

Self-Regulated Learning and Internet Searching

DONNA ROGERS

State of New York University at Albany

KAREN SWAN

Kent State University

As the Internet becomes a resource in the classroom, students must learn to glean maximally from that information using skills that enhance their understandings. Students engage in activities involved with Internet searching to the degree that they are skilled and motivated. This article reports on a research study that demonstrates that the model of self-regulated learning developed by Corno and Mandinach relative to traditional classroom activities can be applied to Internet searching behaviors. The study also found that not all Internet searchers are equal; thus, the article suggests that students need to be helped to become better at it, and the article also suggests ways this might be accomplished, which are linked to the findings and research on self-regulated learning in general. In particular, it gives curricular and instructional recommendations for accomplishing and supporting student learning in both Internet searches and regulation of their own searching behaviors.

Two university students, Allison and Ashley, are observed searching the Internet for information to answer a series of questions regarding Mark Twain. Both students average about 5.5 hours a week searching the Internet for academic information and neither student is an English or a literature major. Both are trying to determine what hypothetical political platform would be part of a campaign if Twain were to run for U.S. president in 2004.

Each student uses widely different search techniques. Allison begins with a keyword search using “Twain” and “politics” and reads each search screen from top to bottom, carefully selecting links she finds appropriate matches for her purposes. Ashley has multiple screens open after searching with two search engines on the same keywords, first “Twain” and “presidency” and then “Twain” and “political actions.” Ashley then selects those Web sites that appear in both lists.

Both students find information they feel is appropriate to the task. Allison takes hand notes while Ashley bounces between the word processor and open Web pages, cutting and pasting information and adding an outline structure to those notes. Ashley refers to these notes and checks for completeness with the assigned tasks. Allison checks the screens with the assigned tasks.

Are these observations indicative of the processes and strategies in self-regulated learning (SRL)? If so, what do they inform us, as educators, about the application of SRL principles (found in traditional classroom tasks) within the context of Internet searching?

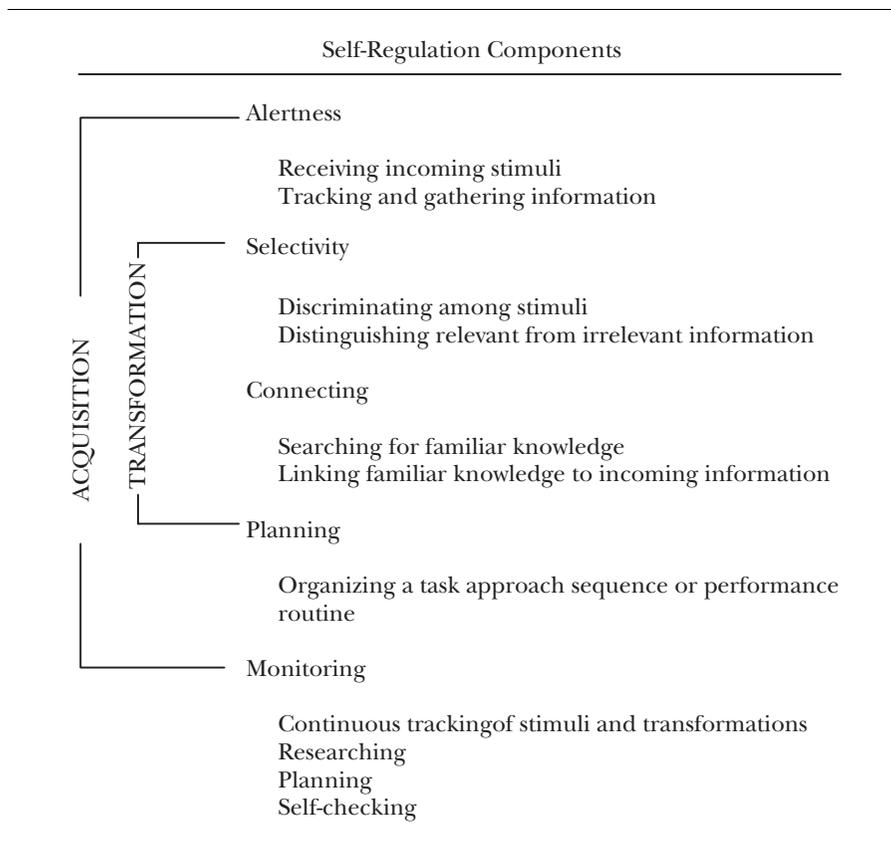
Today's classrooms are highly affected by Vannevar Bush's vision of natural information systems linking ideas by association within a Weblike environment. A truly global electronic environment now exists for educational information resources, enhanced by hypermedia. Now, classroom activities, once relying on printed media as the major source of information, use Web-based materials as well. Students need to transition skills, habits, and strategies acquired in print-centered environments to new electronic formats, and teachers need to adjust instructional components to scaffold such transitions.

The processes and strategies for learning that are employed by active, resourceful, self-motivated students to work toward educational goals have been studied in traditional classroom environments as self-regulation. Self-regulation models, specifically the one developed by Corno and Mandinach (1983) attempt to explain the interactions of processes and strategies as individuals cognitively engage in instructional tasks. Rogers (2001) designed a study to explore the applicability of Corno and Mandinach's model to Internet searching. She determined that the components of the Corno and Mandinach model describe and predict the behaviors of individuals who are engaged in learning from resources on the Internet. Understanding students' written, verbal, and physical actions while searching and browsing the Internet helps characterize their cognitive processes and helps explain the behaviors of students like Allison and Ashley.

BACKGROUND

The Corno and Mandinach (1983) model of self-regulated learning identifies two processes, acquisition and transformation, with five embedded strategies within those processes (Table 1). Their model depicts a cyclic path through which students engage in academic tasks, motivated by a combination of initial and sustaining interest. The relative use of the processes of acquisition and transformation defines four forms of cognitive engagement (Figure 1), with those individuals who use high levels of both acquisition and transformation being labeled self-regulated learners.

Table 1: Metacognitive Relationships in Corno and Mandinach’s Model



According to the Corno and Mandinach (1983) the strategies of acquisition “bound and control the transformation processes of selectivity, connecting new information to that available in memory, and planning use of specific performance routines. The acquisition processes can be seen as metacognitive to the extent that they regulate the transformation processes” (p. 104).

Previous research on the Corno and Mandinach SRL model provides descriptors of the processes and strategies it identifies. Alertness is the receiving of stimuli to apply initial task perceptions. In the case of Internet searching, alertness is signaled by selecting a search engine and specifying keywords or category entries, as well as through advanced strategies such as the use of multiple screens during acquisition stages. Selecting is observed when students make notes, highlight important points (Howard-Rose, 1989), or determine the relevancy or irrelevancy of the information on the screen. Relevancy is also associated with the connecting strategy in which students link familiar knowledge or associations with incoming knowledge.

		Use of Acquisition Process	
		High	Low
Use of Transformation	High	Self-Regulated Learning	Task Focus
	Low	Resource Management	Recipience

Figure 1: Four Forms of Cognitive Engagement from Corno and Mandinach's Model

Observations of connecting behaviors include adding information to an outline provided in the task description (Panagiotopoulos, 1987) and developing notes in a hierarchical arrangement or rearrangement of existing information (Davey, 1990). In Internet searching, frustration when obvious matches between search results and task goals are not readily apparent indicates a lack of connection (Marchionini, 1988).

Planning is associated with organizing and prioritizing subtasks and reacting to feedback. In the transformation stage, students evaluate data received to build understandings from relevant information to make decisions about next steps. Planning is observed as students combine facts and concepts from information sources to indicate potential paths for obtaining further goal-relevant information (Guthrie & Dreher, 1990). Monitoring is much like planning, except that the focus is on the goals of the entire task rather than subgoals.

RESEARCH STUDY

Rogers (2001) explored the applicability of Corno and Mandinach's model, which was developed for print-based activities in traditional classroom, to the observed and reported Internet searching behaviors of college students. Subjects for her study were 80 undergraduate students (51 women, 29 men) at a public research university ranging in age from 19 to 25 years. They were asked to choose one of eight Internet search tasks focused on a variety of traditional academic areas and given approximately 30 minutes to search for the answers to their chosen questions, during which time their behaviors were observed and coded. Coding was based on a list of 39 observable behaviors determined from a pilot study (Appendix A). Other data

collected from the subjects included demographic information; data concerning their search experience; self-reported use of SRL strategies, both in general and during Internet searching; and artifacts created during the search, including their written answers to task questions.

Over 8,000 observable behaviors were coded for this study. Frequencies of behaviors recorded for individual subjects ranged from a minimum of 26 to a maximum of 195, with an average per person of 103. Recorded behaviors were coded as one of the five self-regulation strategies identified by Corno and Mandinach (1983)—alert (A), select (S), connect (C), plan, (P), monitor (M), or other (O). Behaviors categorized as other were essentially navigation behaviors not related to cognitive processes and so were dropped from the analysis. The remaining five strategy categories were standardized as strategy-use-per-unit-time for each subject and strategies amalgamated to calculate process-use-per-unit time as well.

The primary methods of data analysis used in this study were correlational analyses and agglomerative cluster analysis. Correlations were calculated between values for the five strategies and two processes to test the independence of these constructs within the observational and self-report data (Howard-Rose, 1989). Although no correlation was found between the processes in the observational data, the use of the selecting and the monitoring strategies were found to be correlated at the .05 level. On closer review of the data, it was found that when behaviors coded as monitoring were involved in a contextual sequence, they were most often linked with selecting. As very few monitoring behaviors were observed (less than one for every 100 minutes of observations), it is reasonable to assume that the correlation reflects that linking and not a structural dependence. Thus the correlational data supports subjects' use of five independent strategies and two independent processes in subjects' observed Internet searching. Correlational analyses of the self-report data revealed similar but slightly different findings. In the three sets of correlations calculated at the strategy level, only three pairs of strategies were found to correlate, a differing pair for each set, and all pairs consisted of strategies belonging to two different processes. The two processes themselves were not correlated on any instrument. The findings thus support the conceptual independence of the two processes of acquisition and transformation and so support the efficacy Corno and Mandinach model of the forms of cognitive engagement for identifying self-regulation in the process of gathering information from the Internet.

The purpose of the cluster analysis was to see whether the observed behaviors of subjects searching for information on the Internet would suggest classification into the four forms of self-regulation developed by Corno and Mandinach from classroom observations. Cluster analysis is a process of classifying objects into subsets that are similar in relationship to a particular

set of characteristics—in this case, subjects' use of the five strategies standardized to strategy-use-per-unit-time. Agglomerative cluster analysis begins with all individual data sets uniquely specified and proceeds by linking these, one unit at a time, using rules that determine closest similarity between individuals or groups. The resulting transcript of the clustering process was then examined to look for congruence of groupings with the Corno and Mandinach model of self-regulation; in particular, for congruence between clusters created and the four forms of cognitive engagement (determined by the relative use of the processes of acquisition and transformation) identified by Corno and Mandinach—self-regulated learning, resource management, task focus, and recipience. In addition, the stability of group membership for individual subjects across time (the first and second halves of the observational period) was examined.

Indeed, a natural breaking point of four was found in the data, and at that point, all and only the four forms of cognitive engagement were represented in the natural groupings of the clusters (Table 2). This finding provides strong empirical support for the applicability of the Corno and Mandinach model to Internet searching behaviors, in that subjects could be naturally clustered according to their observed behaviors into four groupings that can be mapped to the four forms of cognitive engagement identified by Corno and Mandinach. This is particularly important when considering students' work habits and classroom behaviors because it means that students can be observed and classified according to the Corno and Mandinach model and treated accordingly.

Changes over time in the form of cognitive engagement of subjects was also investigated by dividing the observations for each individual in half and performing a cluster analysis on the resulting standardized strategy-use-per-unit-time data for both the first and second halves of the number of

Table 2. Average Acquisition and Transformation Ranking Scores for Clusters at the Four Groupings Level

Cluster	N	Acquisition ranking*	Transformation ranking*	Form of cognitive engagement
1	10	1.5/low	2.7/high	Task focus
2	6	4/high	3.7/high	Self-regulated learning
3	49	1.5/low	1.3/low	Recipience
4	15	3/high	2.3/low	Resource management

*Values indicate the average number of strategies-used-per-minute for the strategies within the processes of acquisition and transformation.

observations. The results replicate previous classroom findings (Panagiotopoulos, 1987) in that they reveal cognitive engagement as a dynamic process that changes over time. This finding also has implications for classroom practice.

LIMITATIONS OF THE STUDY AND FUTURE RESEARCH

Our study emphasized the recording of specific behaviors, not the self-regulatory strategies or cognitive processes that might be associated with them. We did not translate observed behaviors into strategies until the data analysis stage; therefore, the data point only to probable strategies and cognitive processes. The most frequently observed strategy was selecting, followed by connecting. The least observed strategy was monitoring, followed by planning. This ranking was not surprising since there are fewer observable indicators of monitoring and planning, compared with selecting and connecting. Theoretically, however, few instances of selecting or connecting can occur in searching without alerting having been evidenced. Observations can be used only as a basis to discuss what is seen; they cannot generate conclusions concerning unseen behaviors. Thus future research might ask subjects to talk aloud as they are searching. Coding for mental activities such as monitoring, planning, or reflecting may not be possible without using some such procedure or by tracing, as suggested by Howard-Rose (1989).

CLASSROOM PRACTICES

The educational community of teachers, parents, and curriculum developers can apply several of the results from the research study to enhance meaningful learning from Web searches. These implementations can be categorized into task specification, presearch activities, posttask activities, and patterns of strategy use.

TASK SPECIFICATION

Teachers have demonstrated the ability to identify students who self-motivate while participating in learning tasks (Zimmerman, 1989). All students employ SRL to some degree, using awareness, effective planning, goal setting, and monitoring of feedback to guide their learning processes. Self-regulated learners are distinguished by their proactive efforts to seek out and profit from learning activities through SRL processes and strategies at the various stages of the learning activity. The first stage involves task specification.

Corno (1986) lists conditions for regulated cognitive engagement in tasks: Tasks must be academic and place demands on students' attention capacities; students must have a degree of familiarity with the content to stimulate prior feelings as well as prior knowledge; tasks must be within the range of student competence to enable perceived self-control and self-efficacy; goals and subgoals for the tasks must be recognized and valued; and tasks should be presented in a cooperative environment that contains peer distractions and competitive goals, to allow for student choice. Butler and Winne (1995) add additional characteristics relating to student feedback, which include success with multiple goals, judgments of the relative productivity of strategies, and the affective benefits associated with particular strategy choices. The educator, they contend, should choose carefully the task to be presented to students to include a maximum focus on these characteristics. The creative educator, then, will find Internet searching tasks that include various levels of Bloom's (1956) taxonomy but that concentrate on the synthesis of information between existing realms of experience.

The eight tasks for the Rogers (2001) study were designed to bring students to a synthesis level of the Bloom taxonomy. Students were allowed to choose the tasks from eight interest areas. The complete list of the eight tasks is provided in Appendix B. Taking the Olympic games task as an example, the task initialized with a search for knowledge of specifics to acquaint students to the general context of the question (find the locations for the 1896 and 1996 Olympic games). Step 2 involved combining the specific knowledge to search for a conceptual application. (Over the years, the altitude of Olympic sites has had an influence in comparing records to decide if records have been broken. Why?). By finding the cities where these games occurred, the students could then determine that city's altitude. Students then could search for the effect of altitude on performance in sports. The next step involved choosing and describing a position taken with respect to the previously found information. (Compare statistics of winners' time; prizes, countries represented. What was the role of technology for each of the games, and what are some ethical issues of changes in technology?) The search for specific statistics was to suggest a path for the student search—to find differences in winners' times for some specific contests. Then the student could search for technology that would be involved with that sport, how technology could enhance speed either from better equipment or from better practice conditions, or how the technology could enhance the conditions for any sports events. The careful design of tasks can help students learn SRL as they conduct an Internet search using the five strategy categories from the SRL model. Students who learn to use SRL internalize the task specifications to apply in future, perhaps less-structured tasks. Students who are exposed to the same progression of

levels of the taxonomy can then structure the search for any topic of their interest.

Similar learning objectives can be accomplished against a background of different content areas. Mathematics applications can be used within science, history, and literature. Likewise, curriculum goals in history can be accomplished with a task appearing to be within literature.

PRESEARCH ACTIVITIES

A common aspect of all tasks involving Internet searching is the proper use of vocabulary in the selection of keywords and potential sources. Students need not only recognize the meanings of words but also use those meanings to determine the probable context of the various links generated (Marchionini, 1990). Our research suggests that practitioners can develop pre-search activities to encourage the application of vocabulary words in the context of various curricular areas. One activity that might be appropriate would be to generate concept maps of the various meanings associated with individual words, especially words that can be used as both nouns and verbs.

Two instances in our study point to this vocabulary emphasis. In the search regarding acid rain, students were asked for preliminary knowledge of specifics regarding acid rain—how it is measured and what environmental influences increase the potential for its high levels. Another aspect of the search asked for the name of a specific lake or body of water in upstate New York that was adversely affected by acid rain during the late 1990s. Many students searched for answers to this question using the keywords “acid rain” plus “lakes” plus “New York” and were frustrated to merely find information regarding general effects. On the other hand, successful searchers built on their preliminary readings to recognize, consciously or subconsciously, that acid rain is not a descriptor of lakes, but rather that pH levels are. A search using the keywords “pH” plus “lakes” plus “New York” provided ample information. A concept map of the information obtained from the developing search could have “acid rain” as its main concept, with a subcategory of “pH” with the labeled arrow to that subcategory being “measured by.” Another subcategory would be “factors” with its descriptor being “affected by” and under factors could be categories such as environment, geographic location, and geologic conditions. Another subcategory extending from the main category might be “countering the effects,” which could be the political action groups and their efforts.

Students in our study also used vocabulary insights for successful searches in the task involving the Olympic games. Early questions in the task requested similarities and differences between the games in 1896 and 1996. A follow-up question regarded the role of technology for each of the games

and what ethical issues were involved in the changes in technology. Searchers who used the keywords “technology” and “Olympic games” found few appropriate links; most of the links they found referred to the technology of video-type games. Searchers who searched “technology in Olympic equipment,” “technology in Olympic stadiums,” or “technology Olympic coverage” were more successful. Again, a concept map might have led students to identify things changed by technology advances (e.g., stadiums, practice facilities, equipment, media coverage).

A second area of presearch activities that might enhance students’ use of SRL in Internet searching involves modeling and discussing the ways in which searches are initiated. In the observation used earlier, Ashley used high-level applications and sophisticated Boolean strategies. While similar lists of Web sites could be obtained by careful syntax involving “and” and “or,” Ashley gleaned additional information by comparing multiple searches. She could thus observe the different ways in which her descriptors were interpreted by two search engines and monitor the preciseness of matches. She made notes in her word processor of the other related terms that appeared as she searched, and she used those notes to refine her keywords in subsequent searches. Allison was more obvious in her attempt at thoroughness and carefully revised the hit lists she generated with ongoing to the assignment sheet to evaluate the appropriateness of suggested links. Then she carefully read within those sites what seemed relevant, making notes on a separate paper. The introduction of such differing but useful strategies, modeled by the teacher or a student in presearch activities, might lead to enhanced success in Internet searching for all students and greater use of self-regulatory strategies.

SPECIFIC STRATEGIES AND PATTERNS

Students used strategies identified by the behavioral descriptors in a variety of unique ways. Some students used strategies in unique patterns and paths, while other students exhibited long sequences of repeated short patterns. Selecting and connecting were the strategies used most frequently.

There is an obvious relationship between selecting and connecting. Students determine the relevancy of new information by recognizing elements from previous knowledge. In Internet searching, links pursued as relevant must be evaluated in the context of the task and previous information acquired. New insights are gained as new information adds a new area to the outline that is either provided by the task or developed by the student. If it is contradictory or irrelevant, then it is discarded. Techniques of concept mapping, outlining, and tree diagrams might be employed to instructionally scaffold this process of connecting and selecting.

Certain relationships between specific strategies and other indicators were found in this study. For example, an inverse relationship was found between the use of alerting strategies and experience with Internet searching. Compared with students who used frequent alerting strategies, individuals who used very few alerting strategies spent an additional 3 hours a week searching. It may be that individuals with more extensive search experience have automated alerting strategies to the point where alerting is not observed as a distinct behavior. This supports the claim that self-regulation strategies are learned and become automatized. A direct relationship was found between time spent searching the Web each week and use of the monitoring strategy. Those who spent minimum time were least likely to be observed using a monitoring strategy. In addition, students who exhibited high use of the monitoring strategy were observed using more elegant Boolean searches or employing multiple screens, or both. This supports the claim that monitoring is likewise a learned strategy evolving from familiarity with the techniques of Internet searching. Such findings have strong implications for classroom implementation. They suggest that direct instruction, modeling, and practice with higher levels of Internet searching are needed to enhance students' use of self-regulatory strategies and processes in Internet-related classroom tasks. A carefully sequenced progression of techniques for Internet searching should be developed as a curriculum with specific activities to be completed within each grade, allowing the student to progress in sophistication of search techniques.

There is a possibility that the use of the five observed strategies is influenced by an underlying feedback effect that links monitoring to the other strategies. For example, selection involves the perception of information relevant to an intended goal; monitoring notes progress toward that goal. Every screen in a search provides feedback to the student, whether they recognize it or not. "No results found" indicates a too-narrow keyword combination or a misspelling. A huge list of potential links indicates the need for refining the keywords words used. Students should be taught to make use of these clues. Indeed, feedback may be a catalyst for self-regulated behaviors (Butler & Winne, 1995). This is not unlike the traditional searches in print media. Students need to be instructed, formally or informally, on the components of a search that provide feedback and the meanings such feedback may hold. Partnering students for Internet searches can extend such instruction as students who assist each other in the recognition of feedback not only learn from each other but must voice and reflect on their own strategies for using feedback productively.

Our study showed six unique search patterns. One pattern was clearly visible as an elementary search process. Some individuals approached the tasks in a serial fashion, clicking on the first item in a list of links returned from a keyword entry, reading that Web site information from top to bot-

tom before returning to the original list, then clicking the next item, and so on for several consecutive entries. These students used no Boolean keyword entries, no split screens, and made no attempt to separate relevant from irrelevant information before selecting links. They also rarely navigated more than one level away from the list generated by the original keyword search. Instructionally, these students need scaffolding activities to support their use of selecting and connecting strategy behaviors. One such activity might involve designing a designated keyword search with a short list of links returned, as a paper and pencil, whole class activity in which students discuss the potential relevance of each link and prioritize the list accordingly. This could also be a teachable moment for introducing the meaning of the URL extensions (eg., .org, .com, .gov, .edu) and their part in determining the reliability of Internet sources.

Another search pattern identified in our study involved checking for relevancy. Individuals exhibiting this search behavior reviewed at least two screens of links generated by a search before selecting a link to explore. In addition, they followed this behavior with reading the selected link for content relevancy. Interestingly, this pattern of behavior was observed the least among students in Corno and Mandinach's (1983) recipient form of cognitive engagement in the cluster analysis. Recipients were most likely to use the elementary search process described earlier. This finding again points to the connection between SRL and Internet searching and suggests the importance of teaching such students to use both SRL and Internet search strategies effectively. In particular, the relevancy search pattern suggests another direction that instruction might take, namely instruction in the use of visual cues to determine relevancy. Just as headings, different fonts, and alternative formats indicate importance in printed material, Web screens are structured in particular ways to indicate the relative importance of the information they contain. Some students need to be made aware of these conventions and the parallels to the print resources with which they are familiar.

Another pattern of search behavior observed during this study was selecting a Web site from a list of links, following it to deep levels where students alternated between checking for relevant links to further pages and reading for content. This cycle usually included adding to notes or checking the question. The sequence within this pattern was not consistent, but the cluster of components was evident, and it clearly provides evidence of both connecting and planning within the pattern. This connecting and planning pattern parallels traditional information gathering from print media. Students have been taught to read, take notes, and check to see if the information obtained satisfies the task assigned. They need to be taught to apply similar strategies for gathering information online. Again, the Rogers's (2001) study showed that students also apply the strategy of structur-

ing their needed information and focus from the task stated and then checking the information on the search screen with those notes rather than the original notes.

Another style of searching we observed was described earlier and involves the use of multiple search engines and multiple windows. Some individuals used a split screen with windows open on the left and right and alternated manipulations and selections between sites. Others used the split screens to compare information between them. Some individuals performed this multiple searching with more than two synchronous searches by minimizing windows and starting new searches in another window. The majority of those individuals who used multiple open applications took few notes; in fact many wrote their paragraphs by restoring the various windows from the task bar and incorporating the information into the paragraphs at the time of writing. These individuals were focused on the task of finding the information. Such focus is a good thing. However, here is great risk here for students to merely cut and paste words from the Web sites to their own documents rather than summarizing and developing their own integration of ideas. Students need to practice and value the management of split screens and the opportunity it provides to compare and contrast information (Ashley's original search) as well as the features of note taking and reading for content as nearly simultaneous activities. Developing their own integration of ideas may be more of a problem with information from Internet sources than from traditional sources. One way to ameliorate it might be, rather than requiring an essay as an end product, to assign a more creative task, such as a Powerpoint presentation, a concept map, a skit, or a poem to be evaluated as the learned outcome.

A fifth observed pattern of search behavior was the successive and progressive generation and refinement of keyword vocabulary. Individuals exhibiting this pattern used information from component pieces of initial searches to refine and focus on further keywords. Those who initially knew little of the subject used their initial searches to become oriented to the content. For example, an initial search on the word "jabberwocky" was refined for future searches to include "poetry" and "interpretation." This pattern was not evident in all individuals. For example, it was not found at all in students characterized as recipient. It appears that the student labeled as recipient expected that the information requested in the search existed in its entirety at some Web site and it was merely a matter of finding that Web site; other groups of students seemed more aware that their thought processes had to be employed to combine the information found at a level of understanding to be able to address the required task. Again, the strategies employed in this pattern can and should be taught. This might be a rich source of action research topics within and between traditional content areas.

The most successful of the searches we observed involved students who compared their written notes or outline with the information that appeared on their screens. These notes were used to inform, most often, the choice of vocabulary for keyword searches and the choice of links to follow. The students who used this technique used it repeatedly in their searches and self-reported that they thought they had been successful in the search process activity. Instructionally, there is a difference in the perception of the purpose of tasks that this pattern illustrates. There are tasks that students do solely because they are assigned. Students who employed this particular pattern of searching recognized personal value in completing their chosen task. Instructionally, the characteristics of the tasks we conceive to situate our educational objectives can enhance the possibility of the desired outcomes.

MOVEMENT BETWEEN FORMS

Some of the rigorous observational studies of SRL in classroom environments (Howard-Rose, 1989; Panagiotopoulos, 1987) note that students employ differing forms of cognitive engagement over time. Our study confirmed this finding for Internet searching. The frequency of strategies employed in the second half of the searches we observed was more indicative of the entire search experience than those found in the first half. On a practical level, this means that the motivation to continue with searching must be strong enough to promote the continuation of the search. It also implies that any conclusions on the form of engagement that teachers want to associate with a student for guidance purposes should be determined during the second half of a search experience. Students need time to become comfortable with a search task, to experience search strategy successes, and to experiment with different search strategies. In our study, students attempted different approaches to searching initially but often returned to those they found successful.

On the other hand, we found that passive approaches to searching were rarely changed; students who were categorized as recipient in the first half of their searches remained recipient in the second half. Thus, students who appear passive in early observations should be given special attention to promote more successful use of both SRL and Internet search strategies.

POSTTASK REFLECTION

Perhaps the most influential instructional technique would be a postsearch activity that encourages students to reflect on their search strategies. This can be in the form of self-evaluation, journaling with a focus on the ways students learned how to succeed or the barriers they experienced,

classroom sharing in small groups, or one-on-one conferencing. The process of reflection precipitates self-monitoring and self-analysis, as well as reinforces confidence in the effective use of strategies.

Talk-aloud procedures might be used instructionally to precipitate the development of self-monitoring strategies. Self-monitoring is one of the characteristics educators associate with self-regulated learners. As students learn how to learn, they often repeat to themselves the questions that lead them to successful goal attainment, often referred to as self-talk in the literature. Again, modeling by the teacher or students might be used to encourage students in useful directions. The voice and directions of the teacher become an inner voice to structure the path to success. Talk-aloud forces students to concentrate on their thought processes—on what they are attending to, on what clues are provided on the screen and in the information on the screen, and on what decisions led to that information and how it can be contextualized in that light. Practicing talk-aloud techniques during searching can enhance searching techniques and support the use of self-regulatory strategies.

CURRICULUM, INSTRUCTION, AND EVALUATION

The previous results focused on the individual student's actions and reactions. Since self-regulation is a learned set of responses, we need educators to develop policies, curricula, and assessment procedures that develop successful Internet search habits, both cognitive and motivational. For example, policies could be developed to plan for consistent Web pages at the school district level to support early experiences in a safe, consistent network. Tools on those Web pages should accommodate the learning styles of individuals as they search for information, independent of instructor guidance and reinforcement.

Curricula need to be developed, first at the local district level, to sequence the development of Internet searching techniques. For example, a logical progression might take students from searching previewed sites to find specific information to using elementary search engines to using Boolean strategies to using multiple screens. Use of concept maps and tree diagrams might be included in such a curriculum, along with acquisition of knowledge regarding the use of the URL extensions as indicative of reliable sources of information. Tasks can be developed to support positive student experiences, as all the SRL models address the need to practice the set of learned responses. Such a curriculum should also focus on the development of a knowledge base for Internet searching within appropriate grade levels and align curricular materials to reflect the repeated use of both SRL and Internet search strategies.

Instructional guidelines can be meshed within the curriculum document to indicate classroom management strategies along with the advantages and structure of cooperative learning groups. Types of tasks should be carefully chosen during instructional planning to enhance students' motivation to commit to a goal and volition to continue in pursuit of it. Students can be taught to segment projects into subtasks, enhancing the planning and monitoring strategies. Teachers should model the use of the strategies involved with self-regulation and provide scaffolding activities to develop their use within students.

The work habits of students will have to be transformed for Web searching in which links can be effectively used to delineate a path to more specific information. In traditional classroom settings, teachers design activities and select resources for students. This selection may be as specific as pointing to a particular reference book and chapter containing information or as broad as having a variety of references available for students to search for the required information. The Internet brings overwhelming resources into that environment, necessitating major changes in the way teachers approach instruction. Individuals must narrow choices in Internet searching on their own, a behavior associated with relevancy decisions but something they may not have had to do before. Instruction should include strategies focusing on visual cues to potential relevancy of particular Web sites, as well as strategies for keyword searching. Students need to be instructed in the use of feedback and self-monitoring of progress toward goals, not only through choosing goals and selecting strategies but also by practicing self-regulation in conscious, deliberate assignments that contain multiple types and levels of feedback. Instruction and practice in the types of feedback that drive cognitive processing will facilitate the individual's future application of those strategies (Corno, 1993).

Individuals' perceived use of the planning strategy also differs between traditional and Internet tasks. We found little similarity of perceptions between approaches to Internet tasks and approaches to classroom tasks, both on self-report instruments and in observed behaviors. It is possible that students do not recognize a need for planning and monitoring in Internet searching, particularly since many tasks provide a natural sequence of information to be integrated into a synthesis level written response. Tasks should be developed which directly address the need for planning and monitoring during Internet searches. Webquests (Dodge, 1997; March, 1998) are an excellent vehicle for this type of task.

Webquests are designed to be used in cooperative settings, with real-world problems, with a final product being something other than a written report in the traditional sense. As students complete tasks, their knowledge about tactics and strategies develop simultaneously with task knowledge and content understandings. Webquests also present alternative approaches to

assessment of students' attainment of educational objectives. Evaluation of such projects can move from the traditional written report to enhanced personal and group presentations with tools like Inspiration and Powerpoint. Motivation is enhanced by the reality of the tasks as well as by participation in activities at high levels within an academic area. It is also enhanced because students have choices about their participation, the formation of goals, and the structure of their product.

CONCLUSION

In conclusion, the ideas presented here directly relate to the ideas of Robbie McClintock (1996) in terms of shifting educational focus as a result of increased resources. The innovation of Web-based classroom activities provides an optimum of digital resources that bring about significant changes in pedagogical possibilities. The educational impact shifts from strategies for disbursing scarce knowledge to finding ways to enable students to use their unlimited access to the resources. When teachers ensure that students can successfully access Web-based resources, the result will empower students to develop knowledge and skills at a more sophisticated level, displaying an increased, deliberate participation in intellectual work that runs parallel to the concepts of self-regulation.

APPENDIX A

CODING INTERNET BEHAVIORS INTO CORNO AND MANDINACH LABELED STRATEGIES

Alerting

- Indicating keyword
- Underlining in question sheet
- Narrowing search within search engine
- Accessing search engines
- Using eyes to react to distractions in room
- Accessing history folder

Selecting

- Clicking link, hotword, or category
- Commenting: number of hits
- Commenting: quality of hits
- Highlighting on screen
- Questioning of observer regarding can or how
- Reading description of site for relevancy

Distinguishing relevant/irrelevant information

Scrolling mouse/arrows: fast, no reading

Shaking head no/yes

Using tab/Button to next page listing

Using file menu—not buttons

Connecting

Recognizing word

Linking information directly to task question

Copying and pasting

Comparing information in notes by comparing to task

Reading with care the page of information, line by line for content

Writing notes

Copying notes from screen information

Laughing, giggling, displaying emotions

Using Boolean search tactics

Moving mouse to indicate careful reading

Planning

Using back arrow fewer than two times

Using forward arrow

Splitting screen

Checking question followed by:

Copy, paste highlight for that purpose

Click on category then relevancy, back once

Click on category, then relevancy, content

Content and then notes

Bookmark

Highlight for emphasis or quick finding

Comments relative to relevancy

Read for relevancy

Read for content

Add to notes

One back arrow

Monitoring

Recalling bookmark

Commenting on the system

Using hand movements

Outlining answer as presearch activity

Printing, reviewing printed material

Checking question followed by

Split screen (comparable to two back arrows)

Split screen and any back arrow

Two or more back arrows

- Stop search
- Compare information on notes to questions
- Print material or review of printed material
- History menu
- Saving a file of information (reflects larger goals)
- Read for relevancy and then back arrow twice
- Access a search engine and/or keyword entry
- Checking question following
 - Split screen, question check, back arrow
 - Outline of search topics prior to search
 - Back arrow use two or more times
- Checking question and simultaneously
 - Adding new section heading to notes
 - Indicating another section of the tasks to be searched
 - Reflective thinking, time, no computer activity

APPENDIX B

INTERNET SEARCHING AND BROWSING TASKS

1. Jabberwocky: What does a jabberwocky look like? Why should you be aware of the bandersnatch? Would you want a Jabberwocky, and why? What literacy or practical use would a Jabberwocky serve?
2. Maritime flag signals: Find the maritime flag system and display your first name in the code. What are the differences between the maritime flag system, the semaphore system, and the Morse code system? Create a new flag as a combination of the maritime and semaphore systems, for signaling between two ships in a non-peaceful situation. Tell the meaning to be interpreted by the flag/position.
3. Acid rain: What is acid rain? Find the acidity for a lake of your choice in upstate New York for any given year in the 1990s, and estimate the acidic value for this lake 10 years from now. Why can't acid rain concerns for Upstate NY be controlled by the New York State legislature? Is there such a thing as "basic" rain?
4. Mark Twain: Who was president during this author's lifetime? Find a favorite quotation by Mark Twain, dealing with politics. What advice would Mark Twain have for teenagers today? If Mark Twain had run for the presidency and won, what might his inaugural speech have focused on?

5. Matchbox cars: Who developed them, when, and is there a standard scale? By the same scale as the 1990 cars, how high would be a model for President Clinton? What building materials are used and could be interchanged in model cars today? What would be a scale and use for a larger-than-life model?
6. Olympic games: Find the locations for the 1896 and the 1996 Olympic games. Over the years, the altitude of Olympic sites has had an influence in comparing records to decide if records have been broken. Why? Compare statistics of the winners' time; prizes, countries represented. What was the role of technology for each of the games, and what are some ethical issues of changes in technology?
7. Humor: What is a parody? Find some parodies of "Twas the Night before Christmas." What makes them funny? Give some examples of other perspectives that could be a foundation for additional versions of this parody? When is humor unhealthy or inappropriate?
8. Juggling: What is an early (historically) indication of juggling? Visit sites that describe the motions of juggling, visually and mathematically, and provide an estimate of the level of high school mathematics (algebra, geometry, etc.) needed to analyze the movements? What factors influence the maximum number of objects that can be in a pattern? Devise an instructional technique or mechanical aid to juggle more objects or special objects.

References

- Bloom, B. S. (1956). *Taxonomy of educational objectives. Handbook 1: Cognitive domain*. New York: McKay.
- Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*(3), 245–281.
- Corno, L. (1986). The metacognitive control components of self-regulated learning. *Contemporary Educational Psychology, 11*(4), 333–346.
- Corno, L., & Mandinach, E. (1983). The role of cognitive engagement in classroom learning and motivation. *Educational Psychology, 18*(2), 88–108.
- Davey, B. (1990). Field-dependency-independency and reading comprehension questions: Task and read interactions. *Contemporary Educational Psychology, 13*(3), 241–250.
- Dodge, B. (1997). Some thoughts about Webquests. Retrieved June 8, 2003, from http://ed-web.sdsu.edu/courses/edtec596/about_webquests.html
- Guthrie, J. T., & Dreher, M. J. (1990). Literacy as search: Explorations via computer. In D. Nix & R. Spiro (Eds.), *Cognition, education, multimedia* (pp. 65–114). Hillsdale, NJ: Erlbaum.
- Howard-Rose, D. C. (1989). *Variations in cognitive engagement as evidence of self-regulated learning* (learning strategies). Unpublished dissertation, Simon Fraser University, Canada.
- March, T. (1998). *WebQuests for learning*. Retrieved June 8, 2003, from <http://www.ozline.com/webquests/intro.html>
- Marchionini, G. (1988). Hypermedia and learning: Freedom and chaos. *Educational Technology, 28*, 8–12.

- Marchionini, G. (1990). *Information seeking in electronic environments*. New York: Cambridge Press.
- McCann, E. J. (1999). *The assessment and importance of volitional control in academic performance*. Unpublished dissertation, University of Texas at Austin.
- McClintock, R. (1996). *Renewing the progressive contract with posterity: On the social construction of digital learning communities*. Retrieved March 26, 2003, from http://www.ilt.columbia.edu/mcclintock/renew/ren_main.htm
- Panagiotopoulos, J. (1987). *Cognitive engagement variations among students and classroom tasks in one elementary classroom*. Unpublished dissertation, Columbia University Teachers College.
- Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, 81(3), 329–339.

DONNA M. ROGERS is an adjunct instructor at the State of New York University at Albany. Previously, she was assistant director of instructional technology at North Syracuse (NY) Central Schools. Dr. Rogers's research interests include technology in the mathematics classroom, self-regulated learning in the context of Internet activities, and applications of pathing concepts such as Markov chains.

KAREN SWAN is the RCET Research Professor in the Research Center for Educational Technology at Kent State University. Dr. Swan's research has focused mainly in the general area of media and learning. She has published and presented both nationally and internationally in the specific areas of programming and problem solving, computer-assisted instruction, hypermedia design, technology and literacy, and asynchronous online learning. Her current research focuses on the latter, in particular interaction and the development of social presence and community in online environments, and on student learning in technology rich environments. Dr. Swan's most recent publications include an article on online learning effectiveness in the most recent Sloan Consortium annual edition on quality online education; articles on social presence and virtual community in *Education, Communication, and Information* and the *Journal of Asynchronous Learning Network*; chapters on the same in books edited by Som Naidu, Roxanne Hiltz, and Ricki Goldman; and an article on situated professional development in the *Journal of Technology and Teacher Education*.