Internet Searching by K-12 Students: A Research-based Process Model

Kathleen Guinee
Harvard Graduate School of Education

Abstract

Understanding K-12 students' Web-based research practices and the challenges posed by this task, can help educators assist students with learning to manage this complex process. In this presentation, I propose a research-based process model of K-12 students' Internet search practices. The model describes the ways in which students search for, evaluate, and use information on the Web and suggests strategies that students can develop to improve the effectiveness and quality of their Web-based research.

For United States students, conducting research using "a variety of technological and information resources," including the World Wide Web has become the norm (The National Council of Teachers of English, 2000). The 59% of students ages 5-17 who used the Internet in 2001 reported that their number one use of the Internet was for schoolwork (National Center for Education Statistics, 2003). This widespread utilization of the Web for academic (and vocational) purposes necessitates understanding students' Web-based search processes in order to assist them with learning this complex process.

During the past decade, several research studies have been conducted to investigate K-12 students' Internet research practices. This paper presents a process model summarizing this research. The model describes the ways in which students search for, evaluate, and use information on the Web and suggests strategies that students can develop to improve the effectiveness and quality of their Web-based research.

The Internet as a K-12 Research Tool

Elementary (Kafai & Bates, 1997), middle (Bilal, 2002; Wallace, Kupperman, Krajcik, & Soloway, 2003), and high school (Fidel, et al., 1999) students enjoy searching the Web and using it for school-related research projects (Eagleton, Guinee, & Langlais, 2003; Jackson, 1996). As students enter higher grades, their use of the Internet for schoolwork increases (Lien, 2000). Within various middle and high school curricula, Internet inquiry assignments are being incorporated into language arts (Eagleton, Guinee, & Langlais, 2003; Large, Beheshti, & Moukdad, 1999), science (Fidel, et al., 1999; Jacobson & Ignacio, 1997; Gordon, 2000; Wallace, et al., 2003), social studies (Jackson, 1996; Lorenzen, 2001), and library/media center (Gibson & Mazur, 2001; Hirsh, 1999) classes.

When conducting research, today's students use a combination of electronic and print resources (Fidel, et al., 1999; Gibson & Mazur, 2001; Large & Beheshti, 2000; Lorenzen, 2001). Some students strongly prefer using the Internet as their primary information source (Gibson & Mazur, 2001; Jackson, 1996; Jacobson & Ignacio, 1997; Large & Beheshti, 2000). One reason students give for preferring the Web over traditional print materials is that they feel they can locate information faster when using the Internet (Large & Beheshti, 2000; Vansickle, 2002). Other students decide whether to use electronic or print materials based upon the type of information they are seeking (Large & Beheshti, 2000). For example, students tend to favor the Web for locating up-to-date or relatively obscure (e.g., information about the sport of curling) information and they favor print sources for obtaining comprehensive, organized information on general topics (Large & Beheshti, 2000). Still other students prefer to reference only traditional print materials for their research, despite the increasing prevalence of electronic sources (Large & Beheshti, 2000).

Process Model of K-12 Internet Research

The following model (see Figure 1) outlines the activities students perform while conducting research using the Internet and discusses the ways in which students generally perform these tasks.

Develop Research Question

Research questions guide students through the process of conducting research (Bowler, Large, & Rejskind, 2001), helping them to stay organized and on task (Gibson & Mazur, 2001). Unfortunately, middle school students have difficulty developing research questions (Bilal, 2002; Wallace, et al., 2000). The research questions they generate range from too broad, general questions to too narrow, specific fact hunts, with only about a third being focused, researchable questions (Bilal, 2002; Eagleton & Guinee, 2003; Wallace, et al., 2000). Even high school students falter when constructing research questions because many feel that they don't need to plan ahead while

searching online (Fidel, et al., 1999). Needless to say, developing specific, researchable questions is an important skill to practice with middle and high school students (Eagleton & Guinee, 2004).

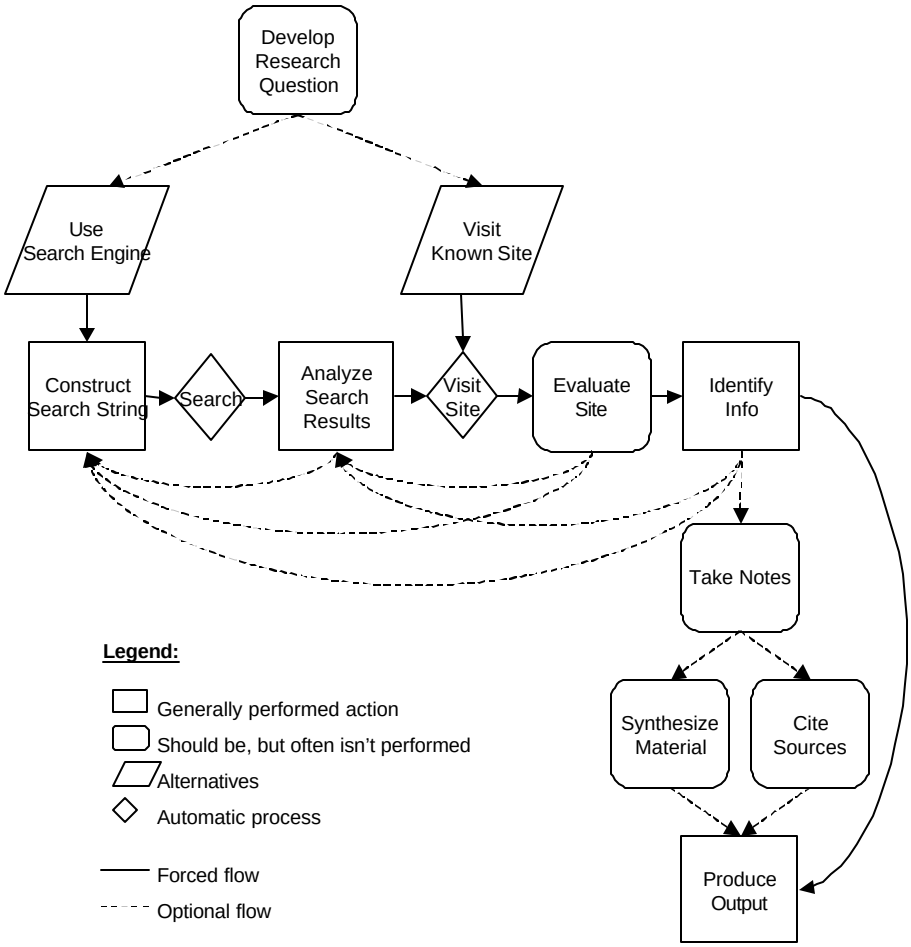

Figure 1. Research-based process model of K-12 students Internet searching practices.

Visit Known Site

After identifying a research question, one strategy students use to locate information to answer the question is to visit a Web site directly. They can do this in several ways. Sometimes, students plug their broad topic into the "dot-com formula," using `www.mytopic.com` as their URL (Guinee, Eagleton, & Hall, 2003). Other times, students visit sites they have used in the past, even if they pertain to a different topic (Fidel, et al., 1999). Students also visit sites they suspect might contain their desired information based on their understanding of the research topic (e.g., visiting the Coast Guard site to research boat safety) and prior experiences with the Web (Guinee, Eagleton, & Hall, 2003). Or, students might visit sites they feel are highly trustworthy, such as those created by universities, the government, or news agencies (Lorenzen, 2001).

Finally, an effective approach students employ for deciding which site to visit is to follow recommendations from others. Educators often provide students with a list of relevant URLs or bookmark appropriate sites on their classroom computer(s) for students to visit. It's important to note that primary grade students are better able to use bookmarks supplied by the teacher than to type long, complex URLs (Kafai & Bates, 1997). In addition to educators supplying potential sites, students often share URLs with one another (Jacobson & Ignacio, 1997).

Use Search Engine

Using a search engine is another strategy students apply to locate answers to their research questions on the Web (Guinee, Eagleton, & Hall, 2003; Lorenzen, 2001). Starting in approximately 5th grade, students can independently locate information using the Web (Kafai & Bates, 1997; Lien, 2000). However, by using scaffolds, younger children are also able to successfully execute searches (Kafai & Bates, 1997; Revelle, et al., 2002).

Students tend to have strong preferences for one search engine or another (Vansickle, 2002). Most use only one search engine in a given search session (Large, Beheshti, & Moukdad, 1999; Schachter, Chung, & Dorr, 1998; Vansickle, 2002). Interestingly, older students tend to use more search engines than younger students, perhaps because they have more experience using the Web and are therefore more aware of different search engines (Lien, 2000). Having a preferred search engine is fine, as long as students are constructing appropriate queries for that engine and are willing to be flexible, occasionally using a different engine when necessary.

While using a search engine can be a successful method for finding information on the Web, it can also be a source of frustration for students. Many students get frustrated by slow response times of search engines and by their own inability to locate their desired information in a "reasonable" timeframe (Fidel, et al, 1999; Wallace, et al., 2000). Students may be able to avoid at least some of this frustration by learning to construct more effective search strings.

Construct Search String

A predominate difficulty students experience while performing Web-based research is constructing effective search strings (Gibson & Mazur, 2001; Large & Beheshti, 2000; Wallace, et al., 2000). In general, middle school students demonstrate unsophisticated skills when constructing search strings, using mainly broad terms and phrases (Guinee, Eagleton, & Hall, 2003; Wallace, et al., 2000). Several factors contribute to students' abilities to develop suitable search strings, such as their background knowledge, language skills, and computer experience, as well as the nature of the task (i.e., open-ended inquiry vs. fact finding and teacher-assigned vs. student-selected topics).

First, possessing sufficient background knowledge is important for constructing search strings (Eagleton & Guinee, 2004; Fidel, et al., 1999). Most obviously, background knowledge helps students identify potential relevant search terms. In addition, background knowledge helps students conceptualize the information space for their topic (Kafai & Bates, 1997). On their own, middle school students tend not to apply an understanding of the topic space to develop a plan for their research (Guinee, 2004). However, with direction, middle school students can focus, narrow, and broaden their search (Eagleton, Guinee, & Langlais, 2003; Kafai & Bates, 1997). Even high school students struggle with conceptualizing the topic space for their query, sometimes omitting required concepts and other times adding unnecessary ones to their search strings (Nahl & Harada, 1996).

In addition to general background knowledge, proficient language skills are important for successfully constructing search strings (Eagleton & Guinee, 2004; Nahl & Harada, 1996). Students must be able to specify relevant search terms, synonyms for these terms, and related terms (Nahl & Harada, 1996). Sadly, Nahl & Harada found that many of the high school students they surveyed did not have sufficient vocabulary skills for constructing successful search strings. Students need strong language skills that can enable them to be flexible when building search strings, by adding new terms or substituting different terms to rephrase a query. For example, a student searching for the amount of money a sports star "makes in a given year," needs to identify "salary" as a likely search term to answer his or her question (Eagleton & Guinee, 2002).

Finally, students who possess more computer experience tend to construct and interpret search strings more effectively than their peers (Bowler, Large, & Rejskind, 2001; Nahl & Harada, 1996). Vansickle (2002) concludes that a student's general computer skills may be related to his or her access to computers. Besides creating an initial discrepancy in students' search skills, differences in general computer skills may escalate over time, causing disadvantaged students to be at an even greater disadvantage. For example, Kafai and Bates (1997) observed that during group work, students with prior Internet experience dominated the interactions at the computer.

On average, middle school students conduct one search every 4 or 5 minutes (Large, Beheshti, & Moukdad, 1999; Wallace, et al., 2000). They use two primary methods to construct the search strings for these queries: discrete terms and natural language (Guinee, Eagleton, & Hall, 2003). During teacher-assigned, open-ended research tasks, most students search using single discrete terms that describe a broad concept (Bilal, 2002; Guinee, 2004). Students generally demonstrate a slightly different tactic when they select their own open-ended research topic. In these cases, students tend to search using multiple (usually two) discrete terms (Bilal, 2002; Large, Beheshti, & Moukdad, 1999), which can be described as the "topic and focus" method (Guinee, Eagleton, & Hall, 2003).

During fact-finding search tasks, students tend to use natural language queries more often than they do on open-ended research tasks (Bilal, 2002; Guinee, 2004). In most search engines, the negative consequence of using natural language queries, as opposed to discrete terms, is that the additional words in the query artificially constrain the possible results. Nevertheless, natural language queries are popular with students. Approximately two-thirds of middle school students and one-third of high school students construct fact-finding search strings by using either natural language phrases or full natural language questions (Nahl & Harada, 1996; Schacter, Chung, & Dorr, 1998). From this observation, Schacter, Chung, & Dorr conclude that students use natural language queries because they do not have an accurate understanding of how the Internet operates or how search engines interpret search strings. They feel that to become effective searchers, students should have an accurate mental model of the Internet and how it works. As an alternate explanation, Guinee proposes that students are failing to abstract the general topic and focus from their specific fact-finding research questions. She suggests that even when searching for facts, students need to identify the topic space for their query.

Analyze Search Results

A seemingly minor, yet important task during Internet research is assessing the list of search results. Generally, middle school students have difficulty differentiating good and bad hits (Large & Beheshti, 2000). One reason for this may be that students are reluctant to read the results list thoroughly, predominately using the titles to determine quickly whether or not to investigate a hit (Kafai & Bates, 1997). It is interesting to note that students visit an average of only one hit per search (Large, Beheshti, & Moukdad, 1999).

Evaluate Site

Middle and high school students have difficulty evaluating the quality of the information they find on the Web (Gibson & Mazur, 2001; Lorenzen, 2001). While one may argue that this difficulty arises from the adult reading level of Web content, readability does not seem to be a stumbling block for older students. Only 38% of middle school students report having problems with the vocabulary on the Web (Large & Beheshti, 2000). The real issue may be one of trustworthiness. Many middle school students believe that all the information on the Web is reliable (Schachter, Chung, & Dorr, 1998).

Alternately, students may be having problems evaluating sites because they're not spending enough time examining them. While searching on the Internet, students make an average of 1 mouse-click every 1.2 minutes (Large, Beheshti, & Moukdad, 1999). Given the amount of time it takes for search results to be compiled and pages to load, this leaves little time for reading content. In addition, students often scroll through a site too quickly to actually read it and rarely follow links to investigate a site further (Wallace, et al., 2000). Students tend to simply glance at a site, often using the quality of graphics as their discrimination criteria, and then return to the search results list (Wallace, et al., 2000). This tendency is perhaps one of the downsides of Internet research. Disappointingly, some researchers have concluded that the interactive nature of the Web impedes students' mission to read and evaluate content while conducting research (Large, Beheshti, & Moukdad, 1999; Schachter, Chung, & Dorr, 1998; Wallace, et al., 2000).

Identify Information

As mentioned earlier, students get frustrated when they can't find appropriate information while searching (Fidel, et al., 1999; Large & Beheshti, 2000). Students have mixed-opinions about how easy or difficult it is to find information on the Web (Jackson, 1996). However, some factors seem to facilitate students' success at finding information. For instance, more experienced computer users are more adept than their peers at finding correct answers to fact-finding tasks (Guinee, 2004). Also, elementary school students who work collaboratively to search the Web have greater success at finding relevant information (Lien, 2000). Finally, the ability to efficiently identify relevant information also depends on the task constraints and students' perceptions of the task purpose (i.e., to find the correct answer).

Generally, students are more successful at locating relevant information for open-ended research tasks than at finding correct answers to fact-finding tasks (Bilal, 2002; Schachter, Chung, & Dorr, 1998). Schachter, Chung, and Dorr concluded that students' success at open-ended research tasks is a result of the simple fact that more potential answers exist for open-ended questions. Students recognize that a requirement of successfully completing a research task is to locate information on their topic. As a result, students can be so intent on finding information for their assignment that they will change their research questions to match information they have already located (Fidel, et al., 1999).

Take Notes

Two competing note-taking strategies seem to exist for taking notes during Web-based research. Some students don't print very many Web sites, and when they do, are extremely selective about which pages to print, making sure the printed pages contain content to answer their question (Fidel, et al., 1999; Jacobson & Ignacio, 1997). One can conclude that this selective note-taking strategy is particularly effective in environments with limited resources (e.g., minimal printing capabilities).

Other students tend to print many Web pages or copy and paste large chunks of text, rather than take selective notes (Eagleton & Guinee, 2003). During this strategy, students make initial high-level decisions about whether information is worth returning to later, and then gather it for later examination (Hirsh, 1999). This "wide net" strategy seems to be adaptive in situations where Internet access is limited. It allows students to gather large amounts of potentially relevant information, which they can peruse offline at their leisure.

Synthesize Information

Unfortunately, the majority of students tend not to synthesize the information they find on the Internet before presenting it in their research products (Bowler, Large, & Rejskind, 2001; Eagleton, Guinee, & Langlais, 2003; Gibson & Mazur, 2001). Students report that they don't copy from the Web or that they are less likely to copy from the Web than from traditional print sources (Guinee, 2004; Large & Beheshti, 2000). However, in practice, a fair number of students copy and submit content directly from the Web (Eagleton, Guinee, & Langlais, 2003; Guinee, 2004). Other students make slight modifications to the text they acquire from the Web, substituting, deleting, or adding individual words (Guinee, 2004; Large & Beheshti, 2000).

Cite Sources

Students tend not to cite Web sources (Bowler, Large, & Rejskind, 2001), even when instructed to do so (Guinee, 2004). This finding is understandable, considering it is difficult for students to keep track of the sources they are using as they rapidly jump from site to site on the Web. In order to accurately collect their sources, students must think of collecting each URL at the precise moment they are gathering information from that site.

Produce Research Product

Students consider "research" to mean finding information, thus they omit the writing and presenting stage of the process (Bilal, 2002; Gibson & Mazur, 2001; Wallace, et al., 2000). As a result, their final research products don't necessarily meet educators' expectations. As mentioned earlier, some students present material acquired directly from the Web (Eagleton, Guinee, & Langlais, 2003). Other students with superb literacy or technology skills create flashy research products containing little content (Eagleton & Guinee, 2004). Fortunately, a few students successfully navigate the complex process of Internet research and use their found content to generate original products.

Learning to Conduct Internet Research

In general, today's students are teaching themselves how to use the Web or are learning about it from their peers (Lubans, 1999; Vansickle, 2002). Even in a classroom environment, students ask lots of questions of one another and give each other advice while searching (Fidel, et al., 1999). Students say they would often prefer to ask a teacher or librarian for help, but these "experts" aren't always available (Fidel, et al., 1999; Lorenzen, 2001). The danger in having students teach one another is that they can (and do) propagate misinformation.

Because teens are learning their Internet skills from one another, they're also comparing their level of proficiency against one another. As a result, the majority of students are content with their searching skills, considering themselves to be "intermediate" level searchers (Fidel, et al., 1999; Vansickle, 2002). Students feel they can successfully search on their own, but will readily ask for help when they run into a problem (Vansickle, 2002). When asked if they want to learn more about searching, students respond that they already know everything they need to know (Fidel, et al., 1999).

However, experts disagree. Many researchers feel that Internet searching and evaluation needs to be taught explicitly to students (Eagleton & Guinee, 2004; Jacobson & Ignacio, 1997; Schachter, Chung, & Dorr, 1998; Wallace, et al., 2000). Students say they would rather learn about the Web in an informal, independent manner, such as from individual assistance or posted tips, rather than in a group setting like a class (Vansickle, 2002). This preference can be readily accommodated and therefore, educators should consider individual learning approaches when designing Internet instruction.

Conclusion

Conducting research is an extremely complex process and performing it using the Internet simply adds to the complexity. Students' approaches to Internet research vary greatly, but most are able to complete Web-based research tasks. However, the quality of most students' performances can be greatly improved. To achieve this, methods and materials should be developed to scaffold students through every phase of the Internet research process outlined in the presented model.

Many factors mediate students' performance when conducting Web-based research. Helping students to develop underlying skills, such as computer experience, can facilitate their Internet research practices. Educators should also help students develop background knowledge in their topic space and an accurate mental model of the Internet information space. Most importantly, strengthening students' traditional literacy skills, particularly their vocabulary, comprehension of expository text, and note-taking, should have considerable positive impacts on their research practices.

Finally, students need opportunities to practice the strategies they are learning and to engage in authentic Internet inquiry research projects. This can be achieved by systematically incorporating Internet inquiry throughout the curriculum. We must help students view Internet research as a *process*, not simply an *event*.

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