Web-Based Learning: How Task Scaffolding and Web Site Design Support Knowledge Acquisition

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Abstract

Using WebQuests for inquiry-based learning represents a higher-order use of technology requiring students to exercise information seeking, analyzing, and synthesizing strategies. This research was designed to obtain a better understanding of how to enhance the pedagogical effectiveness of WebQuests and of how students interact with the various features inherent to informational Web sites. A major objective was to examine the effect of providing instructional scaffolds to support fifth-grade students' WebQuesting experiences. The findings indicated that concept mapping templates coordinated with the research tasks enhanced students' free recall and application of acquired knowledge. The importance of site design features, especially discourse quality, multimedia elements, and navigational systems, are discussed with respect to students' ability to locate, extract, and apply information. (Keywords: WebQuests, information literacy, Web site design, inquiry-based learning, cognitive scaffolding.)

INTRODUCTION

Classrooms have been provided with increasingly easier access to the Internet and teachers are challenged to create meaningful Web-based learning activities for their students. The WebQuest, an approach to organizing Internet-based learning tasks for students (Dodge, 1995), frequently is utilized as an instructional activity in the elementary school curriculum. Major components of the WebQuest protocol include a topic description, a list of relevant Web resources, and a set of task requirements and processes. Teachers, busy managing their classrooms and attending to learner needs, seek a balance between providing structure and encouraging the development of self-regulated learning skills. The purpose of this research project was to learn how task activities should be structured to provide an appropriate level of scaffolding and how to select Web resources to support WebQuest learning experiences.

Internet-Based Learning: Hopes and Cautions

With the rich array of resources such as up-to-date digital libraries, primary source documents, museum exhibits, and multimedia presentations about events, topics, and processes available on the Internet, educators have been optimistic about the value of exposing students to Web-based resources (McArthur & Lewis, 1998). For example, exposure to current, authentic information uniquely available through Web sites can provide students with environments that support inquiry-based and constructivist learning (Oliver, 2000), improve student test performance, and develop broader forms of social, cultural, and intellectual capacity (Guile, 1998). A recent large-scale study in California, how-

ever, found that there was no impact of having access to the Internet in the schools on student achievement scores (Trotter, 2002). The results of the study suggest that mere exposure to Internet resources is not sufficient to improve student learning. Lack of an evidential base of measured student performance has been noted by other researchers (Reynolds, Treharne, & Tripp, 2003). Although one may argue that standardized test scores are not good measures for these kinds of higher-order skills, decades of research on instructional technology suggest that quality instructional design of learning tasks and learning environments is necessary for improving student learning (Clark, 1983, 2003; Jonassen, 2002).

A major issue related to student use of hypermedia oriented Web sites is their ability to navigate through the site, finding the information needed to solve problems and complete tasks. Previous research indicates that students' ability to use hypermedia organized information systems are influenced by factors such as prior knowledge and self-regulation strategies (MacGregor, 1999). Although many students are savvy enough to "surf" the Internet, they may lack the strategies necessary to efficiently and effectively negotiate the reams of available information.

WebQuest

With its six major components, including introduction, task, resources, processes, evaluation, and conclusion, the WebQuest model was created by Dodge (1995) and his colleague Tom March (1998) as a framework for teachers to structure student-centered learning using Internet resources. In the introduction, the topic is usually launched with some interesting background information and a challenging authentic problem. Then a general description of the assigned task is presented in the task section. A set of Web sites that students can explore to complete the task are provided in the resource section or embedded in the process section, which provides detailed step-by-step procedures that students should follow to complete the task. The evaluation component describes the evaluation criteria, usually in the format of a rubric, that will be used to assess the students' work. Conclusion brings closure to the quest, reminds the learners about what they've learned, and encourages them to extend the experience into other domains.

Since its creation, the WebQuest model has been embraced by many educators, and numerous WebQuests have been created by inservice and preservice teachers for all grade levels (Dodge, 1998–2004). However, there is very little in the way of empirical research on the effects of WebQuests on student learning and on elements that make an effective WebQuest (Dodge, 2003). A search of "WebQuest" in the ERIC database located 49 articles published since 1995. Most were about why WebQuests should have an effect on student learning and/or how to design WebQuests. A few articles (e.g., Lipscomb, 2003) describing classroom use of WebQuests indicated that students often found the learning activities interesting and fun. Lipscomb, however, also found that the activities before and after student Internet research were very important in guiding the students. King (2003) conducted an empirical study investigating preservice

teachers' self efficacy and outcome expectancies related to using WebQuests as a strategy to develop inquiry skills among elementary students. Contrary to her expectation, the group of preservice teachers who implemented their designed quests in actual classrooms had lower outcome expectancies than the group of preservice teachers who did not implement their designed quests.

The above results may be unexpected, but not surprising. A similar finding was observed in an exploratory study the authors conducted with two classes of preservice teachers, who designed and tried out their WebQuests with elementary age children (Lou & MacGregor, 2001). The pairs of preservice teachers designed their WebQuests specifically for the children they knew and carefully followed the design guidelines as suggested by Dodge (1998–2004). Before the tryout, most of the preservice teachers were confident that their designed WebQuests were perfect. During the implementation, students found that their assistance was needed by the children more frequently than they expected. In their post-implementation journals, many of them commented about this experience and felt that they needed to design their WebQuests more carefully and provide more supporting activities and materials. These preliminary research studies indicate that WebQuest implementation may be more difficult than designers expected.

Role of Scaffolds in Resource-Based Learning

Resource-based learning differs from traditional instruction in a number of ways (Hill & Hannafin, 2001). Traditional instruction is didactic, focusing on known learning goals using predetermined, well-organized resources and directed learning activities. In traditional instruction, students look to the teacher for what to learn, how to learn it, and whether sufficient learning has taken place. The most common way for students to learn about a topic is to listen to a lecture, read the textbook, and complete the corresponding assignment. In this type of learning, there's no need for the learner to look for additional resources or to evaluate whether the resources are relevant and sufficient for the given assignment. Traditional instruction is often criticized for being too structured and for developing learner compliance rather than critical thinking and self-regulated learning skills that are highly needed in today's fast changing information world.

Different from traditional instruction, resource-based learning such as a WebQuest is often learner-centered, focusing on open-ended learning goals using a variety of authentic resources that are not specifically designed for completing the specific tasks. A resource does not teach as a textbook often does, but "provides candidate information to be engaged and interpreted" (Hill & Hannafin, 2001, p. 5). In resource-based learning, especially on the Web, there is an abundance of resources within easy clicks of a computer mouse. However, unlike refereed books and journals in a library, anyone can publish on the Web without being reviewed or approved by experts, or following any standards in designing the Web site homepage (Nielsen & Tahir, 2002) or information architecture (Morville & Rosenfeld, 2002). Thus, in Web resource-based learning, learners are confronted with the need to quickly and critically evaluate both the credibility and content relevance of a Web site for a given task (Case, 2003). They have to interpret and syn-

thesize a variety of resources that may not be well organized and designed for the assigned task. These needs call for new skills in managing complex information, higher-order cognitive processes (Naidu & Bernath, 2002), and sufficient metacognitive awareness and self-regulated learning skills (Hill & Hanaffin, 2001). Because most of our current learners are accustomed to didactic instruction and directed learning, they often feel insecure and uncomfortable and are unable to learn effectively in such learning environments (Case, 2003).

Resource-based learning has great potential to improve the development of higher-order cognitive skills, critical thinking, and problem solving skills that the fast paced information age demands; however, in order for it to work, students need support and scaffolding in developing the requisite skills (Hill & Hannafin, 2001). This research project focused on investigating the use of a conceptual scaffold in the form of a concept map template in guiding the learners and the design features of Web sites that students used in getting relevant information for completing their WebQuest tasks.

METHOD

An exploratory pilot project was first conducted to determine the effect of providing an explicit set of procedures that directed fourth-grade students' research while completing a WebQuest. The instructional goal of the WebQuest was for students to identify important features (e.g., government, recreation, weather, education) of their community and to create a brochure that depicted positive and interesting features of that community. One group of students (n=12) was provided with the WebQuest goal and was given guidelines for the criteria that must be met for creating the brochure. The other group of students (n=12) was provided with the same basics, but was given an explicit set of directions that identified what information should be included and how that information should be organized.

To ensure that the students in each of the groups had comparable levels of language arts ability and prior knowledge about their community, their recent scores on the Iowa Test of Basic Skills were obtained and a pretest of community knowledge was administered. A comparison of the pretest scores of the two groups revealed that they had similar levels of language arts achievement and prior knowledge about their community. At the end of the last session, the community knowledge assessment was re-administered and the brochures created by the students were scored according to a rubric that included criteria related to the number of different ideas that were expressed, the use of organizational features such as headings and subheadings, the depth of information that was provided, evidence of style and personality, balance in the use of text and graphics, and coherence and consistency in the presentation. Field notes were recorded while students were engaged in the process of searching the Internet, collecting information, and creating the brochure.

A comparison of the performance of the two groups revealed that the students who were given the explicit procedures acquired more community knowledge and created higher quality brochures. Additionally, observations revealed that these students spent more time assimilating information within sections of the Web site, whereas the students in the other group were more likely to surf the site and navigate out to external links that were not necessarily related to the task at hand. It was

also noted, that although the set of procedures provided some direction, a number of the students disregarded some or all of the procedures that were listed. Observations also revealed that many students had difficulty with orientation and navigation within the Web sites they visited, making it necessary for an adult to facilitate the navigation process. In analyzing instances where students had successful and unsuccessful searches, it was apparent that site design features affected the search process and outcome. As a result of these findings, it was determined that providing students with explicit procedures facilitates WebQuest activities and supports the acquisition of knowledge. However, though these procedures were helpful, they were not sufficient in maximizing the knowledge students obtained from their searches. To continue investigating how to design WebQuests to enhance their pedagogical effectiveness, the current study was planned.

Design of the Study

This mixed method research was conducted with two fifth-grade classes (26 students in each class) taught by the same teacher in an elementary school. The students were not the same children who participated in the pilot project. The objectives were to examine: (1) the effects of providing students with a concept mapping template on their free recall of information and their production of an informational multimedia slide show, (2) how students perceived the usefulness of the Web sites accessed, and (3) the relationships among task procedures, resources, and student performance.

Data Sources

Students' prior knowledge of the topic was assessed using a 12-item multiple-choice pretest about topics related to endangered species. Questions about the reasons for endangerment and solutions to the problem were included. Students' knowledge acquisition during and after participating in the project was measured by three assessment approaches:

- A study guide that contained nine items to which the students were directed to find relevant information. The guide was scored such that the student received one point for each item for which they obtained correct and relevant information.
- A free recall protocol where the students were requested to write down "What I Learned" was administered after the students completed their study guide and data collection activities. Students received one point for each item of correct information that they wrote down.
- Multimedia slide shows were created by the students and were scored by a rubric (Table 1) assessing creativity, content, and organization.

Students' perceptions of the quality of the primary Web site they used were measured in two ways:

- An attitude scale designed as a semantic differential consisting of six adjective pairs (boring-interesting, meaningless-meaningful, important-unimportant, informative-uninformative, disorganized-organized, easy-difficult) with five

Table 1. Rubric for Scoring Multimedia Slide Shows

Criteria	Rating
Creativity	
Use of multimedia elements [0=not present; 1=present]	
Creative strength (e.g., use of humor, unusual perspectives, emotional expression, fantasy, movement, richness of imagery) [0=not present; 1=present]	
Content Presentation	
[Each of the following was rated: 0=no accurate information; 1= accurate statement; 2=multiple accurate statements]	
Description	
Habitat	
Threats (i.e., causes of endangerment)	
Solution (e.g., how to help)	
Additional appropriate information (e.g., diet, life span)	
Content Organization	
Organization of content ideas (e.g., each idea has subtitle or is on a separate screen) [0=no organizational elements; 3= some organizational features; 5=extensive organizational features]	
Total Score	

intervals was administered to the students. The target object was the Web site the students selected as most important for researching their topic.

• Observations and individual conversations with students where they were prompted to do "talk alouds" while they visited their sites.

Information provided by the students during the individual conversations and their responses to the semantic differential were considered in the development of a rubric to assess the design of Web sites. The students' responses to the semantic differential attitude scale were used to identify desirable and undesirable Web sites. During the individual observations and conversations conducted by the researchers while students navigated these sites, student comments relevant to the site features were transcribed. A constant comparative analysis (Glaser, 1978) of the transcribed data revealed five categories of the site design that influenced students' perceptions of Web site quality. The rubric (Table 2) was utilized to evaluate the sites for: ease of navigation, the degree to which relevant information was present, amount and usefulness of visual and audio support, discourse quality, and general appearance. Two scorers, using the Web site evaluation rubric, rated the sites from which each student acquired the most information. An inter-rater reliability (determined by percentage of agreement of individual scores) of at least 90% was attained through practice ratings. A similar comparison of the ratings made on a random selection of site evaluations verified the reliability.

Procedures

Students completed the WebQuest activities in their science classroom over a three week period of time during their daily, one-hour science block. The class-

Table 2. Rubric for Evaluation of Web Sites

Features	Rating
Navigation	
Links are well organized and easy to use (e.g., information is no more than one click away) [0=not present, 1=present]	
Locators that let you know where you are (e.g., clear section indicators, image captions.) [0=not present, 1=present]	
Content Presentation	
The site offers sufficient information related to the needs of the assignment [1: one category…, 4: four or more categories]	
Multimedia	
Still graphics [0=not present; 1=present]	
Video clips [0=not present; 1=present]	
Sound effects [0=not present; 1=present]	
Quality of multimedia (e.g., clarity, relevance to text) [1=limited relevance, poor clarity; 3=moderate relevance; 5=high relevance, extends knowledge of topic]	
Quantity of multimedia (% of screen space) [0=none; 1=1% to25%; 2=25% to 50%; 3=>50%	
Discourse Features	
Readability [1= long sentence/paragraph/sections and difficult (i.e., adult) vocabulary; 2= either long sentence/paragraph/section and some difficult vocabulary; 3=short sentences and 5th grade vocabulary]	
The content is clearly organized (e.g., box, labels, headings, subheadings, lists with bullets, etc.) [1=limited use of organizational features; 2=moderate use; 3=extensive use]	
Total Score	

room was set up with clusters of six desks arranged in a table layout. A mobile laboratory was available for the project and each student was given a laptop computer to access the Internet and for using Microsoft Powerpoint to create their multimedia slide shows. These students had average to high levels of computer and information literacy skills and worked independently and collaboratively to complete the WebQuest tasks.

A WebQuest on endangered species was designed by the authors to coordinate with the fifth-grade science curriculum. Students were provided an introduction to the WebQuest through some motivational activities that included a video tape related to the topic and a newspaper article reporting the work of a local scientist. The primary objectives were for each student to (a) select an endangered species, (b) gather information on that species using Internet resources, and (c) create a multimedia slide show that could be used to teach the topic to second-grade students in their school.

The procedures included several steps. First, students were directed to collect information using the study guide that required them to record specific types of information about their endangered species (e.g., habitat, description, reasons for endangered status). Although explicit directions for collecting information

were found to be beneficial in the pilot project, it was determined that they were not sufficient. Therefore, the study guide was required. Addresses for topic-related Web sites were provided, but students were not restricted to these sites. Second, students were required to design their slide show presentation for second grade students. A random selection of half the students in each class was provided with a concept mapping template. The template provided a framework that specified how the learner was to make connections from the information they acquired with their study guide to the major relevant concepts (e.g., characteristics of their species, habitat issues, and how these factors contributed to the causes of endangerment). The concept mapping template was then used as a design mechanism for their slide show presentation. The other half of the students were requested to select and organize the information that they collected with their study guide in their own way to create a storyboard for their slide show. After the students completed the design of their slide show, the free recall "What I Learned" assessment was administered. Subsequently, students were directed to use their designs to create their slide show presentations.

Students were observed and field notes documented their Web site interactions as they searched for information. Additionally, the researchers met with each student individually at a computer station, and asked them to revisit their favorite site. During this individual observation session, the students were prompted to identify and talk about the design features that facilitated and/or impeded their search for relevant information. While they were engaged in reviewing this Web site they were requested to respond to the semantic differential scale.

RESULTS

The data were analyzed using both quantitative and qualitative strategies. Statistical analyses were implemented to test for significance of the quantitative findings and constant comparative analyses were used to find patterns and themes in the observational field notes and conversations with students. The data from only one of the classes were used in the statistical analyses because a more complete set of data was available from this class.

Task Scaffolding

To determine whether providing students with a concept mapping scaffold for organizing their newly acquired knowledge influenced their learning, a comparison between the students who used the scaffold and those who did not was made. To ensure that the groups were comparable, t-tests were conducted to compare their levels of prior knowledge and their performance on the study guide that was completed before the concept map was used. The results of a t-test comparing mean scores on the test of prior knowledge for the concept map group (M=6.44, SD=1.81) and the no-scaffold group (M=5.82, SD=2.04) revealed no significant difference between the groups. Likewise, the results of a t-test comparing the mean scores on the information collected on their study guides for the concept map group (M=8.33, SD=2.24) and the no-scaffold group (M=7.88, SD=2.09) revealed no significant difference.

Preliminary analyses on the dependent variables indicated that the four measures (free recall and creativity, content, and organization of the slide show) were highly correlated. With the exception of the correlation between free recall and creativity (r=.08) and creativity and the amount of content included in the slide show presentation (r=.37), the other correlations were significant: free recall with content (r=.56, p<.01), free recall with organization (r=.45, p<.05), creativity with organization (r=.50, p<.02), and content with organization (r=.80, p<.01). Therefore, a one-way MANOVA by the concept map condition was conducted. A significant Wilks' [lambda]=4.81, F(4,17)=4.58, p<.01, was obtained for the use of the concept map scaffold. Follow-up ANOVAs revealed specific effects for each of the dependent variables. A significant difference between the groups for their scores on their "What I Learned" free recall assessment was found, F(1,20)=9.20, p<.01. A similar pattern emerged for the differences between the groups for both the content of their slide show presentation (F(1,20)=15.93, p<.001) and the organization of that content (F(1,20)=6.84, p<.02). There was no difference in the level of creativity represented by students in the two groups, which makes sense given that the treatment was not designed to enhance creativeness. Descriptive statistics for the dependent variables are presented in Table 3. The significant effects of the intervention have important implications for planning instruction of this type. It appears that providing scaffolding for the students in the form of a concept mapping template helps them to extract information from Web sites and then to be able to remember, present, and organize that information.

Table 3. Mean Scores on Student Measures of Performance by Task Scaffold

Scaffold		What I Learned	Multimedia Slide Show		
			Creativity	Content	Organization
None	Mean	4.53	2.47	4.87	2.54
(n=13)	SD	(1.42)	(0.99)	(2.59)	(1.13)
Concept	Mean	6.22	2.86	7.71	3.67
Map (n=9)	SD	(2.22)	(0.90)	(1.89)	(1.00)

Site Design Features

Observation and Interviews. Discourse quality, mentioned most frequently by students, was comprised of elements of writing style, readability level, and text organization. The students indicated a preference for expository text that was written concisely, clearly, and at a simple readability level. One student commented, "This Web site gave a lot of information, but the words could be easier." The concern with wordiness was expressed by another student: "It had a lot of words and it was hard to find the information." A preference was expressed for sites where there was ample use of subtitles and short segments of corresponding text. Observations of students while they searched for information revealed that, in general, they scrolled through the site looking for relevant headings, and once a heading was located, skimmed the text to find specific information. Students repeatedly noted their preferences for "…bold headings

and short paragraphs." In a few cases students chose sites where the information was written in the context of a story narration and they expressed a keen interest in this kind of format.

Interestingly, students expressed a dislike for menus with links that required them to leave the main page and navigate to other sections. One child went to a site that had navigation buttons across the top of the screen providing connections to the corresponding information. After clicking on one button that went to another page, the child left that Web site and moved to another. When queried about this action, she said, "It's too hard to find what I need." Another student who was working on a site with very simple navigation paths said, "This site isn't hard because you don't have to click on things to find the information…it's all on one page." A possible explanation for this preference at this developmental level is that it may be more cognitively demanding to maintain the conceptual connections when navigation to new space is required.

The aesthetic appearance of the Web page also contributed to students' perceptions of the site usability. Text enclosed in boxes and "fast fact" ways of presenting information were identified as functional features. One student expressed her fondness for the use of borders in saying that "The side chart in the boxes was perfect. It showed what I needed." The use of color backgrounds for text boxes was repeatedly mentioned as appealing. Multimedia features were important to students as they searched for information relevant to their task. "I like the fact that there is a picture of an animal and then a sentence" illustrated the importance of graphic support. An appreciation for maps was expressed: "I liked the map that shows where they live." One student noted the importance of audio clips, "It was very interesting because I found the sound and how they (the animal) communicate." Movie clips, when available, were enthusiastically accessed and one student stated that it was important because "it shows movement and what my animal does." Students didn't settle for sites that were lacking the desired features, and moved rapidly from site to site seeking ones which they believed would provide them the most information quickly.

Rubric-Based Rating of the Sites. The most highly rated sites were those containing screens on which the information was clearly organized (e.g., using borders, subtitles, short paragraphs, or proper white space), had simple, if any, menus, and contained graphics (e.g., charts, tables, photographs) and other multimedia elements such as sound and videos. The lowest rated sites used few, if any, of the desired screen design features, and data from the semantic differential scale indicated that students considered these sites to be disorganized, boring, uninformative, difficult, and meaningless. Table 4 provides a summary of the features that characterized sites receiving both low and high ratings.

Relationship between Task Procedures, Resources, and Student Performance

Bivariate correlations were conducted to test the degree of relationships between the instructional variables, the Web resource features, student perceptions, and the student performance measures, including the study guide, free recall, and multimedia slide show.

A significant correlation ($r=.7$, $p<.001$), determined from the Web site evalua-

Table 4. Characteristics of High and Low Rated Web sites

	High Rating	Low Rating
Discourse	Concise sentences	Long sentences/paragraphs
	Vocabulary at grade level or lower	Complex vocabulary
	Headings	Minimal headings
Content	High relevance to task objectives	Limited relevance to task
	Breadth of coverage	Depth of coverage
Navigation	Limited use of menus	Layers of menus and submenus
	Information that is accessible with only one click	
	Site and section locators	
General Appearance	Borders around text	Web page covered with text
	Color fill in text boxes	Busy space
	Lots of "white" space	
Multimedia	Still graphics providing explication of textual elements	Irrelevance to text
	Audio features	Poor clarity
	Video clips demonstrating concepts	
	Clarity	

tion rubric, was found for the relationship between the content rating of the Web site and the amount of information gathered for the study guide. Total Web site quality was significantly correlated with the students' scores on the "What I Learned" free recall assessment (r=.45, p<.05), indicating that site design features are significantly related to how much a student learns from a particular site. A significant correlation was found between the students' scores on the study guide and their scores on the "What I Learned" free recall posttest (r=.38, p<.05), suggesting that the amount of information extracted from the resource sites and recorded on the study guide had a positive influence on how much students learned as measured by the free recall posttest. This finding underscores the importance of the study guide as a means of supporting student learning. Visual features, including video clips and still graphics, were identified as desirable for providing information that supported or enriched the textual information and this was corroborated by a significant correlation (r=.65, p<.01) between the rating of the multimedia for the sites and the score students received on their study guide. There also was a significant correlation between certain elements of the Web site and the quality and relevance of the content the students produced in their multimedia slide shows. The quality of the multimedia features offered at the site (r=.56, p<.01) and the relevance and clarity of the content (r=.59, p<.01) were associated with higher quality presentations.

The correlations between students' perceptions of the Web sites, measured by the semantic differential scale, and their study guide score (r = .34, p<.05) was significant. This may suggest that their perception of the Web site was related to

how much information the students were able to extract from the sites and how helpful it was to them in completing WebQuest tasks. The Web sites that supported higher levels of knowledge acquisition were judged by the students to be more organized, interesting, informative, meaningful, and were easier to use. Students' awareness of the usefulness of the Web sites that they visited may demonstrate that this particular group of students had a fairly high level of information literacy.

CONCLUSIONS

Using WebQuests for inquiry-based learning represents a higher-order use of technology. It requires students to analyze and synthesize information and exercise information seeking strategies that represent higher levels of cognition than simple knowledge acquisition. Identifying strategies that help the learner to be savvy about how to select sites, extract relevant information from those sites, and then synthesize that information in meaningful ways is an important endeavor to educators at all levels. Prior research indicate that although WebQuests were promising, results of their implementation often were not as good as designers expected.

Hill and Hannafin (2001) suggested four types of scaffolds: conceptual, metacognitive, procedural, and strategic that may be used to support resource-based learning. Conceptual scaffolds may include outlines and concept maps that assist the learner in deciding what to consider or to prioritize what is important. Metacognitive scaffolds may include a simple reminder to reflect on the goal or a problem solving model, which help learners assess what they know and what to do as they learn. Procedural scaffolds may include procedures, site navigation maps, textual charts, and graphic representations that help the learner access and use resources while reducing the cognitive load in the mechanics of procedures and navigation. Strategic scaffolds may include suggestions for alternative approaches to engaging a task that help the learner develop alternative perspective or ways in solving a problem.

The findings of this study revealed that conceptual scaffolds in the form of a study guide and a concept mapping template supported students as they were engaged in learner-centered resource-based learning. Providing a study guide that identified what information to extract and a concept map that provided cues for organizing and synthesizing their information were helpful in keeping students on task and facilitated higher-order learning. The concept map template was effective in guiding students' synthesizing and organizing the information they gathered for their target purpose and audience.

The results of this study also revealed that in Web resource-based inquiry learning, it is important for teachers to be cognizant of the design features within a site and understand how they facilitate student use in achieving learning objectives. Design features that provided support for the students included appropriate discourse readability, high content relevance, easy navigation, user-friendly screen design, and informative multimedia. These findings were consistent with research on reading comprehension on the Internet (Coiro, 2003) and design principles in computer-based instruction (Clark & Mayer, 2002). Due to different features such as hypertext, multimedia, and interactivity, learning

from Internet-based resources places different demands on the learner than traditional text-based, linear resources. Learning is facilitated when multimedia elements such as graphics provide illustration of the concepts, readability is appropriate for the target learners, and when screen design is appealing and easy to read and navigate.

Nielsen and his colleagues conducted extensive usability studies of both corporate Web sites (Nielsen & Tahir, 2002) and children's Web sites (Gilutz & Nielsen, 2002). Based on these studies, they developed comprehensive usability guidelines for designing and evaluating corporate homepages and Web sites for children. Although many guidelines for corporate Web sites focus on the commercial value of design features, several common usability problems were experienced by both adults and children in their studies and were also noted by the fifth grade students in this study. These included unclear site focus and complex navigation structure. When visiting a site, both adults and children want to know quickly what the focus of the site is and whether they can get the information they are seeking from the site. With respect to graphics, the fifth grade students were similar to the adults in Nielsen and Tahir (2002) in their view that graphics should add value to the content. The students also noted that they liked clustered texts with subheadings and textboxes in helping them identify and focus on the most important content. According to Hill and Hannafin (2001), these navigational usability features of Web sites may be considered procedural scaffolds. They reduce cognitive load and help learners focus on their tasks.

Recommendations for Future Research

This research study was conducted using a science WebQuest with two classes of fifth grade students. The results may be limited to the characteristics of the study, especially the characteristics of the students. More research is needed to replicate the study in different subject areas and at different grade levels. It is possible that different types of scaffolds may be needed for different types of learning tasks and for students at different grade levels. Similarly, it is possible that younger or older students with different levels of metacognitive skills and experiences with the Internet may have different perceptions of what constitutes the most supportive site design features.

The results of this study indicate that multimedia elements that illustrate textual information were positively associated with student acquisition of knowledge from the sites they visited. During the WebQuest activities, the authors also noticed that students were often pleased and excited when they found interesting media elements such as the recorded sounds and video clips of the endangered species they were researching. A future study may examine both the motivational appeal and cognitive support of multimedia elements in Internet resource-based inquiry learning. It is also possible that different types of media may be needed for different types of content discourse and learning tasks.

Contributors

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