

# Children's Search Engines from an Information Search Process Perspective

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*A crucial component to using the Web satisfactorily is locating what one is looking for. The paper begins with a description of some of the cognitive and affective characteristics of children and teenagers that may affect their searching behavior. It reviews some of the literature on children's searching in online public access catalogs (OPACs) and using digital libraries. The focus of the paper is on Web search engines. Two search engines are profiled. Some of the difficulties children have searching the Web are discussed in the context of the Kuhlthau's Information Search Process (ISP) model.*

With the increasing visibility of the Internet, many parents, educators, and government officials consider Internet access an important prerequisite to developing information literacy. Yet Internet access alone is not enough. As anyone who has used it knows, it is often difficult to locate information on the Internet (Butler 2000). This is true for both children and adults, regardless of whether they are novice or experienced Web surfers.

This paper will address the following questions, focusing on middle and high school students:

- What does the research literature tell us about children's searching behavior, both on the Internet and with other online resources?
- How does searching the Internet differ from other online searching?
- How well do two leading search engines designed specifically for children work?
- What can we learn from thinking about Web searching from the perspective of Kuhlthau's Information Search Process (ISP) model?

## Cognition, Mechanical Skills, and the Roles of Affect and Motivation

A review of developmental or educational psychology would be beyond the scope of this paper. Suffice it to say that children's cognitive and mechanical skills are not as developed as those of adults' (Hirsh 1998; Kuhlthau 1991). These differences, in conjunction with affective and motivational differences, pose additional issues when developing an OPAC or Web search engine specifically for children. Some of these differences will be described in the following

paragraphs. Kuhlthau's ISP model, which contains cognitive and affective components, will also be described.

## Cognitive Skills

Children do not demonstrate the same higher-order thinking skills that adults do (Neuman 1995). Obviously these skills are on a continuum and are more likely to be found in older children than in younger children. Furthermore, as Chelton and Thomas point out, there is a wide range "of developmental and maturational differences . . . in any group of adolescents" (1999, 8).

One example of a cognitive difference between children and adults that will affect their ability to perform a search is the lack of a developed recall memory (Borgman et al. 1995). While adults typically have better recognition memory than recall memory, the disparity between the two seems to be greater in children. Because children are often novices in the areas they are researching (Kuhlthau 1997), they are unable to create a schema for storing information (Borgman et al.). The lack of schema creates difficulties when a child must modify his or her search (Fidel et al. 1999; Nahl and Harada 1996).

## Mechanical Skills

Solomon (1993) explored the OPAC searching behavior of elementary school children. He pointed out a number of mechanical skills necessary for effective searching: typing and keyboarding, spelling, adequate vocabulary, reading, and alphabetizing. These skills were often weak in the study's participants, particularly in the very young children. Not surprisingly, these mechanical skills increased with age.

In their research on the OPAC behaviors of nine- through twelve-year-olds, Borgman and colleagues (1995) found similar results. Even among high school students, Fidel et al. (1999) found that misspellings created problems when searching. Their study examined Web use behavior and found that keyboarding errors, particularly when typing in URLs, were frequently a hurdle for searchers. They attributed this to the length and case-sensitivity of URLs.

## Subject Searching: Controlled Vocabulary and Boolean Logic

Two issues are consistently brought up in the literature on searching behavior: the application of Boolean logic and the constraints of controlled vocabulary. Research suggests that Boolean logic is confusing to apply, particularly for children (Borgman 1996; Borgman et al. 1995; Nahl and Harada 1996; Schwartz 1998; Solomon 1993). Many end-users may be unaware of the fact that the subject search terms are based on a controlled vocabulary, some of which is quite arcane. Evidence that many searchers are unaware of the role of controlled vocabulary is demonstrated by the fact that many of the children in the study enter their queries using natural language (e.g., "Are dolphins fish?") (Bilal 1998; Nahl and Harada 1996, Schacter, Chung, and Dorr 1998).

## Affective Issues

Kuhlthau's early work on the ISP was groundbreaking in that it acknowledged the role of affect in the search process (1991). She addressed the effect of anxiety, the impact of uncertainty, and

the importance of sensemaking. She suggested ways that an information professional can address these components to facilitate the search process.

In her more recent work, Kuhlthau (1999) introduces the concept of “enough,” and its implications in digital libraries. She suggests that searchers must define “the concept of enough as what is enough to make sense for oneself within a context and to accomplish the task at hand” (6). Within the framework of digital libraries, the concept of enough can be applied at each stage in the ISP to assure effective information seeking.

## **Motivational Issues Specific to Students**

According to Kuhlthau, the role of motivation is particularly noticeable in the first stage of the ISP, during which “thoughts are commonly centered externally on ‘What does the teacher want?’” (1999, 6). For a search to proceed effectively, the individual must develop an understanding of “what makes sense for oneself.” This seems like it would be particularly problematic for children educated in a traditional school environment or for anyone conducting a search for someone else in which they do not feel a sense of ownership. The effect of externally imposed searches has been described by Gross (1998).

Kuhlthau (1997) introduced the concept of “abundance” in the context of digital libraries. In this atmosphere of “abundance” it seems particularly challenging for a library media specialist (LMS) or teacher to convince an unmotivated student to distinguish between an adequate and a better-than-adequate source. In my experience watching high school students try to locate information on the Web, most seemed perfectly content to click on the first source listed and print it. Researchers (Schacter et al. 1998) report the tendency of students to review the first paragraph on a Web site to determine its suitability. Fidel and her colleagues did not find that students immediately print sources but very quickly made note of the information they needed and moved on (1999).

## **Summary of Cognitive, Mechanical, and Affective Issues**

Underdeveloped cognitive skills (e.g., recall memory), mechanical skills (e.g., spelling), unfamiliarity with Boolean logic, and the constraints of controlled vocabulary can create barriers when children are seeking information. Furthermore, children are often conducting imposed queries on school subjects of little personal interest to them and in areas where they have little or no background. This produces a situation in which unmotivated searchers perform searches using relatively limited skill sets. The implication of these factors on children’s online search behavior will now be reviewed.

## **Children’s Search Behavior**

### **Non-Internet Searching**

Solomon (1993) suggested that even very young elementary school children could use OPACs effectively, particularly for simple searches. However, he believed that the search tools should be improved for a variety of reasons. First, many children in his study encountered the mechanical problems described above. Among those who had the mechanical skills, applying these skills

often appeared to absorb all or almost all of their energy and distracted them from the search process in general. If lack of mechanical skills was not an issue, the students encountered conceptual difficulties in conducting the more complex searches.

Because of the mechanical difficulties children encountered, a number of attempts have been made to develop online search tools that children can use (Borgman et al. 1995; Solomon 1993). Perhaps the most well-documented of these is the Science Catalog Project developed by Borgman and her colleagues. Using HyperCard on a Macintosh, these researchers developed a cataloging system which users navigated solely with a mouse. The catalog only contained records from the 500s and 600s of the Dewey Decimal Classification (DDC), the Science and Technology categories. Following the DDC's structure, researchers click on progressively lower levels of the hierarchy until they reach the level of the individual books.

The catalog was tested on children ages nine through twelve from a variety of locations. Interestingly, the Science Catalog Project's focus group data indicated that catalog searching was rated a "poor third" when compared to browsing the shelves or asking a librarian for help (Borgman et al. 1995, 674). The Science Catalog was most appealing to younger children, the ones most likely to encounter the mechanical difficulties described above.

Perhaps the most well-known electronic resource for children is [Electric Library](#) (Weinberger 1997). The Electric Library's search facility uses "intelligent expansion of query terms" so that a query for "smartest animals" would return citations classified as "intelligent creatures" or "clever beasts" (p. 635). The search results are ranked by relevance and grade reading level is indicated. Jacobson and Ignacio (1997) reported that the middle- and high school students they studied had some problems searching the Electric Library but "loved" the online text feature.

Other attempts to enable students to perform more effective searches are [Kid's Catalog](#) (Busey and Doerr 1993), which uses a graphical interface and the online catalog developed by Chen (1993) that she used with 11th graders.

Neuman found that among the twenty-five LMSs she surveyed, the most significant problems their students encountered in database searching were "generating search terms" and "designing effective search strategies." In addition, the LMSs reported that there are "mismatches between personal ideas of how information is organized and how information is actually organized in databases" (1995, 297). While many of the problems the LMSs reported could be attributed to problems conducting research in general, certain problems were exclusive to online searching.

## Internet Searching

Research suggests that children appreciate the graphical interface and multimedia format of the Web. The convenience of (some) full-text and the (relative) immediacy of the results is also appealing (Bilal and Watson 1998; Fidel et al. 1999). Unfortunately, if children cannot find what they need the graphical interface and multimedia format are essentially useless. While the types of problems children encounter using OPACs, Electric Library, or CD-ROMs (Marchionini 1989) probably will not disappear when they use the Internet, can some of them be minimized?

## Web Search Engines

The Internet is a vast network of information that is typically searched using a commercial search engine such as Yahoo! ([www.yahoo.com](http://www.yahoo.com)) or AltaVista ([www.altavista.com](http://www.altavista.com)). What is commonly referred to as a “search engine” is actually an interface that launches a software program to locate information within a database maintained by that company. Web sites are added to the database using “robots”—software that searches the Web for new sites by following links from sites already in the database—or through submission by someone who finds the link valuable. The submission may or may not be made by the author. Any one search engine only indexes a fraction of the Internet (Lawrence and Giles 1999), which accounts for the fact that the same search submitted to different search engines will produce different “hits” (i.e., references to Web sites).

There are two basic approaches for locating information using a search engine: queries and directories (Minkel and Feldman 1998; Schwartz 1998). Queries allow the user to enter one or more search terms, while the directory structure requires the user to click on progressively refined subcategories. A hybrid system combines these two approaches and allows the user to perform queries within the particular level of the classification hierarchy. A metaengine is a software program that allows one search to be submitted simultaneously to several search engines.

A query evokes a search of the database created by the particular search engine for the requested term or terms (Schwartz 1998). On the Internet, the search engine may-unbeknownst to all but the most well-informed researcher-search some combination of the text, title, URL, or (rarely) keywords. But the Internet lacks a mechanism for consistent indexing of keywords and only sources that contain the indexing term will be located (1998).

An alternate approach, designed to minimize the need to know all relevant indexing terms, is the use of directories. The directory approach requires the Web site’s creator or a person employed by the company that maintains the search engine to classify the Web site. Because it uses human indexers and thus is labor intensive, the directory structure accesses far fewer sites than a query of the same search engine. Furthermore, successful searching within a directory structure requires at least some knowledge about the topic (e.g., to know that whales are mammals) in order to navigate the hierarchy. This may pose a problem for children who are novices in the area they are researching.

## Characteristics of the Internet That Differentiate It from Other Types of Online Searching

The vastness of the Internet poses unique challenges for the searcher. Assuming the mechanical difficulties discussed above are not a problem, students will have access to online resources that were unavailable in their local library. But a search typically produces many hits, transforming the search process from that of finding information to finding high quality material best suited to one’s needs. The large number of hits makes it virtually impossible to review all of them for suitability and quality.

Another characteristic of the Web arises from the fact that anyone can create a Web site, making it difficult to be assured of its quality. Not only must students learn to cite their sources but they

must determine the quality of the source (Healy 1998). Jacobson and Ignacio (1997) noted that one advantage of having students create their own Web pages was that it made them acutely aware of how easy it was for anyone to become an author.

Unlike most other online resources, the Internet has commercial potential. On the Internet, a site's viability may require it to have advertising potential, which is a function of the number of visitors it attracts. This leads some less-than-scrupulous webmasters to pad their sites with commonly used but inapplicable search terms in the hope of increasing the number of visitors the site attracts. Unfortunately for the searcher, this can produce hits that have nothing to do with one's search topic.

Another manifestation of the commercialism is advertisements, which can be distracting. Even if one can ignore them, they clutter the screen and reduce the amount of space available for information. The reduction in usable space often forces the creator to add scrolling or additional links. Either makes the navigation task more complex for the user (Denning, Shuttleworth, and Smith 1998) and may be particularly cumbersome or disorienting for children. In addition, searchers have been known to accidentally enter their search in white query boxes that do not invoke search engines but rather redirect the searcher to the database of an online bookstore or other marketer.

Another difference between a search engine database and a bibliographic database is the latter's exhaustiveness. On the Internet, inclusion of a Web site in a search engine database is partly a function of the links in the Web site, because it is these links that determine if the search engine robot will locate the site. A search engine database only contains a small portion of the Internet.

In a bibliographic database the searcher will realize that their choice of search term might be incorrect if the catalog returns no references. On the Internet the search may have produced thousands of hits, but they may be only a portion of the available material due to the use of inconsistent indexing terms. Related to the problems posed by inconsistent indexing is the issue of word-form variations. Specifically the searcher must be aware of the fact that searching for "dogs" will not produce hits, if the subject term used is "dog." Most search engines accommodate truncation or allow searchers to specify *dog+*, where + indicates the wildcard character used by a particular engine. In an OPAC, if there are no exact matches to the sought term, the searcher is typically presented with the terms that are close alphabetically. Nahl and Harada (1996) noted that high school students repeatedly encountered difficulties with word-form variations when composing search statements.

## Description of Two Widely Used Search Engines

The search engines reviewed seemed designed for younger children rather than high school students. Two of the most popular search engines for children are Yahoooligans! (Yahoooligans herein) ([www.Yahoooligans.com](http://www.Yahoooligans.com)) and Ask Jeeves for Kids (AJ4Kids herein) ([www.AJ4Kids.com](http://www.AJ4Kids.com)), the electronic offspring of Yahoo! ([www.yahoo.com](http://www.yahoo.com)) and Ask Jeeves ([www.askjeeves.com](http://www.askjeeves.com)). A site created by the Ramapo Catskills Library System (1999) contains links to most of the major search engines for children. It also includes links to several search engines that run with a filter, although not the Lycos SafetyNet site.

**Yahooligans.** This search engine is designed for children ages seven through twelve. Like its parent search engine, Yahooligans provides a hybrid structure to locate Web sites. This approach is designed to avoid the problems associated with searching, such as misspelling and unfamiliarity with controlled vocabulary.

Most of the sites are submitted by users who classify them into one subcategory. Articles are listed in only one subcategory, although subcategories can appear in more than one place in the Yahooligans hierarchy. According to PC Magazine Online (Falkinburg 1998b), “most of the site’s listed come by suggestion, leaving Yahooligans with sites designed to meet the social needs of 8- to 12-year old users.” Enough said.

A query will search titles, URLs, and the description entered by the person who submitted the site for the search terms of interest. The help materials suggest using a query if you know exactly what you’re looking for. Queries containing more than one search term will only produce hits that contain all of the search terms. Note that this equivalent of a default “and” cannot be overridden.

Yahooligans provides a help facility, but it contains very little information on searching techniques. It provides instruction for teachers, who will presumably pass the information on to their students. It seems odd that a minimal amount of training materials are directed at students, because a large portion of them have Internet access outside of the classroom. However the information for teachers actually seemed quite accessible and could easily be digested by a middle school student.

Compared to the parent search engine, Yahooligans is uncluttered and features minimal distraction. There is no potentially distracting moving text. Advertisements are marked as such.

**Ask Jeeves For Kids.** AJ4Kids seems most appropriate for children younger than high school age. The help materials imply that it can be used as a starting point for high school students, who presumably are expected to use more sophisticated search techniques.

What is noteworthy about Ask Jeeves is that both its adult and children’s versions use a Natural Language Processor (NLP) (Basch 1999). This technique allows the user to enter “how does the baby get in the mommy’s tummy?” instead of “humans and fertilization.” AJ4Kids reworded the original question into “Where do babies come from?” and asked for confirmation that this was the intended question. The NLP provides one or more questions from which to select the one that most accurately represents one’s question. Clicking on the desired question links the searcher to the one Web site that the AJ4Kids staff believes best answers that question. (Although the PC Magazine Online review of AJ4Kids [Falkinburg 1998a] reports that the search they conducted returned two sites, the trials conducted by this researcher never returned more than one.)

The NLP seemed impervious to common data entry mistakes. It functioned without a question mark or quotation marks, and was not confused by mismatched quotation marks. When “Where is Rushia?” was submitted, AJ4Kids replied, “I think you may have misspelled something.” “Where is the Union of Soviet Socialist Republic?” resulted in a statement about a possible misspelling of the word “Republic” and offered “Republic” as an alternative. A spelling check option is available.

If multiple sources related to the topic of interest are available, the NLP provides a series of questions that narrow the search. For queries about “Russia,” “the USSR,” “the Soviet Union,” and “the Union of Soviet Socialist Republics,” each returned “Where can I find a history of the country Russia?” as one of the questions with which to access the database. Each of these four queries produced different additional questions along with “Where . . . Russia?” The query on the “Soviet Union” produced the question “Where can I find extensive historical, economic, and political information about the Soviet Union (former)?” that was not provided in response to any of the other three queries.

If AJ4Kids can answer the question posed, the resulting citation is displayed. However, there is no indication of the location of the resulting Web site. The printed version, however, includes the source URL. Many sites seem to require a higher level of reading skill than many children in the target audience (ages seven through twelve) would have.

If the database does not contain an answer to the question (or thinks it does not because it incorrectly interpreted the question), several popular search engines (InfoSeek, Excite, AltaVista, and Lycos) are invoked. A banner declares that the searches with these other engines use the “Surf Watch” filter. (Each of these engines returned only a few references and no documentation of how these searches were performed is provided.) The InfoSeek search appeared to list only sites completely unrelated to the topics of interest. If the users cannot find a satisfactory answer, they can e-mail the researchers at AJ4Kids, who will help them locate further references.

The NLP seems to avoid some of the problems associated with lack of consistent indexing terms and the use of Boolean logic. However, the fact that the queries about the Soviet Union and Russia did not produce the same hits is disconcerting, because even though they are not equivalent terms students may use them as such. Furthermore, the price to pay for the privilege of avoiding Boolean logic is that the NLP seemed unable to handle complex statements. For example, AJ4Kids was able to handle the query “What animals live in the Amazonian Rain Forest?” but returned inappropriate rewording of the question “What animals were living in the Amazonian Rain forest at the turn of this century?”

AJ4Kids seems cluttered with advertising, although less so than a search engine intended for adults. Unlike Yahoooligans, advertising is not marked as such. There is a large amount of moving text, which may be distracting for some viewers.

## Research on Web Searching

Surprisingly little research has been conducted on children’s Web searching behavior. Presumably this will change as Internet use spreads in schools nationwide.

Nahl and Harada (1996) developed training materials to help students navigate the Internet; they then conducted a study of 191 secondary students to determine the effectiveness of the materials. They asked students to answer questions such as “Why do dolphins migrate?” and “How do the types of dreams and daydreams affect how well we sleep?” Even with the training, when asked to perform what the researchers considered to be simple queries, novice searchers experienced a variety of difficulties. For successful searching, not only must students understand Boolean logic (including the default operators used by the engine) and the implications of the controlled

vocabulary, but that “building adequate content knowledge is a critical first step in successful information searching” (206).

Bilal (1998) and Bilal and Watson (1998) reported on the use of Yahoooligans by a 7th grade science class. While Yahoooligans is well known for its directory structure and the training materials on the Web site suggest the use of the subject categories, Bilal found that the students bypassed the subject categories in favor of keyword searching. Many students appeared to lack the basic skills to use the search engine effectively. Misspellings posed problems for many searchers. Other queries failed because the searcher neglected to use logical operators or resorted to using natural language. Overall the participants in Bilal’s 1998 study expressed frustration using Yahoooligans. She concluded that even successful searches seemed to produce too few materials appropriate for seventh graders.

Fidel and colleagues (1999) observed the Web searching behavior of eight eleventh and twelfth graders in a high school library. The students were completing three horticulture assignments over the course of three weeks. The students received minimal training on using the browser and essentially no training on how to conduct an effective search.

Students bypassed the subject categories in favor of submitting queries. The students were not required to use a particular search engine and all but the most experienced opted to use the engine that was selected at random when they clicked “Search” on the browser’s toolbar. Although the students seemed quite satisfied with their searches, the researchers concluded that they did not effectively navigate the Web. Instead of performing the search for the topic of interest, they often reused keywords or returned to Web sites that had been fruitful before.

## Summary of Children’s Searching Behavior

In contrast to the stereotype of today’s children as computer-savvy Internet experts, the results of the few studies conducted to date found that middle and high school students have surprisingly low levels of success using the Web as a search tool. An exception to this was Lubans’s (1999) study of seventh through tenth graders who were taking college-level summer classes at Duke University. Based on self-reported data, most students reported their “expertise in using the Web at *good* or above (3)” Of course, self-reported expertise is not a good proxy for objectively measured expertise, nor are high school students taking university-level coursework “typical.”

The type of problems reported when children use OPACs have not disappeared on the Internet. On the bright side, technological advances have resulted in some search engine interfaces that contain spell checkers and allow some degree of natural language processing—an improvement over what is typically seen in an OPAC. Nevertheless, successful use of the Internet requires the ability to conduct a search. In response to the low success rates they observe, information professionals (Bilal 1998; Fidel et al. 1999; Jacobson and Ignacio 1997; Watson 1998) stress the importance of training in Internet use. As schools appropriate funds for Internet access, it is important that they realize that funds will be needed to help teachers and librarians develop and disseminate Internet searching skills.

In each of the studies reviewed, the idiosyncrasies of controlled vocabulary accounted for some of the difficulties searchers had in generating terms to enter in a search engine. This seems particularly problematic on the Internet where this is no equivalent to the Library of Congress

Subject Headings to refer to. Many researchers noted that unfamiliarity with indexing terms made it difficult to formulate the initial search and was even more of a barrier when an initial search failed and subsequent searches were needed (Bilal and Watson 1998; Borgman et al. 1995; Fidel et al. 1999; Nahl and Harada 1996).

Neither Yahoooligans or AJ4Kids eliminated the major problem traditionally associated with online searching-knowing how to specify keywords. Furthermore, the search engines did not appear to be sophisticated enough to address the research needs of high school students, but although they may be a useful starting point. A high school student would probably be better served using Yahoo!, AskJeeves, or another search engine intended for adults, rather than their offspring. Note, however, that the screening of materials is not a feature of these engines.

To avoid some of the problems encountered in Web searching, Minkel and Hsu (1999) suggest using “webliographies,” Web pages typically compiled by librarians or school districts containing many (presumably screened) annotated links to sites with materials that can be used for homework assignments or school projects.

As described in the preceding sections, some of the mechanical problems associated with OPACs have actually been addressed in the development of search engines. Spell checking, natural language processing, and readily available hierarchical directory structures avoid some of the problems created by misspelling, controlled vocabulary, and misapplication of Boolean logic. Furthermore, as Jacobson and Ignacio suggest “the electronic environment changes the structure, practices, and culture of information seeking” (1997, 773). This sentiment is endorsed by Kuhlthau (1997), who modified her description of the Information Seeking Process to encompass the wealth of data in digital libraries. The next section describes her model and applies it to the Internet search process.

## Kuhlthau’s ISP and the World Wide Web

In her work on the ISP, Kuhlthau (1991) described six stages of the search process. The searcher does not progress through them linearly but eventually must pass through for successful completion of a complex task. In extending her theory to digital libraries (1997) she points out possible pitfalls introduced due to the larger amounts of information available via digital libraries. These are summarized in the second column of table 1.

**Table 1. Information Search Process Stages and the Internet**

Stage	Description/Possible Pitfalls (Kuhlthau, 1997)	WWW (Why maybe Worse on the Web)
1. Initiation	Thoughts need to turn from “what does the teacher want?” to “what do I want to know and learn?”	Evidence that children are anxious to use the computer and may be less inclined to spend time up front thinking about what they are interested in (Jacobson and Ignacio, Nahl and Harada).
2. Selection	Identify general area of interest	Will ease of locating information on the Internet become a primary

		determinant of what students choose to research?
3. Exploration	Users may try to collect copious/consistent information before their focus is formulated (see next stage); complicated due to inconsistent info	There is even more information, it may be even more inconsistent, and it may not have undergone a review process. Tremendous amounts of time can be spent.
4. Formulation	Important for students to “formulate a focused perspective” and to get an “understanding of what is enough . . . to avoid feeling overwhelmed” (716)”	It is almost impossible not to feel overwhelmed. Issue of “enough” is much more complex in abundant environment.
5. Collection	Gather information pertaining to focus	Evaluation of resources is more critical. As more time is spent in exploration, less time remains to peruse and evaluate critically. Librarian is not necessarily an authority, although she or he may still be perceived as such.
6. Presentation	Need to incorporate a personal perspective	Cutting and pasting makes it too easy to produce a report without incorporating a personal perspective. Complicated if formulation stage is not effectively resolved (which may be more likely to happen in digital library).

Although Kuhlthau was not speaking specifically about the Internet, the last column of table 1 contains an extension of her framework. Kuhlthau states that “the user’s experiences of the stages in the search process is related to how much the person knows about the problem and the degree of construction that needs to be undertaken during information seeking” (1999, 2). The literature suggests that when children perform Web searches, the cognitive load needed to answer a simple question is relatively high, for all but the most experienced searchers (Bilal and Watson 1998; Fidel et al. 1999; Nahl and Harada 1996; Schacter et al. 1998). Therefore, the following paragraphs contain an examination of Web searching within the context of Kuhlthau’s model. One can hypothesize that some of the obstacles that Kuhlthau observed in information seeking are in fact potentially more burdensome on the Web.

For example, Fidel and colleagues (1999) observed the Web searching behavior of eight eleventh and twelfth graders on several proscribed assignments. In stage 1 of Kuhlthau’s model (Initiation) students need to determine what they want to learn. However, Fidel and her colleagues reported that

The interactive nature of the Web supported the students' belief that there was no need to plan ahead because the progression of a search would be largely determined by what they saw on the screen. This principle was clearly reflected in their searching behavior, which was highly reactive. (27)

In stage 2 (Selection) students need to identify a general area of interest. At this stage, will ease of locating information on the Internet influence what a student chooses to research? For example, the Web has a tremendous amount of information on science and less information on the humanities (Minkel and Feldman 1999). Fidel and her colleagues (1999) reported that some of the students they observed changed their search topic (i.e., switched from one plant to another) when they had difficulty locating information about it. Of course, this can happen using traditional media if, for example, the student wanted to do a report on Martha Washington, but the one book in the school library was already circulating. It seems that the variety on the Web could make it easy to get distracted (taken down too many routes) during this stage.

In stage 3 (Exploration) students must be wary of collecting too much information prior to the next stage. On the Web, it is almost impossible not to collect too much information. Web researchers could conceivably get stuck at this stage because the amount of information may seem infinite.

In stage 4 (Formulation) the student must "formulate a focused perspective" (Kuhlthau 1997, 716). In the context of digital libraries "the emphasis is on locating the 'right' stuff and not on formulating ideas" (721). This, of course, makes it harder for effective searching to take place. While the ISP is "recursive" (1999, 3), it seems as if Web searchers, if not careful, could get stuck in a Selection-Exploration-Formulation loop.

Stage 5 (Collection) involves collecting information. On the Web the evaluation of resources is more critical due to the lack of a review process. Perhaps evaluation of resources needs to occur at the earlier stages as well. For example, if all the information available about a geographic location is provided by travel agencies, there may not be enough useful information on the topic of interest. Some of this may be avoidable if a student focuses on noncommercial sites or sites developed by educational institutions. Fidel and colleagues (1999) noticed that the students they observed used information that was readily available from gardening companies but that this was not necessarily the best source for the assignment.

For successful resolution of the final stage (Presentation), each of the preceding stages had to have been adequately negotiated, particularly the formulation stage. One potential Web pitfall is the ease of cutting and pasting, which can make it too easy to produce a report without incorporating a personal perspective. The lack of a personal perspective makes it more difficult for the constructivist thinking essential to successful information seeking to occur (Kuhlthau 1997).

In conclusion, while Kuhlthau's model was designed for more complex tasks than Web searching, the existing literature suggests that it may be applicable. In fact, there appears to be some evidence that some of the traditional pitfalls encountered while searching may be deeper on the Web.

## Other Relevant Issues Not Addressed in Detail

This paper focused on searching behavior primarily from an information behavior perspective. This is just one aspect of the very complex world of the Internet and consequently, many issues have not been dealt with.

Perhaps the most controversial of these is Internet filters. Not only are the technical issues involved with using filters complicated, but the application of filters quickly becomes an issue of free speech (Johnson 1998). It is not difficult to find out if a filter is running along with the Internet connection. However it is not as easy to find out what is being screened if a filter is running. Parents and teachers should be aware of the fact that computers in their children's school and public library may or may not use filters.

Another complex issue that arises in using the Internet is that of authorship. Students must learn to cite electronic sources. Protocols for this are now available from online sources (American Psychological Association 1999; Crane 1997). However, it is not always possible to determine the author and the date the site was last modified.

Surprisingly little research has been done on the use of Web search engines. One area that will need to be addressed is background variables that may affect one's ability to use a search engine. This is particularly important, because a recent Department of Commerce report suggested that socio-economic status and ethnicity appear to account for large differences in computer and Internet access at home (Sanger 1999). Schacter et al. (1998) found gender differences in searching behavior; Nahl and Harada (1996) found gender differences in confidence levels; and Lubans (1999) found differences in computer usage, likelihood of having a personal home page, and self-reported expertise. In addition, Wenglinisky reported racial differences in the academic merit of the classroom time spent on computers (1998). Furthermore, the dominance of English as the language of the Internet may present problems for the millions of American students for whom English is a second language. Each of these variables warrants research.

Finally, as school districts require Internet skills as a component of information literacy, there needs to be authentic and reliable means for assessing whether a student has these skills. Little has been done so far toward this end (Carey 1998).

## Conclusions

Thanks to technology, some of the problems that frustrated children when searching their local libraries may have been minimized when they search the Internet. While an article in the *New York Times* (Slatella 1999) reported that the author's children (aged eight and ten) had no difficulty locating information of personal interest to them, more formal research suggests that children still have tremendous difficulty locating information on the Internet. Unfortunately, this limits the Internet's potential as a research tool. Hopefully, some of the difficulties the researchers observed can be addressed through training.

Librarians are trying to address these issues. Two noteworthy sites worth exploring are the Ramapo Public Library's KidsClick! Worlds of Web Searching ([www.worldsofsearching.org](http://www.worldsofsearching.org)) and the Nueva School Library (<http://NuevaSchool.org>). The first of these is designed to teach children about Web searching. While the content of the site is well-written, its structure (divided

into “worlds,” such as “keyword searching” and “sorted subject guides”) is confusing. How many ten-year-olds would read about “sorted subject guides,” if they did not know what one was? The site lacks a means for orienting children or helping them determine which “world” to enter.

The Nueva school library has a Web page titled “Choose the best search for your purpose (<http://NuevaSchool.org/~debbie/library/research/adviceengine.html>). A person who wants “to get advice and opinions from others” is referred to AskA+, Pitsco’s Ask an Expert, or several sources of Usenet groups. Alternatively, if the user feels they need a “virtual librarian” they can link to Kids Connect or one of the librarians who produce the Nueva’s Web site.

While many schools and libraries have expended valuable resources developing tools such as these or webliographies to direct students toward noteworthy Web sites (Clyde 2000), the commercially available search engines reviewed above have limited educational potential, particularly for older students. Yahoologans, in particular, seems designed more to meet children’s entertainment needs. Even if a student learns to effectively use a search engine such as Yahoologans or AJ4Kids, there are a number of problems with using them. One of the advantages of accessing a fairly circumscribed database is that it eliminates the problem of too many hits, some of which are of questionable quality. However, do we really want our children and students to routinely access only those Web sites that someone decided to include in the database? Furthermore, while the NLP may be useful for very young children, this degree of spoon-feeding does a disservice to older children who could benefit from learning how to apply Boolean logic. Children of all ages could benefit from learning how to verify the accuracy of their sources, from exposure to multiple sources, and from having to decide among multiple sources to include in their research.

On the positive side, research on adult search engine use (Lawrence and Giles 1999) suggests that many searches are easily answered by simple searches, similar to Solomon’s findings (1993) nearly a decade ago in his work on children’s use of OPACs. Furthermore, Lawrence and Giles found that many queries can be satisfied with a relatively small database.

The Internet has had a meteorlike rise. While the Clinton administration’s original goal to have Internet access for all schools by the year 2000 was not met, additional schools are entering the “information superhighway” every day. Watson (1998) points out that in the information age, the “management of what and how students learn may look radically different from what we see in the schools” (1031). Unfortunately, there is little evidence that increasing computer access will necessarily improve the quality of education in this country. In fact, Internet access will exacerbate some of the problems Kuhlthau and others have observed in children during the search process. Unless we are vigilant about teaching our students to be effective searchers, “www” may end up as an abbreviation for “way worse on the Web.”

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