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**Institutions:** University of Maryland, College Park, Google

**Published on:** 10 Apr 2010 - Human Factors in Computing Systems

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# Children's Roles using Keyword Search Interfaces at Home

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## 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 complex 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.

## 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....Slowly the child removes his right hand from the mouse and places it in on his fist in front of him while mumbling through his left hand and 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).



**Figure 1. A 7-year old child who is a just learning to search and type using an Internet keyword search interface**

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 teenagers that it is the focus more than motivation that makes a person successful in their information seeking. However, it is unclear how this can be applied to younger children and what other behavioral aspects might also contribute to their information seeking.

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. However, because his research was looking at all kinds of information seeking, not just online, only a few seem to offer a unique perspective for interface designers. In particular, the category of "Psychological Barriers" which for example represent searchers' feelings of being overwhelmed by what results are there or can mean that searchers didn't think the information was there. Another area that was identified that led to failures was the "Need/Source Mismatch." This occurred when children were in need of a type of information, but they were looking in the wrong place.

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 these models.

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 quickly 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 to fixed tasks, interfaces, and results, as this would subvert our goal of observing children's natural behavior. Consequently, we chose to let children search freely and 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

The participants in our study were 83 children; 42 boys and 41 girls, from the metropolitan [region elided] area. Twenty-eight children were age seven, 29 were age nine, and 26 were age 11. These specific ages were chosen based on previous research [7, 10] indicating that we were likely to see differences in searching behaviors between these age groups. 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, Facebook, personal networks through our friends, colleagues, and neighborhood organizations. The sampling was largely convenience-based, necessitated by our desire to travel locally and interview children and their parents in their homes. However, we were able to get diversity in age, gender, ethnicity, and parent employment. For example, parents reported employment in jobs ranging from software engineer, to real-estate agent, to stay-at-home mom. A consent form was signed by all participating parents and no compensation was provided for participation.

### Data collection methods

Our data collection methods were qualitative, in-home interviews with both parents and children. 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. We did not collect socio-economic data on the families; rather we discussed the family's use of computers and the parents' occupation. (See [18] for detailed parent and child interview protocols).

After the parent interview, the child interview took place. Notes were taken by the researcher and a video camera was used to record the participants' keyboard and screen interaction. Parents were welcome to observe while researchers worked with the child. However, we asked the parent not to step in or help their child as it could potentially impact our findings. The length of the child interviews with search tasks ranged from 10 minutes to 45 minutes, and on average lasted 25 minutes. .

### Tasks

The interview questions were adapted from protocols used by [company elided] user experience researchers. When collecting data, we did not mention any particular search engine or tools to the child participants until either the child mentioned using them or until after the child had demonstrated their search strategies several times. While the initial protocols were designed for use with adult search participants, they were useful in developing background questions for parents and children. The final interview questions were refined through a pilot study [7] to support data collection with child participants.

The interview questions for the children focused on how they typically use the computer, followed by some activities designed to elicit Internet searching. The interviews began by asking open-ended information seeking questions, to see what search tools children regularly made use of, and then moved to more specific search questions to enable us to compare children's search strategies and behaviors.

There were four task-specific questions, starting with a relatively simple query: "How would you search for information on dolphins?" and progressing to a final question that needed a multi-step query to answer: "Which day of the week will the current Vice President's birthday be on next year?" All children worked at the computer that they most often used in the home, which provided a familiar, comfortable setting.

### Data

The final data collected consisted of 31.5 hours of video footage that recorded the children's interview and search experience. In addition, we collected just over 12 hours of audio recordings of parent interviews, and 1,558 pages of observation/interview notes taken by researchers.

### Data Analysis Methods

Qualitative methods were used 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 and Corbin [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.

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* (these terms will be explained 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. An audit trail was kept in journals to maintain accountability and rigor of the analysis process. From this analysis 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 all the data was analyzed, a meta-

analysis was done by three of the researchers to look for the most frequent trends in the data and the largest differences or similarities among 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 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 a 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 completely new to searching or have prior experience, 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 more complex queries, 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.

#### **Content searcher**

*Content 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. *Content 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. *Content 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.

#### **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. *Power Searchers* tend to look for information due to school assignments or personal learning. It is less for entertainment purposes than with *Content Searchers*.

#### **Non-motivated searcher**

*Non-motivated Searchers* display little interest in searching, and have difficulty initiating a search. Many times, the only trigger to start a search is due to another person prompting them to search with specific directions. Often, *Non-motivated Searchers* have strict parental rules guiding their use of the computer; these rules can be a barrier to searching. Other challenges seen by children in this role include being confused by a search interface or having little experience searching. *Non-motivated Searchers* seem to lack an ownership of the content they are seeking online. When asked “Can you search for information on dolphins?”, *Non-motivated Searchers* frequently respond with, “I’d look in a book”. When confronted with multi-step queries, these children simply guess the answer, even when sitting in front of a computer. When *Non-motivated Searchers* 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. Therefore, siblings, pets, music, and television can also be 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 in this study to exhibit in this role, despite the news media’s frequent reporting of this kind of computer use.

Role	Age:	Gender:	Behaviors	Triggers	Breakdowns	Influencer Type and Parent Quote
<b>Developing</b> Total: 58	7 9 11	M F	<ul style="list-style-type: none"> <li>Limited use of search tools</li> <li>Willing to search</li> <li>"I usually just go through [the results], they look the same."</li> </ul>	<ul style="list-style-type: none"> <li>Specific interests, school, or were new searchers</li> <li>"Because I'm interested in the subject."</li> </ul>	<ul style="list-style-type: none"> <li>Queries in natural language</li> <li>Spelling</li> <li>Typing</li> <li>Reading</li> <li>"What do dolphins eat?"</li> </ul>	<ul style="list-style-type: none"> <li>Parents are fixers</li> <li>"I'll go over and type it in myself and see if I can do a better search."</li> </ul>
<b>Content</b> Total: 27			<ul style="list-style-type: none"> <li>Main use of computer is related to content of interest</li> <li>Returns to same sites</li> <li>Often new to searching</li> </ul>	<ul style="list-style-type: none"> <li>Specific interest.</li> <li>"Mostly a lot of stuff- I'm interested in Japanese manga and singers."</li> </ul>	<ul style="list-style-type: none"> <li>New searchers</li> <li>Query formulation</li> <li>"When it says free in the title it usually is free, and there's a whole bunch of games here."</li> </ul>	<ul style="list-style-type: none"> <li>Parents are generally fixers.</li> <li>"Help with getting to 'new' websites"</li> </ul>
<b>Power</b> Total: 16			<ul style="list-style-type: none"> <li>Searches using keywords</li> <li>Able to approach complex queries</li> <li>Reflective</li> <li>"I found stuff and mostly it's about football. We were looking for...dolphins."</li> </ul>	<ul style="list-style-type: none"> <li>School and knowledge seeking:</li> <li>"Research projects...when I want to learn something"</li> </ul>	<ul style="list-style-type: none"> <li>Discriminatory</li> <li>"I'm trying to find a website that I kinda like."</li> </ul>	<ul style="list-style-type: none"> <li>Parents are mentors</li> <li>"Now I really encourage him to find it on his own, I like the independence."</li> <li>"A lot of times she's by herself."</li> </ul>
<b>Non-motivated</b> Total: 13			<ul style="list-style-type: none"> <li>Not interested in searching</li> <li>Limited experience</li> <li>Not persistent when searching</li> </ul>	<ul style="list-style-type: none"> <li>New to searching, or school</li> <li>"My teacher, parents, or projects that are more than one day"</li> </ul>	<ul style="list-style-type: none"> <li>Dislike searching</li> <li>Lack of experience</li> <li>"I don't feel like typing"</li> <li>"I don't want to do this, it looks so boring."</li> </ul>	<ul style="list-style-type: none"> <li>Parents are mentors, demonstrators, and fixers.</li> <li>"Sometimes I sit with her and search, sometimes I give her ideas for keywords."</li> </ul>
<b>Distracted</b> Total: 11			<ul style="list-style-type: none"> <li>Easily distracted while searching</li> <li>Hard to get back on task</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge seeking, specific interest, school, or prompting.</li> <li>"Interesting question from math class, to play games, or even homework"</li> </ul>	<ul style="list-style-type: none"> <li>Images, movies, games</li> <li>Environment</li> <li>"...the official website and I go to products. Hey, wait a minute, what's this?"</li> </ul>	<ul style="list-style-type: none"> <li>Parents are fixers or mentors</li> <li>"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."</li> </ul>
<b>Visual</b> Total: 8			<ul style="list-style-type: none"> <li>Often choose visual interface for searching</li> <li>Images are desired</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge seeking, specific interest, surfing</li> <li>"Find new stuff and look up different things on websites."</li> </ul>	<ul style="list-style-type: none"> <li>Interface does not support visual searching</li> <li>Inappropriately apply preference for visual searching.</li> </ul>	<ul style="list-style-type: none"> <li>Parents are demonstrators</li> <li>"He's good at having us search for images."</li> </ul>
<b>Rule-bound</b> Total: 7			<ul style="list-style-type: none"> <li>Searches are derailed by rules.</li> <li>"Always click on or read through the first result."</li> </ul>	<ul style="list-style-type: none"> <li>School and specific interest</li> <li>"School projects, or cartoon network."</li> </ul>	<ul style="list-style-type: none"> <li>2-step queries.</li> <li>"current vice president of the USA's next birthday"</li> </ul>	<ul style="list-style-type: none"> <li>Parents are present for searches.</li> <li>"Usually I like to be around...I just kinda stand there and watch."</li> </ul>

Table 2. Overview Summary of Children's Search Roles

## 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 have prior searching experience, and frequently are able to effectively use search tools. 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.

## 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, limiting set of rules that they have learned through experience or other people. These children are not able to adjust their rules to adapt to different types of searches. Yet, despite their frustration in searching, these children 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). “I mostly stay on the first page because if I keep going, it just goes on and on” (child, age 9). “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 available 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 from the data, we went on to further analyze the children’s searching by looking at the following: trends in age and gender, frequency of multiple roles, information-seeking success, influencers of search experiences, and search breakdowns.

## Frequency of Roles by Age and Gender

Most children in this study exhibited from one to four roles with an average of less than two roles per child. On average, the 7-year olds exhibited the most number of roles per child, and the 11-year olds the fewest. This suggests that as these children get older their search roles become less diverse and more consistent.

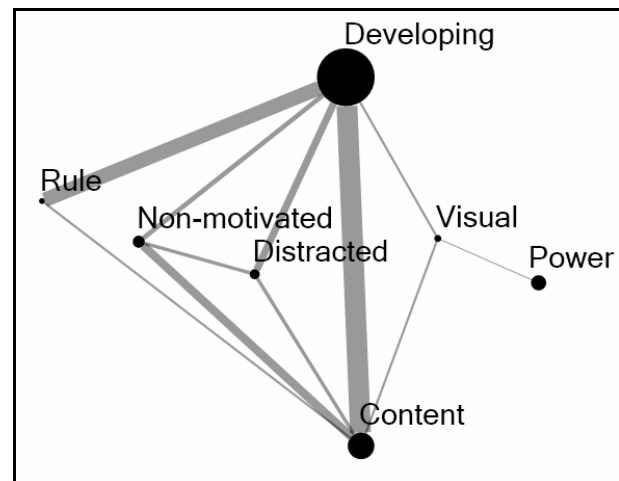
By far, the most frequent role seen was that of *Developing Searcher*. This role was seen in 58 children (see Table 1). This role was equally split between boys and girls, and was most frequently seen in 9 and 7-year olds. This was also the role most frequently seen in combination with other roles such as *Rule-Bound*, *Content* and *Distracted*. *Content*

*Searcher* was seen the second most frequently, with 25 children exhibiting this role. Gender was not a factor with this role, but most of these children were 7-years old. This suggests that children at this age could be much more captivated by their personal interests. The least most frequent role was that of *Rule-Bound Searcher*. No 11-year olds exhibited this role, but predominantly 9-year old boys portrayed this role.

## Multiple Roles in Children

We found that most children exhibited multiple search roles, and there were clear trends that could be identified by what roles could be seen together.

Figure 2 shows the seven roles as nodes, connected by line edges of varying width. In this visualization, 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 feature of this visualization is the thick edges connecting the role of *Developing Searcher* to *Rule-bound Searcher* and to *Content 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 amenable to rules they have learned or about topics they are interested in, but they revert to the *Developing Searcher* role when presented with more challenging tasks or unfamiliar/uninteresting domains.



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

*Power Searchers*, who by definition do not overlap with either *Rule-bound* or *Developing Searchers*, also show less overlap than other roles. This could be due to their consistent understanding of how to search in diverse contexts, leading then to demonstrate directed, goal-driven searches with little error or variance. Other searchers demonstrating smaller frequency of overlap are *Non-*



*motivated Searchers* 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 *Non-motivated Searchers* would rather not search at all, which limits their demonstrated search behaviors. *Non-motivated searchers* overlap frequently with *Developing Searchers*. This could potentially be due to a lack of motivation that leads to a lack of searching skills.

### **Information Seeking Success by Role**

We found that the 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 complex queries. Yet, we found that among all of the search roles, children were more successful when they looked for information of personal interest which motivated them. This is an interesting contrast to the findings of Burdick [4], who found in his work with high school students that focus more than motivation made a person in that age group 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. Not surprisingly though, they were the role most frequently able to find the information they wanted. *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 their own interest. However, they were not successful in finding the information they needed on complex queries, due to the limitations of their strategies. With *Visual Searchers*, the content they could find was limited due to visual search tools and lack of visual content. For *Rule-bound Searchers* their rules limited what they found.

The most challenged searchers were *Distracted*, *Content*, *Non-motivated* and *Developing Searchers*. The children that displayed these roles had a difficult time understanding if they had been successful when conducting complex queries and had difficulty successfully completing the query. *Content Searchers* were the most inaccurate of any of the search roles when it came to perceived self-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. This inability to digest the

content information may point to why complex queries were more challenging for these searchers. In our discussions with them, their lack of motivation stemmed from their lack of experience with the tools, but also their inability to know what information was even available to them by searching, confirming what Shenton refers to as "psychological barriers" to search [13]. It should be noted that when all of these searchers were looking for information for personal interest, they were more successful in their searches and self-perception.

### **The Influencers of Search**

We have found that there are various ways people 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 parents 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 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 *Content Searchers*, more parents were *fixers*, possibly due to the children's lack of search experience. For *Visual Searchers*, they tended to be most influenced by *demonstrators*. This made sense given the visual nature of these children.

The role least influenced by parents were *Power Searchers*. Some parents discussed being *fixers* even though they admitted that they didn't think their child needed help. In fact, a number of the 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, 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, 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 who tended to be more confident.

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.”

With *Distracted Searchers*, their search breakdowns stemmed from being distracted by what was on the screen or in the physical surroundings. With *Content Searchers*, their challenges were due to the limits they placed on their abilities because of their need 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* 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:

*Design for multiple search roles.* Our research suggests that children exhibit different search roles in different situations. It is critical that search interfaces be developed that support a variety of search roles, recognizing that a single child may exhibit multiple roles depending on the search task.

*Learn from Power Searchers.* *Power Searchers* are the most consistent in their roles and successful in their searches. Understanding why they have fewer barriers and are reflective, critical consumers of information may help with design to support other search roles.

*Challenge known barriers.* Motivation deficits, on-going distraction, and limiting rules can all lead to search breakdowns. A troubling trend is that girls frequently focus on search problems rather than solutions. Designs that anticipate and scaffold these challenges may be helpful.

*Create excitement about searching.* *Non-motivated, Distracted* and *Developing Searchers* are in need of interfaces that inspire them to search. Many may be unfamiliar with the tools available, but more importantly; many may not understand the possible content that awaits them if they do attempt to search.

*Consider technologies as influencers.* New technologies are needed that can be *fixers, demonstrators, and mentors* for children. Many young people need to be motivated, focused, and shown paths to success. Adults will continue to play this role, but technology may help as well.

In addition to these broad directions, the following specific *design features* are suggested for developers considering future new search interfaces for children:

### Motivation Prompts

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 – unmotivated and rules-bound searchers won’t bother and distracted children 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.

### Image or Content as Input

For many of the search roles we found, 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 to find visual results, and such an affordance would also benefit *Developing Searchers* who struggle with keyword input. *Content Searchers* and *Non-motivated Searchers* might prefer to start or refine their searches using content they’ve found and enjoyed in the past.

## Results Filtering

Results pages are not necessarily optimized for children in many of the roles we found. *Distra*cted and *Non-motivated Searchers* might benefit from seeing fewer and/or simpler results, while *Content 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.

Our colleagues at Sesame Workshop's Joan Ganz Cooney Center have begun a similar study using our protocols with low-income children in an after-school setting. We have just now begun comparing our results to theirs in hopes of better understanding how to better support low-income children with their information-seeking needs.

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.

## ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support of Google. We could not have accomplished this work without the parents and children who participated. We also thank Megan Monroe, Alex Quinn, Catherine Plaisant and Ben Bederson for feedback and revisions.

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