipate and scaffold these challenges would help *Distracted* and *Rule-bound* searchers in particular. For example, offering new keywords to try or suggesting areas of the results page to click on beyond the first result may be helpful.

Create excitement about searching

Non-motivated, *Distracted* and *Developing Searchers* are in need of interfaces that inspire them to search. Many young people need to be motivated, focused, and shown paths to success. Developing technologies that mirror the roles of *fixers*, *demonstrators*, and *mentors* may be a promising research direction to augment the help of parents.

Provide help at the right time

New interface technologies are needed that go beyond traditional “help,” “agents,” or “tutorials.” Children are in need of support if they don’t know where or why to start a search, or if they get lost or distracted in a search. Clicking off to a separate page of information is unlikely to be helpful – *Non-motivated* and *Rule-bound Searchers* won’t bother and *Distracted Searchers* may never come back. Assistance needs to appear in the moment of searching and a culture of search needs to be supported where children are given tools and inspiration, rather than rules. For example, most search engines already provide alternate keyword suggestions, but they would be more effective if they were displayed more prominently, provided tips for using them more effectively, included interactive spelling assistance, or suggested context for future use.

Support images or content as input

For many of the search roles, alternate forms of search input could be beneficial for both overcoming barriers and motivating and inspiring searches. *Visual Searchers* might want to use an image or video as opposed to a keyword to find visual results, and such an affordance would also benefit *Developing Searchers* who struggle with keyword input. *Domain-Specific Searchers* and *Non-motivated Searchers* might prefer to start or refine their searches using content they’ve found and enjoyed in the past. The ability to copy and paste anything, such as a sound, an image, or an entire web page, into a search input box would be valuable for all kinds of searchers.

Filter results where appropriate

Results pages are not necessarily optimized for children in many of the roles we found. *Distracted* and *Non-motivated Searchers* might benefit from seeing fewer and/or simpler results, while *Domain-specific* and *Power Searchers* might benefit from seeing more and/or advanced results. *Visual Searchers* might benefit from seeing only images and videos. Providing easily discoverable tools to customize the type and style of results could help.

FUTURE RESEARCH

Future studies are needed that focus on quantitative, hypothesis-driven research to develop generalizable theories in the area of search and children. The work reported here has generated some important directions concerning age and gender in barriers to search. In addition, future research could more fully consider the triggers that excite children to instigate and iterate searches.

Beyond this work, we also anticipate useful research comparing the challenges faced by children with the challenges faced by novice adult searchers. For example, what we have learned about influencers of children could extend to experts helping novice searchers as well. As a result, a search engine may be able to broaden its reach to many more users with a modest number of changes.

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