

Adolescent Search Roles

Elizabeth Foss, Allison Druin, Jason Yip, Whitney Ford, and Evan Golub

Human-Computer Interaction Lab, University of Maryland, 2117 Hornbake Building, South Wing, College Park, MD 20742. E-mail: efoss@umd.edu; allisond@umiacs.umd.edu

Hilary Hutchinson

Google Inc., 1600 Amphitheatre Parkway, Mountain View, CA 94043. E-mail: hhutchinson@google.com

In this article, we present an in-home observation and in-context research study investigating how 38 adolescents aged 14–17 search on the Internet. We present the search trends adolescents display and develop a framework of search roles that these trends help define. We compare these trends and roles to similar trends and roles found in prior work with children ages 7, 9, and 11. We use these comparisons to make recommendations to adult stakeholders such as researchers, designers, and information literacy educators about the best ways to design search tools for children and adolescents, as well as how to use the framework of searching roles to find better methods of educating youth searchers. Major findings include the seven roles of adolescent searchers, and evidence that adolescents are social in their computer use, have a greater knowledge of sources than younger children, and that adolescents are less frustrated by searching tasks than younger children.

Introduction

In this article, we present the results of an in-home research study involving 38 adolescents ages 14 to 17 (17 male, 21 female) and their parents. The goal of this study was to better understand how adolescents search on the Internet in their homes to provide key adult stakeholders with ideas for improving adolescent search skills. We examine adolescents in the context of search roles, which we define as patterns of behavior common to groups, building on a framework created for younger children in previous work (Druin, Foss, Hutchinson, Golub, & Hatley, 2010; Foss et al., 2012). We found that each searcher falls into one of seven search roles. This study describes the features and behaviors associated with each role for these older children, as well as trends in adolescent search, including triggers to

search, searching rules, emotional factors, social factors, and how adolescents choose to handle multistep search tasks. Based on these findings, we present recommendations for designers, researchers, educators, and parents.

Need for Research

Recent studies have shown that 95% of American teens ages 12 to 17 now have access to the Internet (Lenhart et al., 2011), and that 84% of children and adolescents ages 8–18 have access to the Internet at home (Rideout, Foehr, & Roberts, 2010). Rideout et al. (2010) report that youth are more likely to go online at home (57%) than at school (20%) or other places such as the library or friends' homes (14%). Adolescents searching in the school environment are often using the computer with tasks imposed on them by others (Gross, 2006) or other limitations such as those of time (Agosto, 2002). These factors may prevent adolescents from reaching their full potential as searchers. Conversely, at home, adolescents are freer to explore on the computer, devoting more time to pursuits that would not be available to them in the classroom. Given the prevalence of Internet searches in the home environment, we argue it is important that researchers conduct studies in the homes of adolescents and observe them searching on their own computers. To date, these types of studies have not been given much attention in the literature, and this study attempts to fill in this gap.

An additional motivation for this study is to expand and refine the framework of roles established in Foss et al. (2012) from younger children to adolescents. The framework of roles in younger children (ages 7, 9, and 11) is defined by seven search roles: Power, Developing, Domain-Specific, Distracted, Rule-bound, Visual and Nonmotivated. These roles (described in more detail below) are identified by examining the whole searcher; behaviors and affect while using the computer as well trends such as triggers and influencers to search, visual searching patterns, search rules

Received: April 23, 2012; revised July 20, 2012; accepted August 15, 2012

© 2012 ASIS&T • Published online 5 December 2012 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/asi.22809

followed, and barriers to successful searching (Foss et al., 2012). Using this framework, we were able to make recommendations for adult stakeholders to design better search tools and educate children about search in new ways. In this research, we seek to do the same, but for adolescent searchers.

Related Work

The areas we explored in the adolescent (ages 11 to 18) searching literature include a broad array of factors or trends that influence search, and we attempted to address all of these in our research to examine the whole searcher. We examine the *triggers*, or search motivators to searching specific to adolescents, as these factors drive the initiation of the entire search process (Agosto & Hughes-Hassell, 2005; Bilal, 2005; Slone, 2003). *Result selection criteria*, or reasons for selecting specific results, can give insight into what types of websites adolescents find useful (Hirsh, 1999; Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). The *visual context* provides a more complete understanding of the role of video sites and image searching in adolescent search (Jochmann-Mannak et al., 2010; Slone, 2003). The people involved in adolescent search and how they *influence* the adolescent shows how *social* adolescents have become in their information seeking (Dresang, 2005; Kuhlthau, 1991; Morris, Teevan, & Panovich, 2010; Wecker, Kollar, Fischer, & Precht, 2010). By examining the *affect* of the searcher we gain a more complete picture of the searcher as a whole person, instead of focusing on a collection of successes or failures (Bilal, 2005; Burdick, 1996; Kuhlthau, 1991). Looking for *rules* that adolescents follow gives us insight into helpful searching patterns (Agosto, 2002; Foss et al., 2012; Rideout et al., 2010). Finally, how adolescents approach *complex search* tasks, or those that require breaking apart a long search task into smaller pieces, can unearth their highest level of capability as searchers (Foss et al., 2012).

Triggers

Different researchers have characterized a variety of triggers to searching. In a study of Internet users in a public library, Slone (2003) found that teens ages 13 to 17 were triggered to use the Internet for two major reasons: school and recreational purposes. Bilal (2005) discusses motivators for middle-school children to use the Internet. In her study, the most commonly reported reasons for using the Internet were for self-confidence, for discovery of information, for the challenge the web presents, and for its convenience. In a study of the everyday-life information needs of urban teenagers ages 14 to 17, Agosto and Hughes-Hassell found that school was a major trigger to seeking information (Agosto & Hughes-Hassell, 2005). Other triggers identified by Agosto and Hughes-Hassell were social life, daily life routine, pop culture, and current events, among others. Interestingly, the youth in Agosto and Hughes-Hassell's study

were more likely to consult other people as information sources than sources such as search engines. Overall, the above studies show that adolescents have a wide variety of triggers to searching.

Result Selection Criteria

In a study of the information-seeking behaviors in elementary-aged children, Hirsh (1999) found that students had a number of criteria for selecting a result from a list of results. In her study, the most frequent reasons for choosing a result were if the result was perceived as relevant, if the result gave previously unknown information about the topic, and if the result was interesting. However, this study was conducted with children in fifth grade (ages 10 to 11). When examining how children ages 8 to 12 performed when conducting searches on multiple search interfaces, Jochmann-Mannak et al. (2010) found that selecting a relevant result from the results page was the most important problem faced. Adults have similar challenges determining the relevance of search results caused by the large amount of information available on the web (Oliveira, Aula, & Russell, 2009). We expect that result selection is an important challenge for older youth as it is for children and adults.

Visual Context

Images and video have become increasingly prevalent information sources returned by search engines. In Slone's 2003 study of users of a public library, adolescents ages 13 to 17 wanted relevant pictures, as opposed to younger users, who were more likely to seek any images as a form of information. This indicates that as searchers age into adolescence, they become more adept at selecting visual results that are relevant to their information need. However, Slone's study did not assess image selection and use in the home environment. In their comparison of different types of search interfaces, Jochmann-Mannak et al. (2010) found that children ages 8 to 12 made use of clickable images presented as results. This information suggests that younger participants may benefit from more visual results pages. However, there may be differing preferences concerning visual results for older adolescents.

Influencers and the Social Landscape

There are a number of people who influence the searching behavior of adolescents, including teachers, peers, and parents. Wecker, Kollar, Fischer, and Precht (2010) created a series of scripts to the left side of Google's search screen to prompt 14-year-old learners in the steps relating to finding information via Google. Prompts included instructions on how to collaborate with a partner while searching, which result to select from Google's results screen, or how to generate queries. Researchers found that having prompts available to structure collaborative search throughout the entire search project aided students in conducting more

successful searches. However, if these scripts were slowly removed over the course of a search project, the students were unable to continue to use the knowledge on conducting good searches. Thus, even with researcher-developed aids for searching, there still appears to be more room for improvement in supporting adolescents' search behavior.

Social search, referring to the process of seeking information via one's social networks (Morris et al., 2010) has revealed motivations for seeking answers via social networks over traditional search engines. Morris et al. found that for adults, social network questioning can allow the asker to phrase questions in natural language and to pose more complicated questions that can be entered as a search query. Additionally, askers have more trust in their social networks, believe that social networks are better resources for recommendation questions, and also believe that search engines cannot answer all of their questions. However, to date, similar research has not been conducted with adolescents.

Another example of searching with others can be found in Kuhlthau's (1991) first stage of the information-seeking process in her study of high school seniors (ages 17 to 18). Kuhlthau mentions that during the initial phases of information seeking, searchers discuss possible topics with others. However, it is unclear how these other people are involved, as Kuhlthau's work focuses more on the process and affect of the search rather than on outside influences to the search. Similarly, in an examination of a body of information seeking literature, Dresang (2005) discusses the need to examine the whole searcher, and finds that youth have a desire to search on the computer with others and to share their knowledge, but there is not enough research with adolescents yet.

Affect

Bilal (2005) discusses how the Internet poses many challenges to middle school aged children when searching. Not only do they have to develop good search skills, they also must modulate their emotional reactions to the information seeking process to be successful searchers. Thus, a greater understanding of the whole searcher is necessary if we are to be better able to educate children in search. This view of the searcher as a whole, and not simply made up of search skills, behaviors, or of emotional reactions as separate parts, is termed the *affective paradigm*.

In other studies on search, there is a body of research examining the affect of the searcher during the search process, but it predates the Internet. Kuhlthau's (1991) ISP (information search process) model describes the emotions felt by high school information seekers at different phases of search. Emotions can range from optimism, frustration, and even disappointment when a search fails. Burdick (1996) also discusses the role of emotion during the search process, reporting that adolescents in her study felt a range of emotions at different points of the search process, including optimism, confidence, and frustration.

Rules

The extent to which parents, teachers, and other adults impose rules on children or adolescents can have a large impact on their behavior, both on and off the computer. Parents of 8 to 18 year olds who impose household rules or limitations on their children's use of all media (not just computers) have children who are more likely to be more social, less likely to report boredom, and are more likely to earn higher grades (Rideout et al., 2010). Foss et al. (2012) describe computer-specific rules imposed by parents on children ages 7, 9, and 11, noting that parents often limited their children's access to certain websites and the amount of time spent using the computer. The extent to which these limitations influenced search skills is not clear, nor has it been investigated for adolescents. Agosto (2002) also discusses how time constraints are a limitation in adolescent searching. The adolescents in her study operated under imposed and self-generated time constraints. The imposed time constraints, in the form of assignment due dates, and self-generated time constraints, arising from beginning assignments as late as possible, put external pressures on the search task. Agosto describes how these time rules affect the number of websites examined before selecting one from which to draw information.

Foss et al. (2012) also describe searching rules that children adhere to, such as which sources to use, rules about the relevance of results presented on the search results page, and rules about the importance of keywords and correct query spelling. These rules were aids to searching when applied flexibly, but could become too strictly adhered to and prevent the searchers from being able to retrieve information. However, the Foss et al. study only showed how elementary-age children applied these rules. These and other rules might apply differently to adolescents.

Complex Search

We define complex search tasks as those that require multiple steps to achieve the answer—searchers must break the task into smaller pieces to succeed. These small pieces of a longer search task may not themselves be complex. The difficulty of complex search tasks lies in parsing the initial question posed into subtasks that can be handled by the search engine. In Foss et al.'s (2012) study, the complex search task was "Which day of the week will the current vice president's birthday be on next year?" (p. 516). When the question was initially written, a natural language, verbatim query would prove to be unsuccessful. Searchers had to use several steps to complete it, and many were unable to do so. However, it is not clear how well adolescents do with these types of search tasks.

Byström (2002) characterized task complexity in adults in terms of a dynamic interplay between the individual and the context of the task. For example, if a searcher can identify needed approaches to solving a task, the task is perceived as less complex. Conversely, more uncertainty leads

to a higher level of task complexity. This differs from the current study in that we measure the task complexity independently of the knowledge of the participant, basing our measure of task complexity on the number of steps required to reach an answer. Byström additionally found that more complex tasks result in broader information seeking strategies, including the consultation of a greater number of information sources as well as other people. In the current study, because of the interview and observation setting, it is unclear whether the adolescents would have consulted others as a source for information during difficult searches.

Methods

For this study, we used methods similar to those described in Foss et al.'s (2012) work. We conducted in-context interviews with both parents and adolescents and observations of adolescents. However, data pertaining to parent interviews will be presented in a later publication. For the in-context adolescent interviews and search observation, we included self-generated search tasks as well as predefined searches ranging in difficulty from one-step tasks to multistep tasks. All of the search tasks are described below. We recognize that researcher assigned tasks, even those asking the searcher to generate their own task, are not the same as naturalistic searches (Russell & Grimes, 2007) as searchers with no personal interest in an assigned topic may not deeply engage in the assigned task. Therefore, following the recommendations of Russell and Grimes, we blended the search tasks to include a mix of self-generated search tasks of the user's own personal interests followed by predefined searches. This mix allowed us to gather naturalistic data with the self-generated tasks and cross-subject comparison data with the assigned tasks. Participants conducted all of the search tasks on the open web and by choice all participants used Google. Participants were explicitly directed to Google for the final two search tasks for ease of comparison across participants.

Participants

Participants for this project were 38 adolescents and at least one parent per child. The adolescents ranged in age from 14 to 17. The study was conducted with participants from suburban Maryland and rural Virginia communities. Most of the adolescents in this study attended public school, although some were home-schooled. Adolescent participants received a gift card in the amount of ten dollars or a study t-shirt as an incentive to participate. Recruitment was through parent teacher associations and personal networks. Participants reported an average of 8.2 years of experience on the computer with about 4 hours per day using the computer on average. Rideout et al. (2010) report finding that among 8–18 year olds, there was an average of 1 hour and 29 minutes using the computer. The users in our study may thus have been more experienced than average, but they were also at the upper age limit of Rideout's study, where we

might expect more computer usage. Sixty-three percent of the participants in the current study reported owning their own computer or laptop, with 37% reporting that they shared a computer or laptop in the home with family members. Rideout et al. report that 29% of adolescents in their study owned their own laptop, so the adolescents in our study were more privileged from the perspective of computer ownership.

Data Collection

Data collection took place in the homes of the participants. Two researchers attended each in-context interview and observation, which lasted one to two hours. One researcher conducted the interviews with the parents and adolescents, whereas the second researcher took notes and ensured a quality video recording. Researchers conducted the adolescent interviews while the adolescent used the home computer with which they were most familiar (on average, parents in each home reported 4.7 computers). Parents were given the option of being present for the interview and observation, although most parents chose not to be in the room. Adolescent interviews lasted 30 minutes as the mode and ranged from 15.5 minutes to 49 minutes.

Researchers used one camera set at an angle from behind the seated participant to capture the adolescent's physical position in relation to the computer, facial expressions, and hand movements. Actual search queries as typed by the adolescent were not captured on camera, but were recorded in notes by one researcher, who noted the exact query entry (including misspellings). Similarly, the results pages were not well captured by the recording devices because of screen angles, and so a researcher recorded the results clicked by the adolescent in field notes. During pilot studies of this work, we found that participants felt that it was overly invasive if we asked to examine search histories or export any search log data from the home computer, as many of the computers are shared among all family members.

Search Tasks

The in-context adolescent interview and observation consisted of three major sections: general computer use questions, six search task questions assigned verbally and general opinion questions about the search engine, frustration, and new tool design at the end of the in-context interview. The six search questions started with two open-ended questions: "Can you show me how you usually search for information on the computer" and "Can you search for something for your own interest that you've never searched for before?" Next we asked two simple, one-step questions: "Can you search for information on dolphins" and "Can you search for information on what dolphins like to eat?" Finally we asked two multistep questions: "Which day of the week will the current vice president's birthday be on next year?" and "Was Michael Jackson's music more popular in 1983 or in 2009?"

The open-ended questions were included to observe the adolescents searching in the most naturalistic fashion possible despite the interview and observation setting. The simple search tasks allowed researchers to observe the typical search habits such as browser and search engine choice. We did not measure success on the one-step and self-generated tasks directly, but instead asked each participant whether they felt they found the information they were looking for as they indicated completion of each task. The dolphin questions were the same questions we used in our prior study with younger children (Foss et al., 2012), so they provided a good comparison point between and across age groups.

Our multistep searches were included to establish the upper threshold of searching competence in adolescents ages 14 to 17. These complex tasks could be evaluated for success or failure, making them easy to compare across users. One complex task, the vice president question, has a definitive answer, whereas the Michael Jackson question allows for the adolescent to give an answer based on information accessed by searching, but both questions are complex in that they require multiple steps to solve. We measured success on the Michael Jackson question by whether the adolescent dynamically altered their search based on their results, whether they switched from the task's prompt of "popular" to a metric, and whether they did a comparison of information between the years in the task. We measured whether a comparison between 1983 and 2009 had been accomplished based on verbal statements indicting both years or by observing the adolescent reading information about both years.

Complex Searches

Foss et al. (2012) found that children under the age of ten had difficulty in the multistep search process for the question "Which day of the week will the current vice president's birthday be on next year?" However, during a pilot for the current study, all 11 adolescent participants were able to successfully answer this question. Therefore, the vice president question did not provide the same challenge for adolescents as for younger children. To explore this higher adolescent skill level, we were interested in a question that required more advanced use of search abilities. We selected the task, "Was Michael Jackson's music more popular in 1983 or in 2009?" This search task does not have a definitive answer, as the term "popular" is open to multiple interpretations. For instance, a musician's popularity could be defined on metrics such as number of fans, music awards, or best-selling albums and songs for a specific year or years. We wanted a search task that would allow searchers to self-determine new queries that were not part of the question itself. Unlike the other search tasks, the answer a searcher provides is not a hard factual answer. Instead, either 1983 or 2009 are suitable answers for solving the task, but the adolescent searcher needs to present evidence for his or her response. The Michael Jackson question also requires the adolescents to deconstruct the task into smaller pieces and

solve the task through a comparison of topics. This is the reason for including years in the task, as opposed to the more open-ended "When was Michael Jackson most popular?" We chose 1983 because Michael Jackson's album, "Thriller," was the best selling album worldwide that year. Michael Jackson passed away in 2009 and a large resurgence in sales of his music and listenership occurred that year.

To solve the Michael Jackson task, searchers needed to use the following four search skills. First, searchers needed to *dynamically* adapt their search approach by changing the term "popular" based on information returned during queries. For example, a number of adolescent searchers in this study began the task by using "popular" as part of the search query. Some searchers stayed fixated on the query, "popular," whereas others looked at the snippets of search results and began to change and adapt their search plan. Second, the searcher needed to determine what the metrics for evaluation was for popularity. For example, searchers needed to translate the term popularity into measurable outcomes, such as "album sales," "music charts," or "number of worldwide fans." Searchers could still use "popular" as a search query, but had to choose some metric in the results page that defines popular. Third, once searchers found specific online sources, they needed to be able to filter out what results and information sources were pertinent to the task. In this step, searchers who were able to clearly articulate what information was pertinent had the advantage. Finally, searchers had to run multiple queries comparing results from 1983 and 2009 to solve the task. Here, searchers had to compare "apples to apples." For instance, they needed to compare album sales in 1983 with album sales in 2009. Overall, we were less concerned with the correctness of the final answers given by the adolescents and more interested in the process they used to search.

Data Analysis

Data analysis for the adolescent interviews took place in two phases. We analyzed the portions of the video recordings where the adolescents were conducting searches to establish the *roles* for each adolescent. Following coding for roles, we used the interview transcripts to establish *trends*. About one-third of the interviews were transcribed by a local transcription service to lessen the transcription workload, and the research team transcribed the rest of the interviews so researchers would have more familiarity with the data. All transcribers were faithful to all speech in the interview recordings. The research notes taken during the interviews were additionally used to establish details not captured by the video, such as the exact queries entered by the adolescent while they were searching.

Roles Development Overview and Process

In coding the videos to establish roles for each adolescent, researchers used the work models described by Beyer and Holtzblatt (1998) to focus on the behaviors and

interactions of the whole searcher. The work models (flow, sequence, artifact, and culture) allowed us to examine each adolescent in the same way, and reminded us to shift our view of the searcher through the lens of each of the work models, providing a more complete view of the whole searcher. The flow model illuminated how adolescents communicate with their network of influencers. The sequence model focused our attention on the steps each adolescent took as they navigated through search tasks, especially how one event triggered another. The artifact model allowed us to consider the layout and functionality of the web pages the adolescents encountered, as well as to examine the search tools the adolescent chose to use. Finally, the culture model made us more aware of the context and environment of the search. Two researchers each coded all of the videos independently and then met to re-watch the videos and come to agreement about the role or roles of each searcher. Researchers looked for patterns of behavior around the four work models of Beyer and Holtzblatt within each participant, and then compared each participant to others with similar patterns. For example, one participant might give minimal verbal answers to questions (flow), repeatedly use short searching paths (sequence), and display no awareness of features of the search engine (artifact). This participant would be considered Nonmotivated, and would then be compared to other searchers who had similar behaviors within the framework of Beyer and Holtzblatt. One assumption of this study is that it is possible for one searcher to fit into multiple roles or have different roles at different times caused by the search task or the context of the search.

This analysis resulted in the seven search roles presented here, confirming that six of the roles seen in young children are consistent in adolescents, and uncovering one new role, that of the Social Searcher. Additionally, researchers did not observe the role of Distracted Searcher, which was present in younger children. We did not set a definitive number of adolescents needed to establish a role, and it is possible that more participants are needed in future studies to expand the definitions for each role.

We observed multiple roles in 26% of the adolescents, but we did not observe more than two roles per adolescent. Multiple roles are possible caused by the variety of search tasks presented to the adolescents, for example the simple versus complex queries, and the variety of skills they apply when approaching different types of tasks. We saw more instances of multiple roles in younger children with 47% of children falling into multiple roles, with some children occupying as many as four roles (Foss et al., 2012). This finding suggests that children settle into fewer roles as they age, becoming more fixed in their search habits as they gain experience with searching.

Trend Development Overview and Process

Following coding for roles, we used the methods of Strauss and Corbin (2008) to iteratively code for trends in the interview transcripts. We used *NVivo* (*NVivo* qualitative

data analysis software, 2010). We were interested in confirming trends observed in younger children (Druin et al., 2009, 2010; Foss et al., 2012) as well as allowing new trends to emerge naturally from the transcripts. For example, expecting to confirm rules in adolescents, we coded for repetitive or rigid search behaviors across search tasks combined with statements explaining these behaviors. In looking for new trends, we examined the data for patterns across different participants using the open coding method of Strauss and Corbin (2008). For example, we noticed that multiple adolescents mentioned use of social networking sites, and this led to the development of codes surrounding social search and use of the computer.

One researcher coded all of the adolescent transcripts twice, until the researcher felt that saturation of coding had occurred. At this point, a second researcher joined the coding process and a detailed coding check was conducted. There was minimal renaming of categories, and the researchers then moved into axial coding, refining categories to ensure that there were strong definitions for each. Finally, researchers selectively coded, separating and combining categories. These decisions were made through meetings of the research team. At the conclusion of this process, we identified seven major trends: triggers to search, result selection criteria, the visual context for search, influencers and the social landscape, affect, rules, and complex search. All but one of these trends were the same as we found in younger children (Foss et al., 2012); the social landscape is new to adolescents, as younger children infrequently described using the computer in social ways.

Results

Definition of Roles

The roles identified in Foss et al. (2012) for children are Power, Developing, Distracted, Nonmotivated, Domain-Specific, Visual, and Rule-bound. When comparing the adolescent roles to the roles identified for younger children in Foss et al.'s (2012) study, we observed several key differences. First, the absence of the role of Distracted Searcher in adolescents is notable. Distracted Searcher children are characterized by a tendency to drift easily off-task when searching and encounter information that does not relate to the topic they are searching. We suspect that some combination of maturity and more Internet use makes adolescents less likely to become distracted while searching. Additionally, adolescents are likely more aware of social expectations placed on them when participating in a research study, and are more likely to answer questions directly. Second, the addition of the Social Searcher is notable as well. Social Searchers are searchers whose main use of the computer is driven by social factors, and are described further below. The younger children in our prior study did not mention incidences of social computer use or social search strategies, but this type of computer use seems to be prominent in adolescents.

Another major difference between the roles in children and adolescents lies within the Power Searcher role. In

younger children, one metric used to identify Power Searchers was the ability to solve the multistep search question, "Which day of the week will the current vice president's birthday be on next year?" Of the younger children, 20% were considered Power Searchers based on their ability to complete this query. When examining just the oldest children from the previous study, the 11 year olds, 45% were able to successfully complete this task. In the design of the current study, we felt it was necessary to include an even more difficult search task for older children. Power searchers are characterized by other abilities as well (described below), but the level of expected ability on complex search tasks seems to vary by age.

Power

Power Searchers as adolescents possess higher levels of searching skills than searchers in other roles. Many of the skills are the same for children and adolescents, but are simply more advanced in older youth. For example, whereas both child and adolescent Power Searchers may be aware of sources and have an ability to use advanced search features of the search engines, Adolescent Power Searchers on average are aware of 4.7 features of the search engine compared to Child Power Searchers, who are aware of 2.25 features of the search engine on average. Adolescent Power Searchers are able to verbalize their search process when asked, and are reflective, demonstrating an understanding of how the search engine works and the features of the search engine. For example, one 16-year-old female searcher describes her understanding of how to use the Google search engine:

Interviewee: So if I were to search, if I wanted to know what um, video camera I had, then I would just [define: video camera] . . . Oh, and if I'm looking for images, for a project, then I just go to Google images . . . And you type in keywords that you're looking for. So keywords would be like proper nouns, because words like *of* and *the*, those are filtered out because they're not very important and they are used in everything . . . Yeah, this part is the title of the page, and that will usually tell you what you're looking for. Under it, in the black writing, that is a description of, like a description of what the site is about and what the page is. And this green here is the URL . . . the bolded words are ones that are, words that are the same as you search, and the more words that you have that are the same, the higher up it'll pop up in the search.

Power Searchers often have better typing and spelling skills when compared to younger searchers, and they display confidence when searching. Of adolescents in this study, 26% were Power Searchers, eight aged 15 and two aged 16. In Foss et al. (2012), 19% of searchers were Power Searchers, a comparable percentage.

Developing

We found that Developing Searchers are the most frequently observed type of searcher in younger children, as

well in adolescent participants. Of adolescents in this study, 34% were Developing Searchers, five aged 15, six aged 16, and two aged 17, compared to 65% in our study of younger children. Developing Searchers have a limited knowledge of search tools, and display unplanned search paths, as they are unable to verbalize their search process when asked and often have varied approaches to solve a single task. This usage pattern is consistent with Aula and Nordhausen's (2006) finding that novice searchers are more likely to have less linear query entry patterns. Adolescent Developing Searchers display difficulty when confronted with multistep search tasks that require them to break the search task apart. Adolescent Developing Searchers may also have an awareness of features of the search engine or of the browser, such as auto-complete features, although their explanations of these features lack evidence of complete understanding. One 16-year-old girl in our study explained Google like this:

Interviewer: Can you show and explain to me how Google works?

Interviewee: Okay yeah. Okay this is Google. And this search bar right here, you can type anything you want to know about in that search bar. And then you hit search and Google will type all around the world and all the computers and all the information and they will pull it up and like popular pages and they have pictures.

In this description, the searcher does not mention specific tools of the search engine and does not understand how Google retrieves or presents results, although she can explain how to retrieve information in a way that meets her needs.

Social

Social Searchers are identifiable by their use of social networking or communication sites as the primary and favorite activity on the computer, whether searching or not. For example, they make use of all social aspects when using the computer, completing homework assignments with friends using programs such as *Skype*TM. They additionally refer to socially searching at a higher rate than adolescents in other roles, making 3.6 references to socially searching, as compared with the next most frequent role, that of Rule-Bound Searcher, with one reference to socially searching per searcher. Social Searchers also instigate conversations with other people online and offline while using the computer, although this behavior was not observable during this study, and was instead documented as anecdotes by the adolescent. For example, another 16-year-old girl reported, "Yeah, my friends will come over and we just watch random stuff on YouTube that we find." Because of the difficulty in directly observing social searching, only three searchers or 8% of participants fell into this role. We suspect that with a more naturalistic study, more adolescents would be in this role. Social Searchers are broadly triggered to search by images, music, conversations, personal interests, and school. We did

not observe this role with younger children in our prior study.

Domain-specific

These searchers use their searching ability to gather information around a specific topic of interest, for example, basketball players' statistics. 13% of adolescents in this study were Domain-specific Searchers, compared to 31% of younger children in our prior study. It is possible that children who remain Domain-specific Searchers through adolescence have established domains of interest that are stable over time, although longitudinal research is needed. They have developed skills and source knowledge around their particular domain, but have not necessarily learned to apply this knowledge in a broader searching context. Adolescent Domain-specific Searchers appear very similar to their younger counterparts, although the particular domains may be more sophisticated. For example, in young children the domain of interest may be online games, but in adolescents in this study the domain may be specific games such as *World of Warcraft*TM. To belong to this role, adolescents must conduct most of their online searching and computer use around a particular domain or set of domains. Domain-specific Searchers displayed an expertise within their domains similar to the expertise displayed by Power Searchers, but this expertise did not always translate to searches outside of the domain of interest. For example, this 16-year-old searcher discusses his familiarity with sources about skateboarding and ability to retrieve skateboarding information from the Internet, but is unable to display the same knowledge of sources when searching for the Michael Jackson question:

Interviewee: Yeah. And after I watch skate videos, it gets me pumped to go look at skate websites and I usually go to CCS. And look at what's on sale, shoes, skateboards. Like my skateboard broke so I actually need a new one. Yeah, if not just Skate Warehouse. Skate Warehouse is actually better because they have boards.

Interviewer: So you know all this stuff? How did you find out all this stuff?

Interviewee: I honestly don't know. I think what I did is like when I first started skateboarding, I just went onto YouTube and just like places to get boards offline and just found them and then just be like religious with it.

However, this same searcher is unable to solve the most difficult search task on Michael Jackson:

Interviewer: All right, so the last search that I have is a little different. Do you think Michael Jackson's music was more popular in 1983 or 2009, and why?

Interviewee: Is 2009 when he died?

Interviewer: Look it up.

Interviewee: I feel kind of grimy typing this in. [when did Michael Jackson die]. Yeah he died in 2009. Um, probably the first date you gave me.

Interviewer: 1983?

Interviewee: Yeah, I mean people started going over his stuff after he died, but he was more of a phenomenon back in the day.

When discussing skateboarding, this searcher has a set of sites he is aware of and consults enthusiastically, but he does not have a set of sites he can rely on for retrieving unknown information, and instead responds to the Michael Jackson question with an opinion rather than finding facts to support his argument.

Rule-bound

Rule-bound Searchers display constrained searching patterns, repeating the same steps for every search. Of adolescents in this study, 18% were Rule-bound Searchers, compared to 8% of younger children in our prior study. This shift into the role of Rule-bound Searcher is interesting as it may indicate that searchers in general become more fixed in their searching habits over time. Exploring this trend more fully will be of interest in future research. They verbalize and follow rules about searching or computer use frequently. These rules fall into a number of categories, such as rules about trusting the site used. For example,

Interviewer: So why did you pick Wikipedia as your first one?

Interviewee: Because it was the first one, so it was easy. Wikipedia always gives you like a basic broad idea, but I mean teachers are always like, "Wikipedia is not reliable information," but I would go with something that is like .org or .edu, 'cause those are like reliable.

Interviewer: So you clicked on Wikipedia because it gives you a broad overview, but generally you like picking .edu or .org websites for reliable information?

Interviewee: Yeah, I would never use Wikipedia if I had to write a project on dolphins.

Although children in all roles have rules that they verbalize, Rule-bound Searchers are more rigid and unwilling to deviate from their search pattern. Teachers and librarians at school also heavily influence Rule-bound Searchers, as all of them report influence by school, and also by watching friends searching. Child and Adolescent Rule-bound Searchers appear very similar in their searching habits.

Visual

Adolescents characterized as Visual Searcher displayed a desire to retrieve information from visual sources such as pictures or videos. Use of Google Images was common. For example, one 16-year-old Visual Searcher began her search this way:

Interviewer: So can you start off by searching for information on dolphins? And explain to me what you are doing and what you did?

Interviewee: Okay, I'm typing in "dolphins" on Google. Umm, I'm going to go look at pictures first and I'll see what they look like.

Sixteen percent of the participants in this study were Visual Searchers, compared to 8% of younger children in our prior study. Although younger children often inappropriately applied this preference for visual information, searching for images when doing so would clearly not answer the search task; adolescents in this study appear to be more discerning in their use. For example, we saw one younger child attempt to find information on dolphins by searching his favorite games website. The preference for visual information is not incidental; Visual Searchers begin searches with the intention of looking in visual sources, and do not merely opportunistically click on visual search results. They mention many influencers, including siblings, adults at school, and friends.

Nonmotivated

Nonmotivated Searchers are compliant with directions to search, but do not generally choose searching or computer use as an activity. This disinterest is the hallmark of the Nonmotivated Searcher. Of adolescents in this study, 11% fell into this role, compared to 16% of younger children in our prior study. The difference here is not large enough to reliably suggest any change as children get older, though more research might uncover one. These searchers have hours comparable to adolescents in other roles logged on their home computers, so their lack of enthusiasm is not due solely to inexperience. Additionally, the disinterest in searching is present regardless of whether the searching task is imposed or self-generated. When considering affect, Nonmotivated Searchers do not show a sense of excitement towards the affordances of the Internet or web searching in the way that we observed in many of their peers. This role appears similar in children and adolescents in this study, with little variation because of age. As an example of a Nonmotivated Searcher's response to a search task, consider this exchange:

Interviewer: Okay. I have one more search. Do you think Michael Jackson's music was more popular in 1983 or in 2009 and why?

Interviewee: Do you want a search for that?

Interviewer: Uh-huh. Yeah, however you think you would find it.

Interviewee: Oh, because it's the day he died. I can't really find. Oh, here. It says, "In the early 1980, Jackson became a figure in popular music." I guess maybe he's more popular back then.

The searcher displays a reluctance to conduct a search, and enters only one query, displaying a short search path.

In-Context Adolescent Interview and Observation Results

These results are based on 34 interview transcripts and four interview notes. We used researcher notes from the interview sessions as a replacement for interview transcripts

because of three adolescents declining audio and video recording and one interview recording being lost (accidentally deleted during transfer to hard drive from interview camera). Gender and age differences are reported where large differences occurred, although it should be noted that this study did not focus on gender or age as variables to search behaviors. A larger sample size would be needed to make conclusive statements about gender and age differences, but observations are included as future areas of interest to investigate.

School and Searching for Adolescents

School was reported as an influencer of search behavior by 53% of the adolescents participating in this study, compared to 27% of younger children reporting schools influenced how they searched in our prior study. As children get older, it appears that school plays more of a role in their need to search. However, many of the adolescents reporting school as an influencer did not report that they used the computer in the classroom. The most common response to the question "How many days per week are you on the computer at school?" was two out of five days, reported by 34% of adolescents. In comparison, when asked "How many days per week are you on the computer at home?" Of adolescents, 89% reported that they used the computer seven days a in the week. Of adolescents, 39% reported that they learned to search at school, but this was frequently a historical reference to a specific skill acquired during elementary or middle school. These results show that while school becomes more of a motivating factor to search for children as they age into adolescence, classroom search education is not keeping pace.

Triggers

Adolescents in this study reported a wide range of triggers to search mostly by school assignments—68% of participants report that they begin to look for information because of school compared to 36% of younger children. Interestingly, more adolescent girls report school as a trigger, with 86% percent mentioning school, compared to only 47% of adolescent boys reporting school. In our prior research, younger children did not report social reasons for beginning searches, so this is a unique trigger to adolescents in this study. Of participants, 39% report hearing about interesting topics from other people such as friends, at school, or from family members that prompt them to search online. Personal interests ranging from video games to local news also frequently triggered the participants to search. Of adolescents, 55% report triggers from personal interest compared to the similar rate of 48% of children in our prior study. Searching for personal interest appears to be a stable trigger across ages. The full results of adolescent triggers to search can be found in Table 1. Broad triggers across the study participants indicate that adolescents ages 14 to 17 have many uses for searching on the

TABLE 1. Triggers to search.

Age	Total	Define or spell words	Desire for more info on topic	School	Shopping	Social	Specific interests	TV	Verification
14	3	0	0	3	1	0	1	0	0
15	19	1	2	13	0	9	10	1	2
16	12	3	1	8	1	4	7	1	1
17	4	0	0	2	0	2	3	1	0
Total	38	4	3	26	2	15	21	3	3

Gender	Total	Define or spell words	Desire for more info on topic	School	Shopping	Social	Specific interests	TV	Verification
Female	21	3	2	18	1	10	10	2	1
Male	17	1	1	8	1	5	11	1	2

Note. $N = 38$, multiple triggers reported per adolescent.

computer, and that they are not simply completing homework assignments. They are embracing searching for a variety of reasons, both personal, for social reasons, as well as for school.

Result Selection Criteria

Adolescents in this study discuss many reasons for selecting a result from the results page after entering a query. These results represent 31 out of 38 adolescents, as not all the adolescents discuss their reasons for selecting a result or were not asked by the researcher why they selected a result, as this question did not always come up naturally during the flow of the interview.

Sixty-five percent of participants report selecting a result because of the snippet of text provided by the search engine, compared to 55% of younger children. However, only 42% of Adolescent Power Searchers select a result for this reason, compared to 100% of Nonmotivated Searchers and 80% of Developing Searchers. Interestingly, 94% of Child Power Searchers report selecting a result because of the snippet, suggesting that this is an important difference between Child and Adolescent Power Searchers. In particular, it appears that as children age, reliance on textual snippets becomes less frequent as searchers learn to use other cues. Adolescent Power Searchers most often select a result because of having prior knowledge of the source, with 71% reporting this, as compared to 81% of Child Power Searchers. This may indicate that having a knowledge base of reliable sources is a more advanced way of selecting a result. Knowing the source is the second-most frequent reason for all adolescent searchers to select a result at 45%. Additionally, knowledge of sources for information as a selection criterion increases with age: beginning with our youngest prior participants, 7% of seven year olds cite this reason compared to 62% of 11 year olds and 91% of 16 year olds. This could be the result of adolescents gaining domain expertise or additional experience with Internet searching, and is undoubtedly helpful in finding information online as Power Searchers rely on known sources frequently.

Furthermore, 39% of adolescents report selecting a result simply because it is the first one on the results page. Girls

reported a higher frequency than boys (53% vs. 21%) of selecting the first result because it is “first.” Although 29% of the adolescents in the study stated awareness of ads at some point during the in-context interview or observation, it is unclear whether they intentionally exclude ads from their selection of the first result. Only 17% of younger children stated awareness of ads. More information on result selection criteria results can be found in Table 2.

Visual Context

We observed that frequently adolescents verbally discussed images and video content: 55% referred to images during their interview, 26% referred to video, and 29% adolescents mentioned video and images simultaneously. Overall, 68% of adolescents expressed verbal awareness of image and video search in the search engine. Similarly, 63% of younger children referred to images during the prior study.

Visual Searchers made the most references to images or video content at 2.83 mentions per adolescent Visual Searcher. In younger children, there were 3.29 mentions per Child Visual Searcher (Foss et al., 2012). Other roles mentioned video or images less frequently, with social searchers at 2.33 mentions per adolescent, Power Searchers at 1 mention per adolescent, and the lowest role of Domain-specific Searchers mentioning video or images 0.8 times per adolescent. Frequent mentions and use of visual information may therefore be a strong indicator that an adolescent falls into the role of Visual Searcher, although this is not the main criteria for belonging to the Visual Searcher role; intentionally searching for video or images is much more important.

Influencers

Adolescent participants verbally mentioned other people either in relation to search or computer usage in general; these people are considered influencers to adolescent search. Adolescents reported that influencers help them by finding sources, giving rules, working with the adolescent on the computer, and helping with keyword formulation. Younger children also reported that influencers help them by finding

TABLE 2. Result selection criteria.

Age	Total	Largest image	First one	Following a rule	Image	Knows source	Source reliability	No reason	Relevant	Snippet
14	3	0	0	0	0	1	0	0	0	3
15	14	2	6	1	1	6	3	0	3	9
16	11	1	5	2	1	5	4	2	6	6
17	3	1	1	0	0	2	0	0	1	2
Total	31	4	12	3	2	14	7	2	10	20

Gender	Total	Largest image	First one	Following a rule	Image	Knows source	Source reliability	No reason	Relevant	Snippet
Female	17	3	9	2	0	9	3	1	5	12
Male	14	1	3	1	2	5	4	1	5	8

Note. $N = 31$, multiple criteria reported per adolescent.

TABLE 3. Influencers.

Age	Total	Extended family	Friends	School librarian	Parents, mom, or dad	Sibling	Teacher	Tutor /mentor
14	3	0	1	0	5	2	5	0
15	19	5	16	1	43	13	15	2
16	12	2	21	3	19	7	10	3
17	4	0	3	0	6	3	0	0
Total	38	7	41	4	73	25	30	5

Gender	Total	Extended family	Friends	School librarian	Parents, mom, or dad	Sibling	Teacher	Tutor/mentor
Female	21	1	29	4	48	14	20	5
Male	17	6	12	0	25	11	10	0

Note. $N = 38$, multiple influencers reported per adolescent.

sources, searching together, and giving rules (Foss et al., 2012). Mothers are the most frequently reported influencers, with 61% of adolescents reporting mothers as an influencer. In younger children, fathers were very infrequently mentioned as influencers, by only 7% of children (Foss et al., 2012). However, fathers are mentioned as influencers by 47% of adolescent participants. Friends were not reported as influencers in young children. In adolescents, 55% of participants discussed that their friends influenced them in their search and computer use habits. This appears to be a significant difference between children and adolescents. Teachers and librarians are mentioned by 52% of adolescents. School is mentioned by younger children as an influencer 27% of the time. Adolescents in all roles discuss learning to search by watching others. Refer to Table 3 for more details on adolescents reporting influencers.

Affect

Researchers coded the transcripts of the interviews for responses to the question, "Is there anything annoying, frustrating, or hard about searching on the Internet?" to collect data on frustration. Additionally, the transcripts provided information on the number of statements of uncertainty or lack of knowledge such as "I don't know," as well as

statements of self-doubt. For example, one 15-year-old girl said, "When I'm researching, it's always really difficult for me. I'm just not good at it."

Frustrations. Frustrations were noted by asking participating adolescents directly if there was anything frustrating, annoying or hard about searching on the computer. Nineteen percent reported no frustrations with searching on the Internet. By comparison, only 4% of younger children reported no frustrations. For those adolescents who did report frustration, examples include a perceived mismatch between the query entered into the search engine and the results returned (16%), searching for difficult topics (16%), and having to sort through many results to find the information they need (11%). Query formulation is also difficult for adolescents ages 14 to 17, with 14% reporting finding the correct keywords to type is a source of frustration. Similar to frustrations caused by sorting through many results, other researchers have reported frustration in adolescent searchers ages 16 to 18 caused by needing to control curiosity during imposed information-seeking tasks (Bowler, 2010). Younger children in Foss et al. (2012) were frustrated more by factors such as developmental limitations such as typing skills or reading level, as well as by feeling as though there were too many results (similar to adolescents), software errors, or not being able to find their information.

TABLE 4. Frustrations.

Age	Total	Can't find it	Correct keywords	Difficult topic	Query-results mismatch	No frustrations	No good info	Sorting results
14	3	0	0	0	1	0	0	1
15	19	1	3	5	3	3	2	1
16	12	2	1	0	2	4	1	2
17	4	1	1	1	0	0	1	0
Total	38	4	5	6	6	7	4	4

Gender	Total	Can't find it	Correct keywords	Difficult topic	Query-results mismatch	No frustrations	No good info	Sorting results
Female	21	2	3	4	3	5	2	2
Male	17	2	2	2	3	2	2	2

Note. $N = 38$, multiple responses per adolescent.

Complete data on reported frustrations can be found in Table 4.

Uncertainty and self-doubt. Uncertainty has long been considered an important part of the search process, becoming more and less prominent throughout different stages of the search (Kuhlthau, 1993). We observed that 50% of adolescents made uncertainty statements of “I don’t know,” “I’m not sure,” or “I have no idea” during the interviews and observations or in response to researcher questions. In comparison, Foss et al. (2012) found that 70% of younger children made these statements. Male and female adolescents made such statements at near equal rates (47% vs. 52%). Interestingly, 80% of Power Searchers expressed uncertainty, compared with only 31% of Developing Searchers. It is possible that a characteristic of Adolescent Power Searchers is the understanding of the upper level of their own knowledge and being able to express their limitations. However, Child Power Searchers reported far fewer statements of uncertainty than Child Developing Searchers, with 32% of Child Power Searchers stating they “didn’t know,” compared to 100% of Child Developing Searchers making similar statements.

Adolescents in this study had many incidents of expressing self-doubt, with the participants making negative statements about their search capability (16%), the validity of their ideas (5%), asking for directions from the researchers (32%), spelling ability (26%), and with interpreting information (11%). We found that 62% of Developing Searchers asked researchers for directions, compared to 50% of Non-motivated Searchers and 10% of Power Searchers.

Rules

We observed that 50% of adolescents follow rules, compared to 41% of younger children. Whether or not this difference is actually significant is an interesting question for future investigation. The rules expressed by adolescents were: Enter Queries as Questions, Choose the First Result, Don’t Use Wikipedia, Double Check an Answer, Only Use the First Page, Use Reliable Sites, Use Few Keywords, and Use Wikipedia. Similar rules exist in children ages 7, 9, and

11 (Foss et al., 2012). Simply stating a rule does not indicate that a searcher falls into the Rule-bound role. Rule-bound Searchers display a more rigid set of searching patterns and are unwilling to deviate from the rules. In contrast, non-Rule-Bound Searchers were able to examine the context of the search and deviate from their rules where appropriate. For example, one searcher describes how .org and .edu sites are the most reliable, but throughout the interview search tasks, relies on sites such as Answers.com to find helpful information. Rules are not always helpful to searchers, but this largely depended on the context of the search task.

Of the 50% (or 19) adolescents reporting rules, Use Reliable Sites is the most popular rule (24%), followed by Use Wikipedia (21%) and Only Use the First Page (13%). Rule-bound Searchers as a group follow all the rules except for Double Check an Answer, and frequently follow the other rules at a higher percentage than adolescents in other roles. To see the full results for rules followed by adolescents, refer to Table 5.

Complex Search Results

Overall, we found that out of 38 adolescents, 42% were successful at providing enough information to complete the Michael Jackson task, “When was Michael Jackson’s music more popular, in 1983 or in 2009 and why?” On average, each adolescent visited 1.9 pages throughout the Michael Jackson task in 2.1 queries. In comparison, for the less difficult vice president question, (76% success rate), the adolescents visited 1.4 websites and completed 2.5 queries. This suggests that during the vice president task (with its definitive answer), adolescents were gleaning needed information from the search results page without clicking through to the websites, but when solving the more difficult Michael Jackson task, they visited more websites, finding information within the pages rather than on the search engine results page.

We observed that 3% of adolescents in the study did not enter any queries for this hardest search task, compared to 12% of younger children on the vice president task (which was the hardest search in the previous study, see

TABLE 5. Rules.

Age	Total	Enter queries as questions	Chose first result	Don't use Wikipedia	Double check an answer	Only use first page	Use reliable sites	Use few keywords	Use Wikipedia
14	2	1	1	0	0	0	0	0	0
15	6	0	0	2	1	0	2	1	2
16	9	0	3	2	1	2	5	0	4
17	2	1	0	0	0	2	0	1	1
Total	19	2	4	4	2	4	7	2	7

Gender	Total	Enter queries as questions	Chose first result	Don't use Wikipedia	Double check an answer	Only use first page	Use reliable sites	Use few keywords	Use Wikipedia
Female	10	0	1	4	2	1	6	1	4
Male	9	2	3	0	0	3	1	1	3

Note. $N = 19$, multiple rules reported per adolescent.

Druin et al., 2010; Foss et al., 2012). The majority of participants (97%) did attempt the task, but 58% failed to complete it. Some participants who failed to complete this search task may have the capability to do so, but could have been uninterested, felt time constraints, or been uncomfortable with the interview or in-context observation setting.

However, we also observed several other reasons for lack of completion. First, similar to Foss et al.'s (2012) study, adolescent participants were likely to type the question in as stated (or close to as stated) by the researcher in natural language. Eighteen percent of participants used a natural language approach, with a total of 11 natural language queries. Younger children were much more likely to enter queries as natural language. Because no definitive and correct answer exists in this natural language form, these searchers could not complete the task. Second, 50% of participants did not change the query term "popular" in the search. Some of these searchers used derivative terms from popular, such as [popularity], [most popular], or [popularity spike]. Others attempted to change the query popular, but instead used search terms that were synonymous with popular, such as [success] or [rating]. Even if searchers used multiple queries, if they fixated on the term "popular" or other synonymous terms, they were unlikely to complete the task. For this search task, it was important that searchers were versatile in their choice of search terms. Third, 39% of searchers ended their search by giving an opinion not based on a comparison of information between 1983 and 2009.

As an example of an unsuccessful searcher, we categorized adolescent searcher #15, a 16-year-old female, as a Visual and Developing searcher. In the Michael Jackson search, the adolescent went straight to the iTunes media player and searched for the popularity of Michael Jackson's music. Not able to find the answer, the searcher used two queries in Google, [popularity of Michael Jackson's music through out the years] and [Michael Jackson's music success in 1983]. In these queries, searcher #15 does not redefine popular, using a synonymous term (success), and does not generate a dynamic, multistep search plan.

Searcher #15 does find a website that lists the musician's achievements, including the fact that Michael Jackson had more number one hits than any artist in the decade of 1980s. The searcher continues to scroll down to look for information for 2009. However, the searcher ends the task by giving an opinion that is not based on information from the site. She chooses the year 2009 and states, "his music focus was more towards, it seemed like it was more towards younger kids, like teenagers and stuff. And also in 1983 they didn't have the technology where people could buy it, like listen to it all the time so people couldn't develop the, umm liking of it." Looking at searcher #15, she was unable to filter the out the important information on the number one hits and could not make a clear comparison between the years 1983 and 2009.

All successful searchers had to make a comparison in queries between 1983 and 2009 and use a metric for evaluation (i.e., album sales, top ten lists). If the searchers used one query and did not make a comparison between 1983 and 2009, they were unable to provide a useful answer. For example, one searcher used only the Michael Jackson article on Wikipedia to complete the search task. However, the searcher specifically used the find text feature (CTRL-F) to seek out "1983" and "2009" in the article, therefore completing two searches. The searcher made a comparison between 1983 and 2009 album sales from the information within the article. In contrast, another searcher used the same Michael Jackson article from Wikipedia, but only offered an opinion stating that celebrities become more famous after they die, not completing a comparison between the two years.

Social Findings for Adolescents

In our interviews, adolescents frequently discussed social computer use. While the social use of the computer is not necessarily limited to search behavior, website search functions and the necessity of searching to access information are so ubiquitous that the two are likely to overlap often. Social computer use and use of social networking sites do

involve access of information, even if the information pertains not to schoolwork but to popular culture and friends' activities. Also, search competence includes basic skills such as familiarity with websites and typing skills, and these skills are transferable between computer use and search. For these reasons, we believe that the social computer use we observed in adolescents is related to the development of search competency.

Younger children in our prior study did not exhibit the role of Social Searcher. By contrast, adolescents in this study had a number of factors surrounding their social use of the computer. Many of the adolescents reported that their friends influenced their search habits (55%). The only influencer mentioned at a higher rate was mothers (61%). By role, all Social Searchers described that their friends influenced their computer use in some way. A total of 67% of Visual Searchers and 60% of Power Searchers report friends as an influencer as well. Interestingly, no Nonmotivated Searchers report that friends were influencers. This last finding suggests that social influence and search motivation are strongly intertwined, but more research is needed to understand how they relate to each other.

When examining examples given by the adolescents, 55% were able to describe an instance of social use of the computer. For example, a 16-year-old girl explained, "If I'm around my friends I'll be like 'hey how do you do this, can you help me', and in a room full of people, my friends, odds are at least one of them knows how to do what I'm trying to do." A 17-year-old boy described watching videos with friends, "Um, usually we search the Internet for funny things, just so we can like link them to each other, and then like watch them later."

The top three favorite computer activities reported by the adolescents in this study are using social media sites such as *Facebook*TM (47%), watching TV or videos on *YouTube*TM (37%), and playing games (16%). These results are consistent with Rideout et al.'s (2010) survey of 8–18 year olds favorite online activities. The overlap of these activities with both social interaction with peers and search is high, and exploiting this overlap may provide useful ways of thinking about how to help adolescents become better searchers.

Comparison Between Child and Adolescent Searchers

Overall, the study exploring adolescent search patterns, combined with the prior work on children's search patterns (Foss et al., 2012), has yielded interesting comparative data. There are differences between the roles as well as in the search trends among children and adolescents. Understanding how and why these shifts occur is an active area of future work. In particular, we expect that re-visiting younger children as they get older and observing them search may yield better understanding about how and why their searching behaviors change.

Figure 1 shows how search roles have shifted between this study and our previous study (Foss et al., 2012). Most

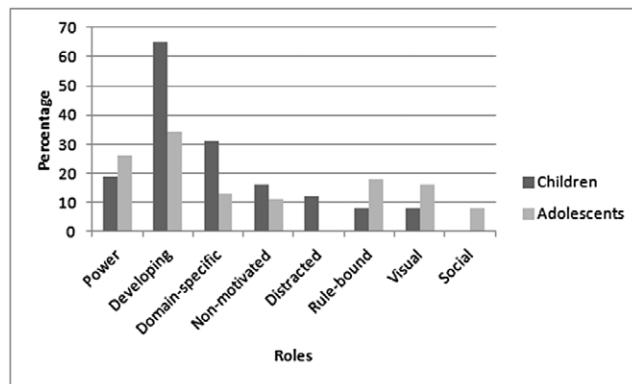


FIG. 1. Comparison of roles for children and adolescents.

notably, there are fewer adolescent Developing Searchers than child Developing Searchers. This suggests that search skill increases with age. Additionally, there are more adolescent Power, Rule-bound and Visual Searchers than we observed in children, and far fewer Domain-specific Searchers. It is possible that as children age out of the Developing Searcher role, they obtain more specific searching skills that place them into other roles, and do not necessarily progress directly into the Power Searcher role. More research with a larger number of users is needed to confirm or refute this idea.

Other notable role findings and implications include:

- Adolescents settle into fewer roles as individuals than younger children, and additionally do not display the role of Distracted Searcher, but do show the role of Social Searcher, which is absent in children.
- Adolescents ages 14 to 17 rely on their social networks when searching and using the computer to complete homework and to increase their enjoyment. This experience of seeking information from the Internet with others may be helpful in teaching child searchers to become better searchers. Exactly when, how, and why this interest in social develops is an interesting question for future exploration.
- Adolescents ages 14 to 17 do not display the role of Distracted Searcher, suggesting that they are able to more easily focus on finding needed information. This may be a result of maturity, more experience searching, or some combination of both. Better understanding how adolescents make this transformation could help adult stakeholders facilitate it in the future.

Major findings in differences and similarities for adolescents and children concerning general trends include:

- Adolescents ages 14 to 17 are able to complete more complex search tasks involving comparisons and parsing than are children. Adolescent Searchers can translate search task terms into keywords that work in the context of the search engine as well as understand when multiple searches are necessary to complete a task. Understanding when and how these skills develop in young searchers will aid adult stakeholders when designing search tools and educating searchers.

- Knowledge of sources for finding information increases with age. This could explain why older searchers are more successful at locating information on the Internet, as they are aware of sources, whereas younger children seem to have less of an awareness of how to discern reliable sites. More research into how older searchers develop this skill, and more education of younger searchers about this skill could be beneficial.
- Visual information, in the form of images and video, is an important source for both children and adolescents. Ensuring that search tools can support the presentation of visual information to searchers will aid in delivering information to searchers in preferred and highly usable formats.
- Adolescents ages 14 to 17 are much less frustrated than younger children when searching on the Internet, and the two age groups are frustrated by different tasks. Younger children are more frustrated by typing, spelling, and reading comprehension and adolescents are more frustrated by sorting through large amounts of information or perceived mismatches between their keywords and the results presented by the search engine. This information might allow adult educators to tailor search education by age more appropriately, and allow search engine companies to tailor the search experience for users of particular ages.

Implications for Adult Stakeholders

For Designers

Adolescents in all roles describe learning to search from watching others. As one 15-year-old Developing and Visual male describes, “I think maybe it’s something I just I picked up, I’m not sure from where, might have been from watching somebody else on the computer.” This method of learning new searching skills by watching others is an opportunity for designers to develop search tools that make the search patterns of others more apparent. For example, Moraveji et al. (2011) developed a classroom tool called *ClassSearch* for teaching and learning the successful search strategies of others by displaying them on a shared screen at the front of the classroom. The instructor then easily points out successful queries and sources to the class for discussion.

Exploring how to capitalize on the social aspect of adolescent searchers is another avenue for researchers and designers to explore together. Given that adolescents in this study are often triggered to search for social reasons, learn to search through observing others, and that many of them are motivated to computer use by their social networks, designing search engines in a way where there is ease of integration with social networks may prove to be an interesting area of research. Research conducted in this areas includes work exploring how to integrate Web 2.0 features such as the bookmarks or tags of others into one’s search results (Amitay et al., 2006) or increasing relevance of documents based on status updates or whether people the searcher knows have interacted with the documents (Karweg, Huetter, & Böhm, 2011).

When asked to design their ideal searching tool, adolescents in this study described wanting a search tool to take

them directly to the best result or results. This may be reflective of the frustrations they reported with query/result mismatches. Designers might consider that while there can sometimes be value in returning large numbers of results, it is also possible that this is overwhelming in some situations. Too many results is also a concern for younger searchers, as discussed in Foss et al. (2012), because child Power Searchers tended to follow the rule choose the first result.

Child and Adolescent Power Searchers share the ability to break apart long search tasks into smaller pieces that are easily handled by the search engine, but children in other roles often struggled with this skill. A search engine tool suggesting a step-by-step search that is triggered by the appearance of a long query could support this skill. Wecker et al. (2010) have established work in this area by providing prompts to searchers within the context of an ongoing search.

For Researchers

To clearly observe the social nature of computer use in adolescents, researchers should be aware that methods other than the in-context interview should be used. The interaction during interviews prohibits social activity such as checking *Facebook*TM, responding to *Skype*TM messages, interacting via email, or watching *YouTube*TM videos through a friend’s account. Other methods could be used to observe these behaviors; perhaps asking teens to log their computer use with a video diary would more readily show aspects of social behavior that cannot be captured during a one-on-one interview. Additionally, this social information can be obtained via interviews with parents, siblings, and friends of the adolescent.

Further, during this study we noticed that the adolescent participants, in contrast to the child participants from Foss et al. (2012), used cell phones and other mobile devices. Examining differences in search patterns based on the type of device used could reveal new search roles. We have also discovered during the course of this research that although search roles appear to have some degree of consistency as children age through adolescence, there are changes in abilities such as typing skill, reading level, domain knowledge, and a rise in sophistication of personal interests. These changes required that we alter our measures of searching ability to accurately reflect the population by adding a more difficult search task to the in-context interview protocol. Other researchers should familiarize themselves with the population of searchers they intend to study by conducting pilot studies to gauge base levels of searching and computer ability to develop the most ideal search tasks for their population.

Research concerning gender and age differences would also be interesting to pursue. While there are many similarities between the adolescents in this study based on gender, it seems there are some differences worthy of note, such as how girls are much more motivated to search from school than boys. Additionally, this study uncovered trends

by age, such as how knowledge of sources becomes more prominent as adolescents age. Studying differences like this could lead to interface design differences based on gender or age.

For Information Literacy Educators

Despite the fact that these adolescents searched at home far more than at school, the most frequent search trigger reported is for school, at 68%. Adolescents appear to use the computer to complete their school assignments, but without much guidance from the school on search techniques, source reliability, or query generation. The number of students who were not able to complete the complex Michael Jackson query suggests that more education is needed. Google is providing some useful lesson plans for search education, which could be implemented in a classroom (<http://www.google.com/insidesearch/searcheducation>). This website provides not only lesson plans but live training in video form as well as hosts the *Google a Day*TM search challenge. Any of these tools could easily be implemented in a classroom setting to improve searching skills for youth.

Complex search questions do not involve a one-to-one correspondence between the search task and the search queries required to answer them. Search needs to be taught as a step-by-step process that involves dynamic generation of a search plan based on initial results. For example, in the Michael Jackson query, searchers started out searching for popularity, but some of the successful ones started to refine the term based on the snippets they were reading. Searching can be taught as an evolution and dynamic adaptation of strategies. In the classroom, information literacy educators can encourage skills for successful searching and help students practice searches with complex search topics and compare complex tasks with simple tasks.

Having both teachers and parents provide “search challenges” to their adolescent children could encourage more search development in a context that would be seen as fun rather than work. This approach would be especially useful for adolescents in the Nonmotivated role. Additionally, in a classroom setting, teachers could encourage students to compose difficult search tasks for each other to solve. This would capitalize on the domain knowledge of the students, and would possibly engender more engagement, as well as allow searchers to understand the steps involved in composing and solving multistep search tasks. Further, given that 55% of adolescents reported being motivated to search for personal interests, allowing students to self-generate search tasks students might raise interest in assignments.

Finally, with much information available on the Internet in visual format, including online education sources such as *Udacity* (www.udacity.com), *Coursera* (www.coursera.org) or *Khan Academy* (www.khanacademy.org), how-to videos from sites such as *Instructables* (www.instructables.com) or the variety of videos available from *YouTube*TM (www.youtube.com), awareness of visual information could be extremely advantageous to adolescent searchers who want

to use the Internet as a tool for learning. Educators could promote awareness of sites such as these to aid searchers to learn in new ways.

Limitations

First, we concede that the presence of researchers observing the searching process could have possibly altered normal searching behaviors in the adolescent searchers. For example, the presence of the researchers could have put pressure on the adolescents to complete searches that they would have otherwise abandoned. The imposed nature of some of the search tasks additionally limits the ability of this study to observe searching behavior in the most naturalistic way possible (Russell & Grimes, 2007). As noted above, we also limited the ability of teen searchers to make use of social aspects of searching during the in-context interviews, which made at least some of the tasks less realistic. Is it also possible that some of the participating adolescents expected that our search tasks would be solvable within a finite set of results rather than by a series of searches. As we did not assess research skills possessed by each adolescent, it is possible that this is a reason for search failure in our more difficult search tasks. Finally, we did not collect demographic data on the families enrolled in this study. It is possible that because of the geographic region and the presence of home computers and Internet access that the participants represent a more affluent segment of the general population of adolescents.

Future Work

This paper provides a baseline with which to measure how children search as adolescents. We plan on revisiting participants from our previous, larger study of 83 younger children, which looked at how children of ages 7, 9, and 11 search the Internet (Druin et al., 2009, 2010; Foss et al., 2012) to see how their role classifications have changed as they have aged. This will allow us to answer questions such as whether years of experience on the computer correlate to more search expertise or whether roles are static. In addition, we will be able to observe whether the major differences summarized in the discussion section hold true when examining the same group of individuals over the span of several years.

Acknowledgments

We would like to thank the adolescents and their families who allowed us into their homes; without them this work would not be possible. Thanks to Ian Hickman for his perspectives and encouragement throughout the study. We would like to thank Dan Russell for his continued support. Panagis Papadatos, Robin Brewer, Luis Sanchez, and Phillip Lo were all invaluable for their help when collecting data. This research was made possible with a Google University Research Grant.

References

- Agosto, D.E. (2002). Bounded rationality and satisficing in young people's web-based decision making. *Journal of the American Society for Information Science and Technology*, 53(1), 16–27.
- Agosto, D.E., & Hughes-Hassell S. (2005). People, places, questions: An investigation of the everyday life information-seeking behaviors of urban young adults. *Library and Information Science Research*, 27(2), 141–163.
- Amitay, E., Carmel, D., Har'El, N., Ofek-Koifman, S., Soffer, A., Yogeve, S., & Golbandi, N. (2009). Social search and discovery using a unified approach. In *Proceedings of the 20th ACM Conference on Hypertext and Hypermedia (HT '09)* (pp. 199–208).
- Aula, A., & Nordhausen, K. (2006). Modeling successful performance in web searching. *Journal of the American Society for Information Science and Technology*, 57(12), 1678–1693.
- Beyer, K., & Holtzblatt, H. (1998). *Contextual design: Defining customer centered systems*. San Francisco, CA: Morgan Kaufmann Publishers.
- Bilal, D. (2005). Children's information seeking and the design of digital interfaces in the affective paradigm. *Library Trends*, 54(2), 197–208.
- Bowler, L. (2010). The self-regulation of curiosity and interest during the information search process in adolescent students. *Journal of the American Society for Information Science and Technology*, 61(7), 1332–1344.
- Burdick, T.A. (1996). Success and diversity in information seeking: Gender and the information search styles model. *School Library Media Quarterly*, 25(1), 19–26.
- Byström, K. (2002). Information and information sources in tasks of varying complexity. *Journal of the American Society for Information Science and Technology*, 53(7), 581–591.
- Dresang, E.T. (2005). The information-seeking behavior with youth in the digital environment. *Library Trends*, 54(2), 178–196.
- Druin, A., Foss, E., Hatley, L., Golub, E., Guha, M.L., Fails, J., & Hutchinson, H. (2009). How children search the Internet with keyword interfaces. In *Proceedings of the 9th International Conference on Interaction Design and Children (IDC)*, Como, Italy (pp. 89–96). New York, NY: ACM Press.
- Druin, A., Foss, E., Hutchinson, H., Golub, E., & Hatley, L. (2010). Children's roles using keyword search interfaces at home. In *Proceedings of the 28th International Conference on Human Factors in Computing Systems (CHI '10)*, Atlanta, GA (pp. 413–422). New York, NY: ACM Press.
- Foss, E., Druin, A., Brewer, R., Lo, P., Sanchez, L., Golub, E., & Hutchinson, H. (2012). Children's search roles at home: Implications for designers, researchers, educators, and parents. *Journal of the American Society for Information Science and Technology*, 63(3), 558–573.
- Gross, M. (2006). *Studying children's questions: Imposed and self-generated information seeking at school*. Lanham, MD: Scarecrow Press, Inc.
- Hirsh, S.G. (1999). Children's relevance criteria and information seeking on electronic resources. *Journal of the American Society for Information Science*, 50(14), 1265–1283.
- Jochmann-Mannak, H., Huijbers, T., Lentz, L., & Sanders, T. (2010). Children searching information on the Internet: Performance on children's interfaces compared to Google. In *Proceedings of the SIGIR Workshop on Accessible Search Systems*, Geneva, Switzerland (pp. 27–35). New York, NY: ACM Press.
- Karweg, B., Huetter, C., & Böhm, K. (2011). Evolving social search based on bookmarks and status messages from social networks. In *Proceedings of the 20th ACM International Conference on Information and Knowledge Management (CKIM '11)* (pp. 1825–1834).
- Kuhlthau, C.C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science*, 42(5), 361–371.
- Kuhlthau, C.C. (1993). A principle of uncertainty for information seeking. *Journal of Documentation*, 49(4), 339–355.
- Lenhart, A., Madden, M., Smith, A., Purcell, K., Zickuhr, K., & Rainie, L. (2011). Teens, kindness and cruelty on social network sites: How American teens navigate the new world of "digital citizenship". Pew Research Center's Internet & American Life Project. Retrieved from http://pewinternet.org/~media/Files/Reports/2011/PIP_Teens_Kindness_Cruelty_SNS_Report_Nov_2011_FINAL_110711.pdf
- Moraveji, N., Morris, M.R., Morris, D., Czerwinski, M., & Riche, N. (2011). ClassSearch: Facilitating the development of web search skills through social learning. In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems (CHI '11)*, Vancouver, Canada (pp. 1797–1806). New York, NY: ACM Press.
- Morris, M.R., Teevan, J., & Panovich, K. (2010). What do people ask their social networks, and why? A survey study of status messages and Q&A behavior. In *Proceedings of the 28th International Conference on Human Factors in Computing Systems (CHI '10)*, Atlanta, GA (pp. 1739–1748). New York, NY: ACM Press.
- NVivo qualitative data analysis software; QSR International Pty Ltd. Version 9, 2010.
- Oliveira, F.T.P., Aula, A., & Russell, D.M. (2009). Discriminating the relevance of web search results with measures of pupil size. In *Proceedings of the 2009 Annual Conference on Human Factors in Computing Systems (CHI '09)*, Boston, MA (pp. 2209–2212). New York, NY: ACM Press.
- Rideout, V.J., Foehr, U.G., & Roberts, D.F. (2010). *Generation M2: Media in the lives of 8–18 year olds. A Kaiser Family Foundation Study*. Menlo Park, CA: Henry J. Kaiser Family Foundation. Retrieved from <http://www.kff.org/entmedia/upload/8010.pdf>
- Russell D.M., & Grimes, C. (2007). Assigned tasks are not the same as self-chosen Web search tasks. In *Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS '07)* (p. 83). Washington, DC: IEEE Computer Society.
- Slone, D.J. (2003). Internet search approaches: The influence of age, search goals, and experience. *Library and Information Science Research*, 25, 403–418.
- Strauss, A.L., & Corbin, J. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Third edition. Thousand Oaks, CA: Sage Publications.
- Wecker, C., Kollar, I., Fischer, F., & Prechtel, H. (2010). Fostering online search competence and domain-specific knowledge in inquiry classrooms: Effects of continuous and fading collaboration scripts. In *Proceedings of the 9th International Conference of the Learning Sciences (ICLS)*, Volume 1, Chicago, IL (pp. 810–817). New York, NY: ACM Press.