Middle School Students and Graduate Students as Web Information Seekers

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ABSTRACT

This study investigated the information-seeking behavior of middle school students and graduate students in using the Yahooligans! Web search engine/directory to find the correct answer to a fact-finding search task. It analyzed and compared the overall patterns of both student groups' Web traversal behaviors, including searching moves, browsing moves, backtracking moves, looping moves, target location and deviation moves, and the time taken to complete the search task. It examined the success of both student groups in locating the correct answer to the task. The students' Web activities were captured using Lotus ScreenCam software package. Nine graduate students out of twelve and twenty-two middle school students out of ninety participated in this study. Fourteen out of twenty-two middle school students' Web sessions and nine graduate students' Web sessions were analyzed. The study findings reveal that 89% of the graduate students found the correct answer to the search task as opposed to 50% of the middle school students. Graduate students were more successful than middle school students in finding the correct answer to the task. They were also more efficient in navigating the Web. However, they, like middle school students, had an inadequate preset "mental model" about how to use the engine, possessed naive skills in using Netscape Web browser, and encountered problems in finding relevant results. Implications for Web user training and system design improvements are made.

RÉSUMÉ

Cette étude examinait le comportement de recherche de l'informatique des étudiant-e-s du premier cycle du secondaire et des étudiant-e-s gradué-e-s en utilisant le moteur de recherche du Web *Yahooligans !* pour chercher la bonne réponse d'une séance d'information. On a analysé et a comparé la conduite globale du comportement transversal du Web des étudiant-e-s tout en incluant leurs démarches inquisitrices, plus précisément, cellse qui aidaient à parcourir le net, à faire marcher arrière et à se rebouler sur le Web. De plus, on a vu leurs démarches de localiser et de dévier de l'objectif et le temps mis pour compléter la tâche de recherche. Cette étude examinait le succès des deux groupes des étudiant-e-s qui cherchent la bonne réponse à la tâche. On a révélé que 89% des étudiant-e-s ont trouvé la bonne réponse à la tâche tandis qu'il y avait 50% des étudiant-e-s du premier cycle du secondaire dont leurs réponses étaient correctes. Les étudiant-e-s gradué-e-s navigueaient le Web avec plus d'efficacité. Cependant, ces étudiant-e-s, comme les étudiant–e-s du premier cycle du secondaire, avaient un « modèle mental » programmé insuffisant en ce qui concerne l'emploi du moteur du recherche. De plus, les deux groupes des étudiant-e-s avaient des techniques naïves pour utiliser le navigateur Netscape et éprouvaient de la difficulté à trouver des résultats pertinents. Des implications pour de l'entraînement de l'utilisateur et des améliorations du plan du système sont faites.

INTRODUCTION

The nature of the Web as a hypermedia, heterogeneous and dynamic information retrieval system has reshaped how users seek, retrieve, and evaluate information. Use of the Web has proliferated in various types of libraries and homes, but little is known about how young people and adults find information on the Web and, specifically, how these two user groups seek information in the same Web search engines. Little is also known about how well the interface design of Web search engines supports user information seeking.

The Web has unique navigational properties that are "likely to exacerbate users' feelings of being lost in hypertext," and cause them difficulties in navigating WWW subspaces" (Cockburn and Jones 1996, 108). Research on children's use of the Internet/Web (Bilal 2001; Bilal 2000; Large, Beheshti and Moukad 1999; Bilal 1999; Bilal 1998; Bilal and Watson 1998; Watson 1998; Kafai and Bates 1997) and adult use of the Internet/Web (Wang, Hawk and Tenopir 2000; Wolfram and Ross 2000; Jansen, Spink and Saracevic 2000; Saracevic 1997; Meghabghab 1995) show that both groups have cognitive difficulties constructing effective search queries, and that most of them do not use the Web effectively.

To date, Web research has mainly focused on how children use search engines that are designed for adults (Large and Beheshti 2000; Large, Beheshti and Moukad 1999; Schacter, Chung and Dorr 1998). Research studies that involved adult users focused on their interaction with the whole Web (Wang, Hawk and Tenopir 2000; Tauscher and Greenberg 1997; Catledge and Pitkow 1995) or with a single search engine such as *Excite* (Wolfram and Ross 2000; Jansen, Spink and Saracevic 2000). Research by Bilal (2000; Bilal 2001; Bilal 1999; Bilal 1998; Bilal and Watson 1998) has examined children's information seeking in Yahooligans!, a search engine and directory designed for children ages 7-12. Although this engine is designed for young people, it provides links to educational sites suitable for use by parents, teachers, and school librarians.

Information seeking on the Web is a research area that has only recently emerged. Understanding how young people and adults seek information for identical search tasks in one search engine will provide a better understanding of their information seeking behaviors and information needs. Although one may assume that graduate students possess higher cognitive skills than do children and, therefore, ought to be better at using a search engine designed for children, the author argues that "age" is only one interacting factor influencing information seeking. As Marchionini (1995) notes, information seeking involves multiple factors: the information seeker, task, search system, domain, setting, and search outcomes. In fact, the topic of individual differences in information seeking is a renewed interest due to advances in virtual environments, including the Web. Recently, a special issue in the *Journal of the American Society for Information Science* addressed various aspects of individual differences (Chen, Czerwinski and Macredie 2000). No study in this issue examined differences between children and adults in seeking information on the Web. This study is a first attempt to investigate how children and graduate students use Yahooligans! to find the correct answer for the same search task.

Results gained from this study will offer guidance for Web user training and system design improvement.

PRIOR RESEARCH

Children's Use of Electronic Resources

Research on children's search behavior in using information retrieval systems, such as CD-ROM databases and OPACs, has shown that although children were able to use these systems, they encountered problems in spelling, formulating effective search queries, selecting appropriate search concepts, and using adequate search syntax (Borgman, et. al. 1995; Solomon 1993; Hirsh 1997; Marchionini 1989; Large, Beheshti and Breuleux 1998; Large, et. al. 1994). In using commercial online databases and CD-ROM databases, Neuman (1995) found that young adults experienced significant difficulties in using these resources.

Children and the Web

Bilal (2000) investigated the cognitive, physical, and affective behaviors of seventh-grade science students in using the Yahooligans! search engine/directory to find the correct answer for an assigned fact-based task about "the age of alligators in the wild and captivity." The study results reveal that fifty percent of the children succeeded and fifty percent failed. Children's cognitive behavior reflected an understanding of the search task, term relationships, search formulation, and subject hierarchies. However, they possessed naïve Web navigational skills.

In a second study of Yahooligans!, Bilal (2001) examined the cognitive and physical behaviors of seventh-grade science children in using Yahooligans! to locate relevant information for an assigned research task about "the depletion of the ozone layer." The study findings reveal that sixty-nine percent of the children partially succeeded and thirty-one percent failed. Children's success levels were influenced by the way they approached the task. They seemed to seek specific answers to the task rather than develop understanding from the information found. Overall, children had more difficulty with the research task as opposed to the fact-based task they performed in the previous study (Bilal 2000). This difficulty was attributed to children's inadequate level of research skills, misunderstanding of how to complete the task successfully, absence of incentive (e.g., a grade) in performing the task, and lack of engagement in the assigned topic.

In a pilot study, Bilal (1998) examined the success and searching behavior of middle school students in using Yahooligans! to find information for a research topic about "diet." Students were unsuccessful in their quest. Children's limited knowledge of how to use the engine and the inadequacy of Yahooligans! surfaced as main problems that affected information seeking.

In a recent study of children's experiences with Web searching and use of print sources, Large and Beheshti (2000) found that children liked using the Web but found it

harder to use than print sources. Many students were overwhelmed with the high number of hits retrieved. They were also frustrated due to finding few pertinent sites for their assignment. In a prior study, Large, Beheshti and Moukad (1999) studied the Web navigational skills of grade six students as they searched Alta Vista and Infoseek to locate information for a research task about "Winter Olympics." They found that children were inefficient in using the Web and possessed naive navigational skills. Their use of the Netscape *Back* command, for example, accounted for 90% of their total Web activities.

Schacter, Chung and Dorr (1998) examined the success and searching behaviors of elementary school children in using the Web on two types of tasks: fact-finding and research. The study results show that most children had inadequate knowledge of how to use the Web. Sixty-two percent queried search engines in natural language. Overall, children were more successful on the research task than the fact-finding one.

Kafai and Bates (1997) investigated elementary school students' interaction with the Internet by building annotated directories of Web sites for other children. Findings show that children experienced difficulty with typing, spelling, search formulation, and use of Boolean logic.

Fidel, et. al. (1999) examined young adults' use of the Web for a class assignment. Results reveal that students were inefficient in using the Web and that they experienced difficulty with spelling URL addresses.

Adult users and the Web

Few studies explored how adult users interact with the Web. Wang, Hawk and Tenopir (2000), for example, examined the information seeking behaviors and success of graduate students in information science in using Web resources to find the correct answers to two assigned factual tasks. Results reveal the students' success varied by search task. Students had limited understanding of how the Web worked and how search engines differed from one another.

In a study of the *Excite* search engine, Jansen, Spink and Saracevic (2000) investigated the searching behaviors of 18,000 users based on analysis of transaction logs of 51,000 query data set. They found that users did not have many queries per search, rarely modified queries, and used advanced search syntax in constructing queries minimally. Fewer than 10% of the queries submitted, for example, employed Boolean operators; of these, users applied the Boolean "AND" operator incorrectly.

Catledge and Pitkow (1995) pioneered a study at the Georgia Institute of Technology that captured the browsing behavior of 107 staff, faculty and students. The study findings show that following a link and using the *Back* command were the most frequent Web actions these users made (52% and 41%, respectively). In a follow-up study, Tauscher and Greenberg (1997) explored the *History* mechanism in selected Web

browsers. They found that use of the *Back* command accounted for 30% of the participants' Web activities, and was the second preferred action after opening a URL (50%).

In sum, the literature reveals that both children and adults experience difficulties in using the Web. The interacting factors that influenced these users' information seeking included: inadequate "mental state" about how to use both Web browsers and search engines, limited use of advanced search syntax when provided, misspelling including URL addresses; nature of the tasks, inadequate level of research skills, lack of engagement in performing "assigned" tasks, slow system response time, affective states, prior experience, and the design interface of the search engine used.

None of these studies has examined the information seeking behavior or the type of problems children and adults may experience in using the same search engine. Most studies of children's information seeking on the Web included search engines that are designed for adults. What happens when adults use a search engine that is designed for children?

RESEARCH QUESTIONS

This study sought answers to these questions:

(1) How successful are middle school students and graduate students in finding the correct answer to the fact-based task in Yahooligans!?

(2) What similarities and differences in the cognitive behaviors do middle school students and graduate students demonstrate in using Yahooligans!?

(3) What similarities and differences in the physical behaviors do middle school students and graduate students exhibit in using Yahooligans!?

(4) What affective behaviors do middle school students and graduate students experience in using Yahooligans!?

(4) a. What design improvements do middle school students and graduate students recommend for Yahooligans! interfaces?

METHOD

This study employed both quantitative and qualitative inquiry methods. The quantitative method employed an online logging technique to obtain empirical data about the behavior, success, problem solving, Web navigation skills, and knowledge of using Yahooligans! The qualitative method used interviews and journal writings.

The Setting

Study I. Middle school students

This study took place at a middle school, grades 7-9, designated "Middle School" for confidentiality purposes, located in Tennessee. The School library was the site of the research experiment. Middle school students' Web activities were captured, saved, and transferred electronically to the first researcher's computer.

Study II. Graduate students

This study took place in a computer laboratory at the School of Information Sciences, the University of Tennessee, Knoxville. Graduate students' Web activities were captured, saved, and transferred electronically to the first researcher's computer.

Participants

Study I. Middle School

The population of this study consisted of ninety seventh-grade science classes taught by one science teacher. Due to the School's Internet Use Policy, children's parental consent to use the Internet was sought. Out of 90 invitations for participation, thirty consent forms were received. Of these, twenty-five children were willing to take part in this study. Three were involved in pilot testing, leaving twenty-two children in the sample. Due to Lotus ScreenCam failure to replay eight sessions fully, fourteen sessions were analyzed.

Study II. Graduate Students

The population in this study involved twelve graduate students in information science who were enrolled in an introductory computer course at the School of Information Sciences, the University of Tennessee. Three students were absent during the research experiment, leaving nine students in the sample.

The Search Task

A fact-based task was given to both groups to search in Yahooligans! Fact-based tasks are usually simple, certain, and uncomplicated in nature. Such tasks have a target answer that may be a date, a location of an address, a lifespan of an animal, and the like. As Vakkari (1999) maintains, "simple tasks are routine information processing tasks where the elements of the task are predetermined, i.e., [the user] knows them" (p. 826); meaning that the requirements of the task (e.g., the amount of information needed) can be determined by the user. In Study I (middle school students), the science teacher assigned the following fact-based task to search in Yahooligans!: *How long do alligators live in*

the wild, and how long in captivity? In Study II (graduate students), the author assigned the same task to the graduate students to search in Yahooligans!

Success measure

Both student groups were judged to be successful if they found and extracted the correct fact (i.e., age of alligator in the wild and in captivity). They were judged to be partially successful if they submitted an incomplete answer (i.e., age of alligator in the wild or in captivity). They were judged to be unsuccessful if they submitted an incorrect answer.

Limitations of the Study

The study of middle school students was limited to seventh graders in three science classes taught by one teacher. It took place at one middle school and included use of only one Web search engine. The children who participated in this study may not represent the cognitive, physical, and affective behaviors of all middle school students in Tennessee, nor may they represent the whole population of seventh grade science students. In addition, use of one "assigned" search engine may not provide a wider perspective about children's information seeking behavior.

The graduate students in information science who participated in this study may not represent "typical" or "normal" adults. Therefore, the results may not be generalized to graduate students or to adults, in general.

The difference in maturity level between middle school students and graduate students, as well as the use of a search engine designed for ages 7-12, may impact the validity of the results especially in relation to graduate students. In addition, the performance of graduate students may be influenced by the simplicity of the same search query that was administered to them and to middle school students.

RESULTS

The results are reported within the context of the five research questions posed. The term "children" will be used instead of the term "middle school students." Due to Lotus ScreenCam to replay all children's Web activities fully, fourteen sessions were usable. All graduate student sessions replayed successfully.

1. **How successful are children and graduate students in finding the correct answer to the fact-based task in Yahooligans!?**

Graduate students were more successful in finding the correct answer to the search task than children. Eight-nine percent of the students found the correct answer as opposed to fifty percent of the children. Only one graduate student was "partially" successful. He/she submitted the answer as "alligators live up to 50 years in captivity." The children who failed either did not locate the target hyperlink or when they did, they did not view the text from the target page.

2. What similarities and differences in the cognitive behaviors do children and graduate students exhibit in using Yahooligans!?

The cognitive behavior of both student groups was observed in terms of search and browsing moves.

Search Moves

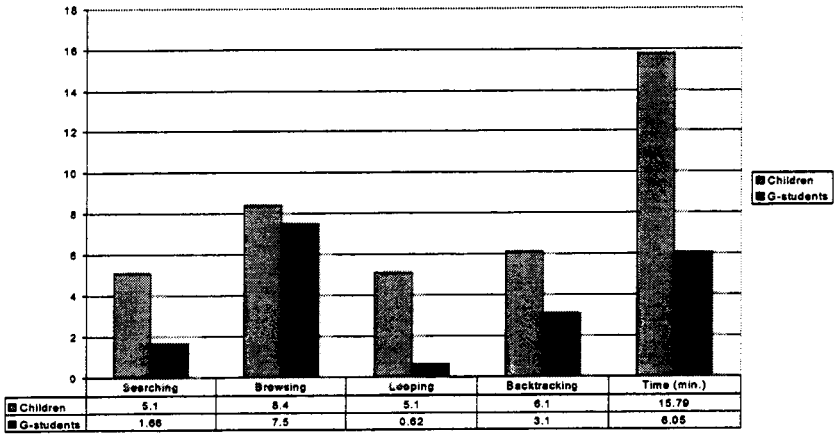
Sixty-four percent of the children began their initial moves in Yahooligans! by performing analytic searches and thirty-six percent by browsing subject hierarchies. In contrast, sixty-seven percent of the graduate students started their initial moves by browsing subject hierarchies and thirty-three percent by making analytic searches. The average number of queries a child made to complete the task was M=5.1, whereas the average number of queries a graduate student made to complete the task was M=1.66. Graduate students adopted a "systematic" approach to finding the information when the searches they submitted failed. They browsed the target subject hierarchies that lead to the answer (Science and Nature, Animals, etc.) and hardly looped searches. On the contrary, children repeated many of the searches that failed and browsed the target subject hierarchies as a "last resort."

Children and graduate students employed search syntax that was not supported by the engine. Children used natural language phrases and graduate students used Boolean operators and nesting techniques. This finding indicates that both student groups had incorrect preset "mental models" of how to search Yahooligans!, an issue that information professionals should address in Web training programs.

Browsing Moves

Browsing relates to scanning returned hit lists and activating hyperlinks from the lists. As mentioned earlier, thirty-six percent of the children began their initial moves by browsing subject hierarchies, as opposed to sixty-seven percent of the graduate students. Overall, children and graduate students activated appropriate categories and hyperlinks.

Fig.1. Children's and graduate students' Web activities by mean.



	Searching	Browsing	Looping	Backtracking	Time (min.)
Children	5.1	8.4	5.1	6.1	15.79
G-students	1.66	7.5	0.62	3.1	6.05

Figure 1 shows that children browsed slightly more sites than graduate students did (M= 8.4 vs. M=7.5, respectively) and looped searches (re-executed searches previously made) and hyperlinks (re-activated hyperlinks previously visited) more often (M=5.1 vs. M=0.62, respectively). These scores suggest that children were less focused on the task than were graduate students. Reasons may be low cognitive recall (Siegler 1991) and/or difficulty in finding the desired information. Given the fact that the Web imposes memory overload that reduces recall during navigation (Cockburn and Jones 1996), children become prone to loop searches and hyperlinks more frequently than adults. This finding suggests the need for intervention by information professionals who train children in using the Web.

In sum, the cognitive behavior showed more differences than similarities between children and graduate students. Children made more analytic searches than graduate students did, made more searches that included a single concept, looped searches more frequently, and browsed target subject hierarchies as a "last resort." Children and graduate students, however, employed a search syntax that was not supported by Yahooligans!, and almost ignored Yahooligans!' *Help* feature.

3. What similarities and differences in the physical behaviors do children and graduate students exhibit in using Yahooligans!?

The physical behavior reported here includes backtracking (use of Netscape *Back* button) and traversal time (the time taken to complete the task).

Backtracking

Children backtracked twice as often as graduate students did (M=6.1 and M=3.1, respectively)(Figure 1). Neither children nor graduate students who backtracked used shortcuts to navigate among Web pages (e.g., the Netscape *Go* button, *History list*, or URL list) when they were far away from the pages they previously visited. This finding

may indicate that neither group was familiar with Netscape shortcuts. The difference in backtracking moves between the two student groups may be explained by the fact that children browsed more hyperlinks, made more analytic searches, retrieved more pages and, subsequently, backtracked multiple times to revisit previous pages. Although backtracking is common among Web users, regardless of age (Bilal 2000; Wang, Hawk and Tenopir 2000; Large, Beheshti and Moukad 1999; Fidel, et. al. 1999; Tauscher and Greenberg 1997; Catledge and Pitkow 1995), frequent backtracking raises the issue of efficiency in navigating the Web. Information professionals who provide Web training should address this issue in their user instruction programs.

Traversal time

Traversal includes all activities performed from task initiation to completion. As seen in Figure 1, children took more time to complete the task than graduate students did (M=15.79 minutes vs. M=6.05, respectively).

In sum, the physical behavior showed more differences than similarities between children and graduate students. Children backtracked more often, deviated from the targets more frequently, made more Web moves, and took more time to complete the task than graduate students did. Both groups did not use Netscape shortcuts (e.g., *History* list) to navigate among Web pages.

4. What affective states do children and graduate students experience in using the Web and Yahooligans!?

A holistic view of the information-seeking process encompasses user affective experience as well as cognitive constructs (Ingwersen 1992; Kuhlthau 1993; Dervin 1983). Children's affective experiences were gathered via interviews at the conclusion of the research experiment. Overall, children liked using Yahooligans! because it provided keyword searching, gave them self-confidence, and was convenient. However, they were confused and frustrated due to difficulties in retrieving relevant results, inadequate screen display, and slow response time.

Graduate students' affective states

Most graduate students expressed satisfaction and comfort after they completed the task and found the answer. However, they too were frustrated during searching. Reasons were lack of matches with Boolean searches, task difficulty, and the time it took to find the answer.

DISCUSSION

This study analyzed children's and graduate students' cognitive, physical, and affective behaviors in using the Yahooligans! Web search engine/directory. The results of this study unveiled important aspects of children's and graduate students' information seeking behaviors and success.

Graduate students were more successful than children in finding the correct answer to the fact-based task in Yahooligans! (89% vs. 50%, respectively). What may explain this difference is that the graduate students were more focused on the task and more thorough in examining the returned results.

Children made more analytic searches than did graduate students (M=5.1 vs. M=1.66, respectively). Graduate students adopted a "systematic" approach in finding the target information by relying on browsing the target subject hierarchies. In using Yahooligans! for fact-based tasks, browsing subject hierarchies may be more successful than analytic searching mainly because Yahooligans! is more of a directory than a search engine. As a directory, it does not index its Web pages as thoroughly as Web search engines do.

Children and graduate students had incorrect preset "mental models" about how to search Yahooligans! They both employed search syntax that was not supported in the engine. Information professionals should assist Web users in adjusting their preset mental models to the search syntax and rules supported in a Web search engine.

Children looped searches and hyperlinks more often than graduate students did (M=5.1 vs. M=0.62, respectively). Looping may be influenced by children's lower recall level (Siegler 1991) and the cognitive overload and disorientation associated with using the Web (Cockburn and Jones 1996). Teachers and school librarians could enhance children's recall by teaching them how to keep a conceptual map of the searches they make, and how to use shortcuts (e.g., *History* list) to view the hyperlinks they visit.

While there was little similarity in the cognitive behavior between the two groups, no similarity was found in the physical behavior. Graduate students backtracked less frequently (M=3.1 vs. M=6.1), were more thorough in viewing the returned results (91% vs. 69%, respectively), did not deviate from the target hyperlinks after locating them and, subsequently, took less time to complete the task (M=6.05 minutes vs. M=15.79 minutes).

Both children and adults used Netscape *Back* command exclusively to navigate among Web pages. Although backtracking is common among Web users, regardless of age (Large, Beheshti and Moukad 1999; Catledge and Pitkow 1995; Tauscher and Greenberg 1997), it raises the issue of efficiency in using the Web and suggests the need for intervention by information professionals who provide Web training.

(4) a. What design improvements do middle school students and graduate students recommend for Yahooligans! interfaces?

Most children liked using Yahooligans! mainly because it provides keyword searching, has colorful graphics, is easy and fun to use, and is part of the Web. They, however, were distressed about its slow response time, the zero hits it returns, and the structure of its retrieval interface. Children made these recommendations for improving Yahooligans!:

Add more sites, add more categories, add more keywords, improve screen display, and *enhance response time.* Improving these features in Yahooligans! would certainly enhance children's information seeking and alleviate the negative feelings they experience.

Graduate students liked Yahooligans!' hierarchical structure due to its simplicity and comprehensiveness. They also favored the simplicity of the engine's design, especially its uncluttered screen and colorful graphics. Like the children, however, they were dissatisfied with the zero hits it returns. They recommended these improvements in Yahooligans!:

Provide a more in-depth database with more sites, improve the help files, make headings and text in the help files more precise, include how to use Boolean in the help files, add a browsable index, add more search options (phrases, proximity, and nesting), provide a mechanism for using the engine without browsing the hierarchies, enhance response time, and *reduce the number of duplicate sites.*

CONCLUSIONS

This study reported the results of children's and graduate students' information seeking behaviors and success in using Yahooligans! to find the answer to an identical fact-based task. It analyzed the cognitive, physical, and affective behaviors of children and graduate students in information science. Findings revealed more differences than similarities in information seeking between the two user groups. Graduate students were more successful in finding the correct answer to the search task and were more effective and efficient in using Yahooligans! Main reasons were focus on the task, serious engagement in completing the task successfully, and systematic approach to locating the desired information. Graduate students' higher performance may also be due to use of a search engine designed for children, as well as to the simplicity of the search task.

The fact that half of the children failed in their quest to find the answer to the task in a search engine designed specifically to support their information seeking raises the issue of how well children use Web spaces that are designed for adults!

Regardless of maturity level, both student groups experienced cognitive difficulties in using Yahooligans! and had incorrect preset "mental models" about how to search the engine. With effective training, both student groups will be able to adjust their "mental models" to the configurations provided in all search engines. Children, per se, need to learn how to scan, analyze, evaluate, extract, and synthesize information on the Web. These skills are vital for their information literacy and are at the heart of *Information Power* (AASL and AECT 1998) and Big6 Skills of information problem solving (Einsenberg and Berkowitz 1990).

This study revealed that Yahooligans! had several limitations that affected children's and graduate students' information seeking. System designers should provide intelligent user interfaces that support children's and adults' information seeking. These interfaces should be based upon users' information needs, cognitive abilities, and information seeking behavior.

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