

How Children Search the Internet with Keyword Interfaces

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ABSTRACT

Children are among the most frequent users of the Internet, yet searching and browsing the web can present many challenges. Studies over the past two decades on how children search were conducted with finite and pre-determined content found in CD-ROM applications, online digital libraries, and web directories. However, with the current popularity of the open Internet and keyword-based interfaces for searching it, more critical analysis of the challenges children face today is needed. This paper presents the findings of our initial study to understand how children ages 7, 9, and 11 search the Internet using keyword interfaces in the home. Our research has revealed that although today's children have been exposed to computers for most of their lives, spelling, typing, query formulation, and deciphering results are all still potential barriers to finding the information they need.

Author Keywords

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

ACM Classification Keywords

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

INTRODUCTION

The leading activity for all age groups on the Internet is general exploration: activities such as searching, surfing, and reading about interests, sports, and movies [6]. Recent studies in the U.S. have shown that 74% of children ages 8-18 years have access to the Internet [18]. Children make up one of the largest groups of users of computers and the Internet [17]. Despite childrens'

frequent use of the Internet and exposure to technology at an early age, when asked 'what frustrates you most about searching on the Internet', several child participants in our study provided some revealing answers.

Child (age 7): "Writing words is hard for me because I'm not really good at the writing."

Child (age 9): "It doesn't do all the words you say."

Child (age 11): "It's hard because you have to find the right words to put in the box."



Figure 1 – Child (age 7) searching for information on her home computer.

These challenges were a just a few of several we saw when conducting our initial study on how children search the Internet. When, where, what, and how they search were prominent concerns as we interviewed the children and parents who participated. This paper describes our methods, highlights our findings, and offers considerations for the design of future Internet search interfaces for children.

The Need for Research

Browsing the web exposes children to vast numbers of websites on every imaginable topic and in many different media formats (e.g. web sites, documents, videos, images). Using a search engine to find information from large numbers of disparate web pages is very different from searching the finite and pre-determined content found in the CD-ROM applications, online digital libraries, and web directories of the past. However, most of what we know about how children search is based on studies using these kinds of sources.

Today's search engines are not only more expansive than past technologies, but more ubiquitous in a child's world. It is not uncommon for young people to begin to go online with a parent or sibling by the age of three or four. They move from their home computers, to their schools' computing facilities, to their mobile phones, searching for online games, information for school assignments, and random facts they are curious about because of the world around them. Today's children are the first generation of what are being called "digital natives" [1]. As a result, it is important to explore how children search the Internet with today's ubiquitous keyword interfaces.

With the knowledge gained from such studies, we hope to design and test new interfaces and algorithms to better support the needs of children.

RELATED RESEARCH

The research on children's search interfaces includes three areas of HCI and information science research: (1) search strategies; (2) typing and spelling; (3) deciphering results. These three aspects also identify the areas of considerable challenge for children. In the sections that follow, we discuss research and challenges in each of these areas.

Search Strategies

Twenty years ago, Marchionini [15] found that while using a CD-ROM encyclopedia to search, children had difficulty formulating search terms and frequently used natural language or phrases instead of keywords. The younger children in the study, 8-10 year olds, were much more likely than the 11-12 year old group to use phrases or sentences, leading to unsuccessful searches.

Large et al. [13] found that while using multimedia CD-ROM programs, 11 and 12-year old children preferred to browse for information rather than to search. Schacter et al. [19] suggest that lack of planning when attempting a complex search and a desire for the easiest path to the desired information lead children to prefer browsing to keyword search. This finding is consistent with the observation that novice adult users tend to prefer strategies that require less cognitive load [15].

Bilal [3, 4] also found that when looking for information on Yahoooligans, a web directory, 12 and 13 year old children were better at finding information by browsing than by searching, and that they browsed much more than they searched. Despite this, the children still preferred to use keywords to search. Thus, while children might use sub-optimal search strategies and fail to find the information they need, they still may want to use keyword search interfaces.

Typing and Spelling

Typing and spelling are challenges for children at many ages, particularly at younger ages. King and Alloway [10] studied children ranging in age from 4 to 8 and found that the keyboard was the slowest method of input across all age groups when compared with the mouse and the joystick. Researchers have also found that certain keyboard letters may be harder to find for children, causing them to be slow at entering letters for a keyword search [7]. Typing also compounds the challenge of spelling words correctly. Solomon found spelling and typing difficulties to be the most common reason for search failure with children aged 7-11 [20]. In addition, children tended to make more spelling errors when the query was more complex. However, by age 11-13, after keyboarding classes are taught in school, children acquire keyboarding skills that do not hamper searching [5]. Solomon found that when children develop the ability to type and spell more fluently, they are also able to focus more on their query formulation [20].

Selecting Results

Finally, once a search is entered, children can also have difficulty understanding the information presented to them on the results page due to their cognitive abilities, the amount of information presented, and the design of the page. Large and Besheti found that children were frustrated by the return of too many results and didn't have the ability to determine the most relevant and "best" information [11]. Another study on home use of search showed that children expressed confidence in their ability to search the web, but in practice often did not find what they wanted, did not trust the information they found, did not ask for help, and did not fact-check the results they selected [14].

Several problems have also been cited in the design of results pages. Naidu [16] found that children reported that sites with many and poorly organized links were "messy". The number of links on current search results pages may therefore be overwhelming to some children. Children appear to prefer text in narrower columns, although wider columns did not slow children down when researchers tested reading speeds [2]. Current search engines typically make full use of the whole screen when presenting results and the effects of full screen results are not well

understood with children. Naidu [16] also found that children did not use the scrolling option on homework help web pages [3]. Current search engines generally require scrolling to see all of the results, which may have an impact on children's use of the results.

STUDY METHODS

In the summer of 2008, we undertook an initial study to better understand how children search for information on the Internet and to answer some of the research questions we had from the literature. The purpose of this study was to begin to gather initial qualitative data, pinpoint trends in children's behaviors, and to further develop our methods for future larger studies.

Participants

The participants in our study were randomly selected from a convenience sampling and included 12 children; 5 boys and 7 girls, from the metropolitan Washington D.C. area. Four children were age 7, four were age 9, and four were age 11. These specific ages were chosen based on previous research [9] indicating that we were likely to see differences in searching behaviors between these age groups. It should be noted that few studies concerned with Internet searching have included children as young as 7 years of age.



Figure 2 – Child (age 11) searching for information about his favorite movie.

Data collection methods

Our data collection methods were qualitative, in-home interviews with both parents and children. The parent interviews were designed to be short discussions away from the computer. The children were interviewed at their home computer and asked to show researchers how they performed certain computer tasks. By using qualitative methods we enabled children to work in their natural environment without placing additional burdens on parents to allow us to install tracking software.

The interview sessions involved two researchers. Each session began with one researcher interviewing the parent

while taking notes and audio recording. During this interview, the other researcher would talk or play with the child. This method allowed us to interview the parent with the child out of the room so that the parent was not distracted by the child or influenced by hearing the child's answers. It also allowed the second researcher time to establish a rapport with the child. Parent interviews were typically short, lasting 15-20 minutes on average. (See [8] for parent and child interview protocols).

After the parent interview, researchers interviewed the child. The researcher who spoke to the parent functioned as the note-taker for the child interview and a video camera was used to record the participants' keyboard and screen interaction. We have found that this method of having two researchers working during the child interview helps to free up the researcher speaking with the child for a more interactive interview. Parents were welcome to observe while researchers worked with the child. However, we asked them not to step in or help their child as it could impact our findings.

Tasks

The interview questions were adapted from protocols used by Google user experience researchers. However, researchers did not mention Google to the child participants until either the child mentioned using it or until after the child had demonstrated their search strategies several times. While the initial protocols from Google were designed for use with adult search participants, they were useful in developing background questions for parents and children. The final interview questions were refined to be appropriate to the needs of the child participants.

The interview questions for the children focused on how they would search for information on the Internet, along with some activities designed to elicit Internet searching. The interviews began by asking open-ended questions, to see what search tools children regularly made use of, and then moved to more specific questions to enable us to compare children's search strategies and behaviors. The four task-specific questions started with a relatively simple query: "How would you search for information on dolphins?" and progressed to a final question that needed a multi-step query for the answer: "What day of the week will the Vice President's birthday be on next year?" All children worked at the computer that they most often used in the home, which provided a familiar, comfortable setting. Overall, these interviews took between 30 and 45 minutes.

Data

The final data collected consisted of 7.5 hours of video footage that recorded the children's interview and search experience. In addition, we collected almost 4 hours of audio recordings of parent interviews, and 156 pages of

participant observation/interview notes taken by researchers.

DATA ANALYSIS METHODS

Qualitative methods were used to understand the process and outcomes of the children's search experiences. Based on the methods described by Strauss and Corbin [21], categories for analysis were not imposed during data collection but developed inductively after all the data was collected. At an initial analysis meeting, themes for further analysis were generated from the data. Then categorizing, sorting, and comparing were used by two of the researchers to further develop the categories for analysis. Each of these categories was reviewed by two of the other researchers for consistency and refinement.

Analysis of all forms of data began with "open coding" of the text, video, and audio to identify categories and properties. These codes were systematically compared and contrasted in discussions among all researchers. Questions, speculation, and emerging categories of codes were noted in the personal journals and at times represented visually with post-it notes on a board.

Following open-coding analysis, we used "axial coding" to make connections between a category and its subcategories more explicit [21]. Selective coding was then conducted to see if additional categories were needed or if certain categories were not needed due to infrequency. This sorting, comparing and contrasting was done until "saturated," or no new codes or categories emerged. An audit trail was kept in journals to maintain accountability and rigor of the analysis process. From this process, eight categories emerged for analysis:

1. Interaction between keyboarding and screen use – gaze direction, use of auto-complete
2. Children's knowledge and use of Google search – prior use, features known, overall perception
3. Searching frustration – reported frustration, observed verbal and non-verbal frustration
4. Typing and spelling approaches – one-handed vs. two-handed input, touch-typing method, spelling errors, assistance tools
5. Place of query entry for children – use and understanding of textboxes
6. 2+ step query – query completion, stages of query completion, switching between search strategies, keyword vs. natural language input
7. Deciphering results – use of multiple-page search results, result number selected
8. Magic Tool – reported search features desired from parents, reported search features desired from children, comparison of desired features

Multiple categories could be applied to a given piece of data. Before full analysis of the data was done, two of the researchers did an initial test on the same 40% of sample video and notes and their analyses were compared to look for inter-rater reliability. In all, there were 20 trends analyzed. For 3 of these, both evaluators worked together on all participant data. For the other 17, after training together, an average inter-rater reliability of 91% was achieved, with a standard deviation of 9%.

Once all the data was analyzed, a meta-analysis was done by three of the researchers to look for the most frequent trends in the data and the largest differences or similarities among child participants. These trends are reported in the section that follows.

FINDINGS

Based on the data analysis methods described in the previous section, eight areas for further discussion were found. These findings are described below.

Interaction of Children's Keyboarding and Screen Use

One of the most consistent results in this study across all ages was in how the children's typing abilities impacted their interaction with and use of the screen. None of the children looked at the screen while beginning to type. Their gaze was focused on the keyboard initially (see Figure 3).



Figure 3 – Child (age 9) typing a keyword on his home computer.

dolphin fo	
dolphin football	4,420,000 results
dolphin food	10,000,000 results
dolphin football schedule	573,000 results
dolphin font	1,180,000 results
dolphin forum	5,740,000 results
dolphin fountain	207,000 results
dolphin for kids	6,720,000 results
dolphin football schedule 2008	625,000 results
dolphin football pool	742,000 results
dolphin football stadium	500,000 results
	close

Figure 4 - Google's auto-complete feature during a search for dolphin food.

However, as the queries became more complex, children would sporadically look at the screen more often while typing. This rapid glancing was not frequent enough for the children to take advantage of the auto-complete feature (see Figure 4) often provided by search engines.

One child did notice the auto-complete drop-down box quite by accident, and then selected the correct spelling of his search term. Almost all of the participants looked at the screen at the end of their typing just before submitting their query. Rarely did this practice cause any of the children to change their input; they simply looked to see what they were about to submit. This critical disconnect from keyboard to screen seemed to impact children's ability to retrieve the search results they needed.

Children's Knowledge and Use of Google

Almost all of the children in this study used Google Search prior to our interview. This came as a surprise to us since no previous research had suggested children's extensive use of Google. In addition, the children we chose to work with were randomly selected for the study and we did not direct them to use Google when we began the interview. Ten out of 12 children reported regularly using Google, however two of these (the 7-year-old girls) were not familiar with a majority of Google's features. Only one child reported never using Google Search prior to our visit but had heard of it. When asked to describe the features of Google and explain how to use the search engine, seven children spent time pointing out the text box used to enter search terms. Only four children explicitly pointed out the results page, and just three of the twelve children interviewed discussed content filters such as Google images, maps, news, etc. Of all the children participants, only one described using the "I'm Feeling Lucky" button.

Interestingly, the children's overall perception of the Google search engine was quite positive. When asked why they use Google such comments shared were, "Google is easy and I like Google" (9-year-old boy); "Because my grandfather told me it's a cool site where you can find lots of information" (11-year-old boy); "I can find a lot" (7-year-old boy). Despite the difficulties that many of these children experienced, this positive attitude is consistent with that of Livingstone et al., [14] who found that children liked and considered themselves adept at searching even if the reality was otherwise.

Children's Frustration During Search

When children were asked directly what most frustrates them about finding something on the Internet, they most often reported being frustrated when they felt information was hard to find. As one 11-year-old boy suggested, "They just don't have what you want on the Internet—it's really annoying." On the other hand, an 11-year-old explained, "Google takes up the entire Internet. What's not on Google, there isn't." Under either perception, not finding what you want was the most frustrating.

Four of the children discussed their frustration when it came to perceived barriers in the software. For example, one 9-year-old child explained, "It doesn't do all the words you say," suggesting that even though he entered several keywords, he still could not find the information he wanted. One 7-year-old child suggested, "When stuff gets messed up, it does things and I don't know what will happen." This child was referring to a number of situations: unexpected pop-up windows, browser errors or crashes, and unexpected results.

Another four children indicated that what frustrates them is encountering unexpected information from a search. As one 11-year-old shared, "When you type in something other things pop up that don't have much to do with it."

Our team defined 'frustration' as the point at which a child stated a phrase that expressed their frustration and their body language confirmed their displeasure. Signs of frustration were found in all child participants, but each age group experienced different sources of frustration. In general, younger children indicated more frustration with typing their queries. Older children were more frustrated when they weren't able to find the desired information. Other causes of observed frustration for all age groups included not understanding when to use the back and forward buttons and not knowing what to do if they received errors from the browser. When comparing the reported frustrations with the observed frustrations, we found that children were able to state accurately the causes for their frustration.

Children's Approaches to Typing and Spelling

The majority of the participants in this study used the "hunt & peck" method of typing – three or fewer fingers to type with a steady gaze at the keyboard seeking the desired letter. Of these, only one of them used two hands while hunting and pecking. The "hunt & peck" children included all the 7-year olds and almost all of the 9 year olds.

A seven year old declined performing searches due to his inability to "write" using the keyboard. One of the nine year olds stated, "I should really learn how to type" while typing with one finger, indicating his awareness of the difficulty of searching without typing proficiency. Three of the participants (one 9-year-old and two of the 11-year-olds) used more than three fingers to type, but were not using a touch typing method. There were only two participants (both 11-year-olds) that used the touch-typing method.

These results confirm the findings from Borgman, et al., [5] that as children grow older, they become more adept at using the keyboard as an input device. King and Alloway [10] also noticed this improvement with age. Although almost all of the participants reported beginning computer use at young ages and most rated themselves at a medium level of expertise, the problems experienced by participants in this study mirror the problems researchers documented 15 years ago, before home computer use was common. All of the 7-year-olds in the study had spelling errors. Overall, 7 out of 12 participants had spelling errors in some query they made during the study. This is consistent with the literature on spelling challenges for children, which shows that children's spelling begins to improve around age 11 [5]. The children participating frequently asked researchers if their spelling was correct before initiating their search. A participant (age 9) asked, "Is dolphins two L's, or two F's, or one L or a mix of that?", and then immediately discovered Google's 'Did you mean' spelling suggestion feature.

In this instance, 'Did You Mean' was able to assist the child in his search. However, most spelling errors were severe enough that the feature did not help (see Figure 5). Additionally, the placement and visual style of the 'Did you mean' feature led to many children overlooking it entirely as they looked at the results page.

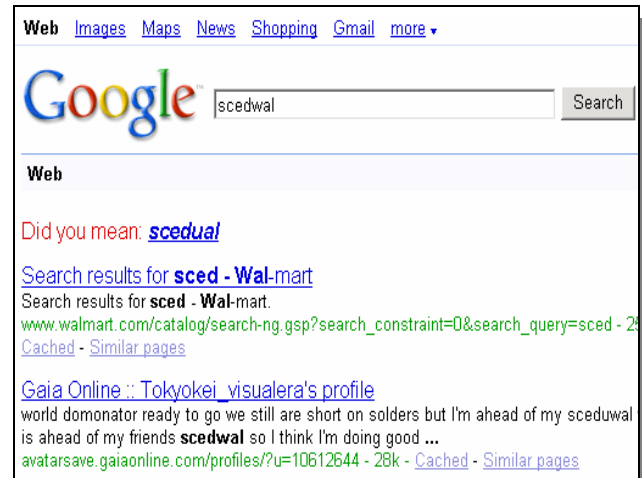


Figure 5- A child's misspelling of 'schedule' and Google's 'Did you mean' feature, in this case not helpful.

Our findings suggest that mere familiarity and comfort with technology has not allowed children to become proficient at typing, and spelling difficulties also continue to pose problems. Designers of search engines have attempted to alleviate some of the difficulty experienced by users in spelling and typing their queries by providing features such as auto-complete and 'Did you mean', but our research demonstrates that these tools are not always discovered by children.

Place of Query Entry for Children

The majority of the children in this study chose to type their queries into the Google webpage textbox, the text box available either in the center of the Google homepage or at the top of each Google results page (see Figure 6, #3). This preference may be due to either the participant starting on the Google home page for each new query or using the results page from the previous search. A few of the participants chose to use the 'back' button to initiate a new search.

In less than half of the queries entered by the participants, the toolbar textbox in the browser was used (see Figure 6 #2). This textbox was located to the right of the address bar at the top of the browser window. Those who used the address bar knew the URL of the webpage to visit in order to find the answer and did not need to perform a search. Only three of the participants showed they were comfortable with either method of query entry by switching from the webpage textbox to the toolbar textbox when they typed a query and vice versa. These search preference emphasize the 'stickiness' of the Google webpage search box when performing searches.

Toolbar textboxes are fairly new search tools. Although commonly installed, they may not be discovered or understood by children. Further study is needed to better understand the use and impact of searching using this browser search component.

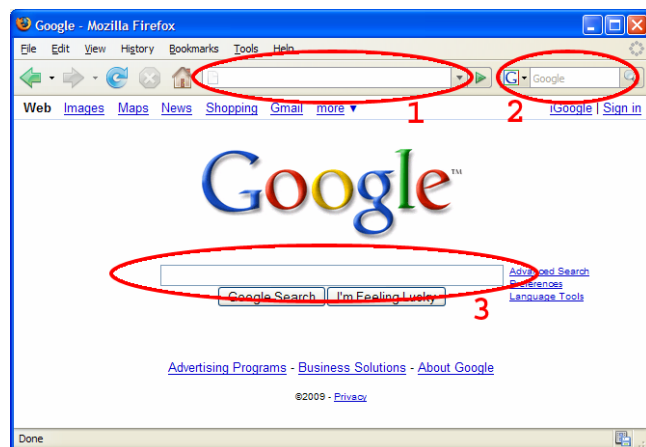


Figure 6 – Three Google options for locations of search entry (1) address bar, (2) toolbar text box, and (3) webpage text box.

Children's Approaches to Complex Queries

When the children in this study were asked to search for the answer to: "Which day of the week will the Vice-President's birthday be on next year?" none of them were able to answer the question. In fact, only one 9-year-old participant even began with a reasonable approach by searching for two or more pieces of information separately. This question required children to engage in a multi-step search to retrieve three pieces of information: the name of the vice-president, the day and month of his birth, and a calendar for 2009.

Previous research studies have asked children to employ Boolean techniques to find information that meets two or more criteria (e.g. [9]). However, none of these studies have analyzed how children search when the target must be found by performing a series of interdependent searches. In these scenarios, each subsequent piece of information is found by utilizing a previous result. Two of the children seemed to know who the Vice President was and made it beyond the first search step. However, three children, all age 7, couldn't begin to answer the question, and didn't try. One 11-year-old boy attempted the query once and when he didn't find the answer to the question, he assumed, "No one cares to put it [the information] on the Internet because it doesn't really matter." This finding was important to understand, since we know of no studies that have explored the limits of children's abilities with multi-step keyword queries.

The majority of the children's queries in the study were built using keywords, as opposed to natural language

structures. However, for the multi-step search question, natural language was more common. Half of the children who chose to attempt this query began by using natural language questions typed into the search box. Frequently these natural language queries were the verbatim question asked by the researcher. The other half of the children started searching with keywords, and only one switched from natural language to keyword use during the course of his search. Thus, despite more familiarity and experience with searching, these children exhibited the same tendency to fall back on natural language queries noted by Marchionini 20 years ago [15].

How Children Use the Results

The majority of the participants never went beyond the first page of results and typically, the first result was selected. The second, third, fourth, and sixth results were selected second with an even distribution. This finding confirms Bilal's earlier finding that children rarely examine more than five result links [3] and highlights the need for changes to the design of result pages for children. This suggestion was expressed in previous studies [e.g., 3, 12] yet still has not been embraced by most search engines.

Some of the children decided to investigate the 'related searches' at the bottom of the results page after scanning through the list of results and not selecting any links to visit. This feature assisted with keyword creation and prompted them to continue the search. This finding confirms previous studies that describe the usefulness of a tool that helps users with keyword creation and selection by displaying potential synonyms and other related words [15]. However, the location of these related searches at the bottom of the page meant that many children did not see them.

Several of the children quickly came to the conclusion that if they could not find the information they were looking for, that it simply was not on the Internet. This is quite different from the persistence children demonstrated when searching for information in smaller, more contained repositories reported in previous studies [13, 15]. This previous persistence was explained to be a result of motivation, self-confidence and a heightened faith in technology [3]. Are children today no longer confident in technology or motivated to search further for the information they seek? Does the magnitude of information presented make them less confident in their ability to search and find the information they request? These questions need to be investigated in order to address the information seeking behaviors of today's children.

What Children and Parents Want for Search Tools

We ended our interviews with both parents and children by asking them what they would design if they could create a “magic tool” for searching. The responses suggested that they all cared about Internet safety, clearer results, and the option of multiple forms of input (e.g., audio or visual). Changing the current format of displaying results was the most frequently requested by the children. One child, a 9-year-old boy, said he expected, “only the thing you wanted would show up, instead of all these [results], only one thing.” Three children cared about how fast they could search, while this was not mentioned by parents. Other changes desired by children included spelling help and safety. The top response from parents was a desire for developmentally appropriate results. Safety was the second most suggested from the parents, and multiple forms of input for search was the third most common response.

The open-ended nature of this question also meant that we got some wild, “blue-sky” ideas. Responses included vivid descriptions of telepathic searching tools, extra keyboard buttons, and magic microphones that transcribe searches. While these responses may be impractical when examining current search interfaces, they open a world of possibilities to innovative designers. Additionally, they confirm parent concerns, a perspective not generally present in previous studies.

DESIGNING FUTURE SEARCH INTERFACES

Based on this study, the following design directions are suggested for developers considering future search interfaces for children: (1) consider alternative input methods, (2) explore alternate auto-complete algorithms, (3) limit or expand the results, and (4) age the interface.

Consider Alternate Input Methods

While there is some evidence that children like keyword interfaces, this approach to search clearly presents problems. Typing and spelling slow children down, and auto-complete does not seem to help because children aren’t looking at the screen at the right time. Even selecting keywords to type often leads to complete failure, particularly with complex queries, and the assumption that the information simply isn’t available. Interfaces that enable alternative forms of query input, such as clicking on pre-defined categories or speaking an audio query would address these issues.

Explore Alternate Auto-complete Algorithms

Our research suggests that auto-complete as it is currently implemented is not optimal for children in the 7-11 age group. Children aren’t looking at the screen when auto-complete triggers. However, they are looking at the screen once they finish typing. Perhaps offering suggestions after a long pause, or when the search button is pressed, could be more helpful for understanding intent, catching

spelling mistakes, and offering suggestions for common and complex queries. In addition, perhaps locating the auto complete feature near the bottom of the screen might catch children’s attention as they focus on typing at the keyboard.

Limit or Expand the Search Results

Our research shows that “paging” through results is not a common behavior for children. This finding confirms previous research that suggests densely packed, link-heavy results pages which require vertical scrolling are not optimal for use with children [13]. A single page of results with less text, fewer links, and no scrolling required might be more useful for children in the 7-11 age range. By contrast, another alternative to a simplified results page might be a redefined interface that better indicates to the young user that there is more information to be found on subsequent pages.

Age the Interface

While safety is one obvious concern, age-appropriateness for the interface in general is an issue with both the input and the search results. In terms of input, it is clear that children, especially young ones, struggle with typing keywords, yet this is how they choose to search. Perhaps the ability to change the interface temporarily would enable younger children to be more successful in their search, yet not ask them to go to another web page or website that they don’t perceive is “good.” This would enable more visual or audio options to be offered.

For the results, given that children are likely to select from just the first few items returned, ensuring that the content is designed for their reading level is important.

CONCLUSION AND FUTURE WORK

This initial study has uncovered several critical problems children experience when searching on the Internet. Despite their status as digital natives, children continue to struggle with spelling and typing, so they tend not to look at the screen while composing their search. Therefore, tools designed to make searching easier such as auto-complete and spelling suggestions go unnoticed in their current form. In addition, children in this study showed an inability to construct queries requiring more than one search step. Finally, once a search was executed, results went largely ignored except for the first few items on the first page. All of these challenges frequently led not only to failure, but also to observable frustration.

Based on the results of this study, we are currently working on a much larger study to confirm these results and to explore children’s reasoning behind why they think they got “bad” or “good” results. We are also looking to see if there is any difference in search behaviors by gender or socio-economic status. With this work, we hope to develop concrete solutions to improving the search experience for children.

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REFERENCES

1. Bennett, S., Maton, K., & Kervin, L. The 'digital natives' debate: A critical review of the evidence. *British Journal of Educational Technology*. 39, 5 (2008), 775-786.
2. Bernard, M., Fernandez, M., and Hull, S. The effects of line length on children and adults' online reading performance. *Usability News*. 4, 1 (2002).
3. Bilal, D. Children's use of the Yahoo!igans! web search engine: I. Cognitive, physical, and affective behaviors on fact-based search tasks. *Journal of the American Society for Information Science*. 51, 7 (2000), 646-665.
4. Bilal, D. Children's use of the Yahoo!igans! web search engine. III. Cognitive and physical behaviors on fully self-generated search tasks. *Journal of the American Society for Information Science and Technology*. 53, 13 (2002) 1170-1183.
5. Borgman, C., Hirsh, S., Walter, A., and Gallagher, A. Children's searching behavior on browsing and keyword online catalogs: The Science Library Catalog Project. *Journal of the American Society for Information Science and Technology*. 46, 9 (1995), 663-684.
6. Corporation for Public Broadcasting (CPB). Connected to the future: A report on children's internet use from the Corporation for Public Broadcasting. (2002). http://www.cpb.org/stations/reports/connected/connected_report.pdf
7. Crook, C. and Bennett, L. Does using a computer disturb the organization of children's writing? *British Journal of Developmental Psychology*. 25, 2, 313-321.
8. How children search the internet with keyword interfaces: Interview protocols. <http://cs.umd.edu/hcil/KidsSearch/AppendixA/pdf>.
9. Hutchinson, H., Druin, A., and Bederson, B. Supporting elementary-age children's searching and browsing: Design and evaluation using the International Children's Digital Library. *Journal of the American Society for Information Science and Technology*. 58, 11 (2007), 1618-1630.
10. King, J. and Alloway, N. Young children's use of microcomputer input devices. *Computers in the Schools*. 9, 4 (1993).
11. Large, A. and Beheshti, J. The web as a classroom resource: Reactions from the users. *Journal of the American Society for Information Science*. 51, 12 (2000), 1069-80.
12. Large, A. and Beheshti, A. Interface design, web portals, and children. *Library Trends*. 54, 2 (2005), 318-342.
13. Large, A., Beheshti, J., and Breuleux, A. Information seeking in a multimedia environment by primary school students. *Library and Information Science Research*. 20, 4 (1998), 343-376.
14. Livingstone, S., Bober, M., and Helsper, E. Internet literacy among children and young people: Findings from the UK Children Go Online project. London: LSE Research Online, (2005).
15. Marchionini, G. Information-seeking strategies of novices using a full-text electronic encyclopedia. *Journal of the American Society for Information Science*. 40, 1, 54-66.
16. Naidu, S. Evaluating the usability of educational websites of children. *Usability News*. 7, 2 (July, 2005).
17. National Telecommunications and Information Administration (NTIA). *A nation online: How Americans are expanding their use of the internet*. (2002). <http://www.ntia.doc.gov/ntiahome/dn/anationonline2.pdf>
18. Roberts, D. and Foehr, U. Trends in media use. *Children and Electronic Media*. 18, 1 (Spring, 2008), 11-38.
19. Schacter, J., Chung, G., and Dorr, A. Children's internet searching on complex problems: Performance and process analyses. *Journal of the American Society for Information Science*. 49, 9 (1998), 840-849.
20. Solomon, P. Children's information retrieval behavior: A case analysis of an OPAC. *Journal of the American Society for Information Science*. 44, 5 (Jan, 1993), 245-64.
21. Strauss, A. and Corbin, J. *Basics of qualitative research: Grounded theory procedures and techniques*. Sage, Newbury Park, CA, USA, 1990.