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WebQuests : an online strategy for web-based inquiry learning

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WebQuests : an online strategy for web-based inquiry learning

Abstract

This review discusses the WebQuest format, a strategy to support web-based inquiry learning, from both inquiry learning and web-based learning perspectives. The purpose of this review is to reveal what elements in WebQuests support learning effectively in a school setting while using resources regarding inquiry, web-based learning, and the implementation of WebQuests. The result shows WebQuests can be a solution for teachers to integrate inquiry learning and the Internet into the classroom effectively, and also for students to go through the inquiry process by using appropriate information. WebQuests require the inquiry process and significant elements to support web-based inquiry learning. A well-designed WebQuest can be an effective strategy to support the learning outcomes.

WebQuests: An Online Strategy for Web-Based Inquiry Learning

A Graduate Review

Submitted to the

Division of Educational Technology

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Chieko Homma

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ABSTRACT

This review discusses the WebQuest format, a strategy to support web-based inquiry learning, from both inquiry learning and web-based learning perspectives. The purpose of this review is to reveal what elements in WebQuests support learning effectively in a school setting while using resources regarding inquiry, web-based learning, and the implementation of WebQuests. The result shows WebQuests can be a solution for teachers to integrate inquiry learning and the Internet into the classroom effectively, and also for students to go through the inquiry process by using appropriate information. WebQuests require the inquiry process and significant elements to support web-based inquiry learning. A well-designed WebQuest can be an effective strategy to support the learning outcomes.

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INTRODUCTION

The purpose of this review is to discuss a strategy to support web-based inquiry learning. About ten years have passed since WebQuests were introduced to K-12 teachers. The WebQuest format was devised by Bernie Dodge with Tom March at San Diego State University and defined as “an inquiry-oriented activity” with web resources (Dodge, 1995, ¶ 2). Websites related to WebQuests are increasing and teachers can obtain WebQuests for all subjects easily from the Internet. The content and quality of WebQuests in the websites, however, varies and some of them do not support learning (Jonassen, Howland, Moore, & Marra, 2003). The problem is that few articles have presented what elements in WebQuests support learning effectively, and teachers use and create WebQuests in the classroom without knowing effective design components.

This paper reviews books and articles regarding web-based inquiry learning and Webquests. As a WebQuest is an inquiry-oriented activity, investigating inquiry learning and Internet use in education are appropriate. This review also focuses on questioning and thinking skills because the inquiry process relates to these skills.

A WebQuest is a strategy which teachers can create and implement easily. The importance of the problem is that there is no formal training for creating WebQuests and some of them are not well-designed and do not support learning. Creating well-designed WebQuests with thoughtful questions requires knowledge of the inquiry process and web-based learning. To use WebQuests in the classroom effectively, a teacher needs to know possible outcomes of web-based inquiry learning and what factors of the web-

based inquiry design influence learning. This review will reveal what elements are needed in a well-designed WebQuest to support learning effectively.

The scope of this review includes inquiry learning, web-based learning, and the implementation of web-based inquiry learning, and WebQuests. The review is limited to web-based inquiry learning in the classroom. These topics will be addressed while trying to answer the following research questions are:

- 1) What is inquiry learning?
- 2) What is web-based learning?
- 3) How can web-based inquiry learning be implemented?
- 4) What are the elements of a well-designed inquiry-based WebQuests?

The results of this review can be applied to elementary, middle, and high school classrooms and provide ideas for teachers to integrate technology effectively for students' learning. This review discusses how the inquiry process facilitates students' thinking skills and how the Internet can be a powerful tool for inquiry-based learning. This review also reveals the elements of a well-designed WebQuest. When teachers create WebQuests, they will pay attention to the inquiry process and include the elements of a well-designed WebQuest in their own WebQuests to support learning. By using a well-designed WebQuest, teachers will integrate both inquiry learning and the Internet into the classroom effectively.

METHDOLOGY

Analyzed for this review are articles and books regarding inquiry learning, web-based learning, and WebQuests. The analyzed sources of inquiry learning include the inquiry process, thinking, questioning, and the implementation of inquiry learning in the classroom. The sources of web-based learning are regarding the Internet and the implementation of web-based learning. The sources of web-based inquiry learning include components of WebQuests, scaffolding, and the implementation of WebQuests. The sources were gathered from the Rod Library located at the University of Northern Iowa and through electric databases including ERIC, Expanded Academic ASAP, and Educational Full Text. Other sources were also gathered from the Internet. A search of web-based inquiry learning through Google.com and kartoo.com yielded information regarding WebQuests, inquiry learning, and web-based learning. The descriptors used for searching sources were “inquiry”, “WebQuests”, “inquiry method”, “discovery learning”, “questioning”, “information literacy”, “the Internet”, “World Wide Web”, and “web based instruction”.

Criteria used for evaluating the information found include whether the publishers were reputable and whether the articles were scholarly. The researcher evaluated the reliability and credibility of all information in this review.

ANALYSIS AND DISCUSSION

The researcher analyzed sources regarding inquiry learning, web-based learning, and WebQuests to reveal the effectiveness of web-based inquiry learning. Inquiry learning supports students in constructing their own knowledge and facilitating the development of critical thinking skills. Students can gather a variety of resources from the Internet and communicate with experts of all subjects through the Internet during inquiry learning. The combination of inquiry learning and Internet use in the classroom can have an effective influence on students' learning (Hughes, 2003; Jonassen et al., 2003; Bodzin & Cates, 2002; Owens et al., 2002; Windschitl & Irby, 1999). As a WebQuest is a format of web-based inquiry learning, WebQuests help teachers by facilitating the implementation of web-based inquiry learning in the classroom.

Inquiry Learning

Definitions and Structures

The history of inquiry learning is not short. Dewey's (1933) "reflective thinking" has influenced the concept of inquiry learning. Even though many researchers have mentioned Dewey's concept, they have defined inquiry and demonstrated the process differently. Beyer (1979) indicated that some authors defined inquiry as just questioning and the others defined it as dissecting information. Beyer defined inquiry as "purposeful, systematic thinking... to make new meanings out of the given information—to gain new insights, to resolve a problem, or to answer a question." (p. 17). Lipman (2003) defined inquiry as "a self-corrective practice in which a subject matter is investigated with the aim of discovering or inventing ways of dealing with what is problematic" (p. 184).

Wells (1997) defined inquiry as “an approach to the chosen themes and topics in which the posing of real questions is positively encouraged whenever they occur and by whomever they are asked” (p. 65). Like these definitions, various people defined inquiry differently. Some authors focused only the inquiry process and did not define inquiry itself clearly. As Beyer’s definition shows what inquiry is clearly, this review discusses inquiry learning based upon Beyer’s definition.

Researchers have identified different structures to implement inquiry learning in the classroom (Beyer, 1979; Dewey, 1933; Hunkins, 1989; Massialas & Cox, 1966). Beyer (1979) and Dewey (1933) identified five stages, Hunkins (1989) listed four, and Massialas and Cox (1966) showed six. Even though the definition and the structures of inquiry were inconsistent, the primary components in inquiry process were similar. The similar four key components of the inquiry process include (a) identifying problems, (b) formulating a hypothesis, (c) confirming the hypothesis, and (d) drawing the conclusions. First, inquirers need to have a problem to solve or a question to answer to start the inquiry process (Beyer, 1979; Dewey, 1933) because they need a purpose to inquire and a motivation to dissolve the doubt. Dewey maintained that inquiry problems puzzle the brain, and thinking occurs in situations where students choose from the alternatives. Dewey emphasized the importance of disturbance in students’ minds in starting inquiry. On the other hand, Massialas and Cox (1966) presented that either teachers provide problems, or students find problems during reading assignments to start inquiry. While identifying a problem, teachers ask some questions to lead to formulate a hypothesis. Teachers need to help students acquire competence to notice a problem or question

(Hunkins, 1989). Over all, the first stage of inquiry has two approaches: (a) students derive a problem and question by themselves, or (b) teachers assign problems and questions to support students. When students identify a problem or create questions, teachers need to instruct students on how to find a problem and how to create questions to lead their inquiry.

The second component of inquiry is formulating a hypothesis to solve the identified problems. According to Beyer (1979) and Massialas and Cox (1966), students state possible solutions and tentative answers as the hypothesis based upon their experiences and the limited data they have. The hypothesis has a role in leading students to search for data. Beyer indicated that formulating a hypothesis is a significant step because the hypothesis narrows the range of data that is searched.

Testing the hypothesis is the third component. Inquirers gather information and analyze the data to prove the hypothesis. Beyer (1979) categorized the testing hypothesis phase as steps of gathering, arranging, and analyzing evidence. While inquirers assemble information, they judge the accuracy and validity of the information. The arranging phase includes categorizing the data for the analysis step. During the analysis of evidence, inquirers distinguish patterns and continuity, and identify a correlation between the data and the hypothesis (Beyer, 1979). While they test the hypothesis, it is important that students keep asking questions about how to communicate with the data by themselves, or teachers ask questions of them because questioning facilitates the data processing and reminds students to be aware of the procedures. Teachers need to provide

assistance based upon the students' developmental levels and competence of inquiry (Hunkins, 1989).

The final component is drawing a conclusion. In this phase, students evaluate whether the evidence proves the hypothesis or not, and then they state the conclusion. Massialas and Cox (1966) offered that the conclusion provides justifiable solutions, but it is tentative and is not an "absolute" (p. 120). If the hypothesis fails, students revise it and create another statement (Beyer, 1979).

The process and intentional thinking are essential for inquiry (Beyer, 1979). During inquiry, students identify a problem, create a hypothesis, gather data to test the hypothesis, and state the solution. Teachers need to conduct inquiry learning through the specific components in the process, and the process, however, is not always in a sequential order (Beyer, 1979; Dewey, 1933; Hunkins, 1989; Massialas & Cox, 1966).

Thinking and Questioning

Researchers have addressed the roles of thinking in inquiry learning (Beyer, 1979; Massialas & Cox, 1966; Foster & Padgett, 1999). Beyer (1979) applied thinking in the steps of the inquiry process to Bloom's taxonomy. Bloom, Engelhart, Furst, Hill, and Krathwohl (1956) classified "the intended behavior of students—the ways in which individuals are to act, think, or feel" into six categories including knowledge as a simple level, comprehensive, application, analysis, synthesis, and evaluation as a complex level (p. 12). The levels of the knowledge, comprehension, and application are categorized as lower-order thinking skills, and the analysis, synthesis, and evaluation are categorized as higher-order thinking skills. Beyer (1979) created the "taxonomy of inquiry" and showed

how the inquiry process matches each level of Bloom's taxonomy. Beyer did not include the knowledge level in the taxonomy of inquiry. In the identifying a problem phase of inquiry process, inquirers interpret information which they were given. This interpretation matches the comprehension level of Bloom's taxonomy. In the same way, while formulating a hypothesis, inquirers interpret, analyze, judge the limited data they have, and synthesize the hypotheses. Then, they interpret the data they gathered and synthesize the correlation to test the hypothesis. Finally, they evaluate the hypothesis and the solution (Beyer, 1979). Thus, this inquiry process facilitated students' thinking skills (Beyer, 1979; Foster & Padgett, 1999). In addition, Bloom's taxonomy can be used as test items (Bloom et al., 1956). Bloom et al., (1956) introduced the test items to support each level of the taxonomy. For example, the items are "Which of the following is an assumption implicit in the extrapolation?" (p. 151) used to assess students' analysis skills and "Write an essay of from 250 to 500 words, describing and evaluating the foregoing poem" (p. 198) used to assess their evaluation skills. Massialas and Cox (1966) indicated that educators can use Bloom's taxonomy as criteria to evaluate the outcomes of inquiry.

The importance of questioning in the inquiry process has also been addressed (Hunkins, 1989; King, 1995; Owens, Hester, & Teale, 2002). Hunkins (1989) indicated that higher-level questions related to Bloom's taxonomy facilitate students' higher cognitive level, and teachers need to ask questions to have students absorb information, rather than just provide information. Owens et al. (2002) indicated that inquiry is not just reporting information, rather it expands to create questions by using words including who, what, where, and when. Owens et al. mentioned that questioning is a key for students'

comprehension. Similarly, King (1995) emphasized the importance of questions asked by students during inquiry learning and called the questions “critical-thinking questions” (p. 14). The questions include “What do you think would happen if...?”, “What is a possible solution to the problem of ... ?”, and “Do you agree or disagree with this statement: ...? Support your answer” (King, 1990, p. 669). These questions guide thinking skills, such as analysis, synthesis, and evaluation, and the skills also match the higher-order levels of Bloom’s taxonomy. The National Council for Excellence in Critical Thinking defined critical thinking as “the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action” (as cited in Paul, 1993, p. 110). King (1995) stated that critical-thinking questions facilitate critical thinking during questioning and answering. Teachers also can use the critical-thinking questions in all subjects (King, 1995). It is clear that the inquiry process improves thinking skills.

The Teacher’s Role in Inquiry Learning

To implement inquiry learning effectively, it is important to note the role of teachers. Owens et al. (2002) indicated that students with some prior knowledge of the subject of the problems can inquire well. This shows that teachers need to know what topics students are interested in when teachers provide a problem or a question. On the other hand, students with little experience in inquiry learning require instruction because they do not have the knowledge to inquire (Pappas, 2000). Teachers need to help students while identifying a problem, formulating a hypothesis, and testing the hypothesis

(Suchman, 1965), and provide directions to go through the inquiry process (Edwards, 1997; Pappas, 2000). As mentioned previously, as inquiry has the necessary four components to prove a solution, it is difficult for students to go through the inquiry process if they do not know the process. When students inquire a topic, they use a lot of sources. Teachers need to choose the materials deliberately (Missialas & Cox, 1966) and inform the extent of sources and references is effective for beginners of inquiry (Foster & Padgett, 1999). Teachers also need to provide instructions on how to manipulate resources for students to avoid plagiarism (Foster & Padgett, 1999). Teachers change their roles to be facilitators in inquiry learning (Beyer, 1979; Pappas, 2002), and this is a significant role (Owens et al., 2002). It is clear that teachers' support is a necessary element to implement inquiry learning into the classroom successfully.

The Student's Role in Inquiry Learning

Inquiry learning changes the role of students and learning style in the classroom. Owens et al. (2002) indicated that inquiry learning requires students to create and answer their questions instead of teachers asking questions of students in the traditional classroom. They also noted, however, that teachers need to avoid having students choose the subject of inquiry by themselves entirely. They recommended that teachers should provide topics to scaffold their selection because teachers know students' reading skills, necessary resources for inquiry learning, and appropriate materials. Scaffolding is "a temporary structure used to help learners act more skilled than they really are" (Dodge, 2001, ¶ 34) and "provides assistance at critical times in the form of skills, strategies and links that the students themselves are unable to provide to complete the task" (Oliver,

Omari, & Herrington, 1998, ¶ 15). Basically, students conduct inquiry learning by themselves (Hunkins, 1989) or learned with classmates interactively in a small group (Pappas, 2002). Teachers support their inquiry as facilitators.

The Benefits of Inquiry Learning

Many researchers have mentioned the benefits of inquiry learning (Beyer, 1979; Chang & Mao, 1998; Dewey, 1933; Foster & Padgett, 1999; Hunkins, 1989; Massialas & Cox, 1966; Vanfossen & Shiveley, 1997). Hunkins (1989) stated that the most effective strategy for students is inquiry learning. Similarly, Vanfossen and Shiveley (1997) maintained that inquiry is the proper methodology for all grade students in social studies, and it is essential for students to learn through the inquiry process, such as questioning, formulating hypotheses, gathering information to test the hypotheses, and drawing conclusion to acquire problem-solving skills. Students can acquire competence including critical thinking skills required in society through the inquiry of history (Foster & Padgett, 1999).

According to Chang and Mao (1998), students who learned through using inquiry learning had higher scores than students who were taught by teachers in lecture. Their ninth grade students learned the Earth-Sun system through inquiry while the other students learned it in traditional lecture style. Inquiry in this research focused on gathering and analyzing data during discussions in small groups. The researchers analyzed the results by using the Bloom's taxonomy, especially the knowledge, comprehensive, application levels. The results showed that the scores of students who learned through inquiry were higher than students who learned in lecture regarding the

comprehensive and application levels. However, no significance of the scores was shown in the knowledge level. The researchers concluded that students should acquire inquiry skills, such as gathering and analyzing data, and drawing conclusions. This research shows that inquiry learning benefits students' learning.

Even though inquiry learning is effective for students, many teachers have rarely integrated inquiry into the classroom (Etheredge & Rudnitsky, 2003; Krajcik, Blumenfield, Marx, Bass, & Fredricks, 1998; Vanfossen & Shiveley, 1997; Welch, Klopfer, Aikenhead, & Robinson, 1981). The main reason why teachers do not integrate inquiry in the classroom is the overall difficulty. Teaching through inquiry is not easy (Foster & Padgett, 1999), and teaching subject knowledge through inquiry is complex (Etheredge, & Rudnitsky, 2003). Edwards (1997) indicated that creating materials are difficult because students need to create questions and hypotheses, and investigate by themselves in the inquiry process. Similarly, Vanfossen and Shiveley (1997) pointed out the feature of inquiry, especially the problem identification part in the process, is the most difficult. As mentioned in the beginning, as the meanings of inquiry are too vague, teachers do not understand well what inquiry is (Etheredge, & Rudnitsky, 2003).

Students also feel the difficulty during inquiry learning. Krajcik et al. (1998) found the difficulty of inquiry learning in the science classroom of a middle school. Their research reported that students in the inquiry process could not create appropriate questions, focus on what they needed from resources, and make the connection between the data and the conclusion because of their lack of experience. Krajcik et al. concluded that teachers needed to provide scaffolds while students were doing inquiry. What this

research makes clear is that students need the experience of inquiry learning and teachers' support to learn through inquiry successfully.

Researchers have discussed inquiry learning for many years. Even though the inquiry process basically has not changed, the dawn of the technology age provides other aspects to inquiry learning. The spread of the Internet in schools changes one of the inquiry steps, gathering data. Students can gather information from the Internet. Learning with the Internet, web-based learning, will be discussed in the next section.

Web-Based Learning

The Internet has spread throughout classrooms rapidly in the U. S. over the past decade. According to the National Center for Education Statistics (2002), the ratio of students and computers with Internet access in 2001 was 5.4:1 while the ratio in 1998 was 12.1:1. These statistics show that students have more opportunities to access information in the classroom. When students use the Internet for learning, it is considered web-based learning. Lockard and Abrams indicated that web-based instruction is "delivered primarily or entirely via the World Wide Web" and usually shows distance learning (p. 422). Cunningham and Billingsley (2003) defined "web-based" learning as "activity that is conducted primarily on the Web" including an online course while "web-enhanced" learning as "activity that is performed in an environment other than the Web, but which is improved by use of the Web for certain aspects of the activity" (p. 212) including Internet use in the classroom. Web-based learning is indefinite. For the purposes of this review, the definition of web-based learning will be used the definition of web-enhanced learning by Cunningham and Billingsley (2003).

Resources on the Internet

One of the Internet functions which can be used in the classroom is searching for information. The Internet has a variety of resources, such as statistical data, primary sources, and other information tied to the curriculum. Students can access the latest information and investigate the authentic issues during web-based learning (Zukas, 2000). Accessing websites of libraries, museums, and databases influence learning effectively (Mioduser, Nachmias, Lahav, & Oren, 2000). Zhao (1998) indicated that the Internet provides opportunities for supporting teaching and learning and help a variety of educational activities in ample resources on the Internet. Jonassen et al. (2003) suggested that teachers need to have students use information to accomplish learning goals in order for the Internet to be an effective learning aid. This means that teachers should use the Internet as an instructional tool. Students used to learn with textbooks and books in a library as their only source of information. The use of web-based learning has the benefits because students can obtain the latest information and primary sources easily from the Internet. Moreover, Coiro (2003) indicated that the Internet facilitates students' web-based reading comprehension through collaborative activities which interact with information across the borders and culture. In addition, students need to acquire searching skills. Acquiring knowledge for searching and using information effectively is very significant, and people need to start learning it during an early age (Hargis, 2001). Hargis mentioned that teachers need to provide web-based learning environments and have students acquire the necessary skills for their future.

When students use the Internet for learning, they need to acquire information literacy. Information literacy is “the ability to find and use information” (AASL & AECT, 1998, p. 1), and one of the information literacy standards stated that “the student who is information literate evaluates information critically and competently” (p. 8). All information on the Internet is not always accurate (Banks & Banks, 1999; Milson & Downey, 2001; Owens et al., 2002; Vidoni & Maddux, 2002). Students should evaluate information on the Internet critically when they use the information. For example, Healy (1998) indicated that students need to acquire a skill to “distinguish information from opinion on propaganda” to become critical consumers (p. 252). Similarly, Pappas and Tepe (2002) stressed that students need to know information in diaries and journals can be biased when they are used as primary sources. While students evaluate many resources on the Internet critically, they can learn how to find appropriate information. Shiveley and Vanfossen (1999) indicated that students need critical thinking skills to select appropriate information from the Internet. Those skills are useful for students' future because they will need to select appropriate information and judge appropriate contents by themselves.

The Internet as a Communication Tool

Students not only use the Internet for retrieving rich resources, but they also use the Internet as a communication tool, through email, chat, and bulletin boards. Email can be an effective tool for the instructions (Maddux, Johnson, & Willis, 2001) because the Internet has the function for students to communicate and collaborate with various people (Banks & Banks, 1999; Murphy, 2002). The Internet provides opportunities to ask

questions of experts (Jonassen et al., 2003) and to communicate with people in the world.

Thus, the Internet facilitates students' communication skills (Mioduser et al., 2000).

Web-based learning provides students with the opportunity to communicate with people outside schools and obtain a variety of information easily.

Students' Motivation

Moreover, web-based learning facilitates students' interest and motivation (Owens et al., 2002; Scheidet, 2003). Scheidet researched whether or not web-based learning facilitated high school students' motivation and interest in the global history curriculum in comparison with a traditional teacher-centered class. Students who learned through web-based learning solved real-world problems while accessing the Internet and sharing what they found. The results from surveys, interviews, and observations showed that Internet use in the curriculum facilitated students' motivation and interest more effectively than a traditional class. Students kept their motivation and interest high in every class while teachers in a traditional classroom had to motivate students. Thus, teachers can use web-based learning as a tool to motivate students.

The Implementation of Web-Based Learning

Using the Internet in the classroom is easy (Maddux et al., 2001) and has benefits; however, teachers have not integrated the Internet into the classroom well. Becker (2000) found that the application that teachers require students to use the most in the classroom was word processing, not the Internet. Moreover, teachers felt frustration at how to find appropriate resources from thousands of websites on the Internet and how to have students use the web-based resources. Murphy (2002) pointed out that the teachers

just did not know how to use the Internet in the classroom. These teachers have caused ineffective computer use. Levin and Arafah (2002) researched how students considered the Internet when they used it for their learning. According to the research, students felt that the web-based assignments provided by teachers were deficient and boring. Students wanted to learn more with web-based assignments and activities, and they wanted assignments that were related to their lives. The research showed that teachers did not integrate the Internet in the classroom effectively and did not provide appropriate materials for web-based learning.

Similarly, when students searched for information, they found it difficult to find the information they needed because there are many websites on the Internet (Jonassen et al, 2003; Scott, & O'Sullivan, 2000; Windschitl, & Irby, 1999). Scott and O'Sullivan (2000) indicated that students could not find appropriate information on the Internet because of their inadequate retrieval skills and they also lost their focus in millions of pieces of information. The authors mentioned that students felt that using the Internet to find information was time-consuming. It is difficult for students who do not have search skills to find specific information by themselves. Consequently, teachers waste students' learning time if they do not first teach them how to search effectively.

Huske, Protheroe and Shellard (2001) alerted educators that the Internet cannot enhance students' abilities without instruction, and teachers should tie the Internet to the curriculum in order to support learning. They also emphasized the importance of appropriate directions for students when teachers integrate the Internet into the

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curriculum. It is obvious that the Internet needs instructions to become part of an effective learning environment.

Web-Based Inquiry Learning: WebQuests

Inquiry learning, where students use the Internet as a tool, is called web-based inquiry learning. Many researchers mentioned that the Internet is an effective and powerful tool for inquiry learning (Hughes, 2003; Jonassen et al., 2003; Bodzin & Cates, 2002; Owens et al., 2002; Windschitl & Irby, 1999). Students can use primary sources and authentic information on the Internet to analyze and show the evidence during inquiry learning (Bodzin & Cates, 2002). For example, students can use the latest raw data in the Census Bureau and NASA websites instead of using the data in secondary sources, such as textbooks (Windschitl & Irby, 1999).

Even though the combination of inquiry learning and the Internet is powerful, it is difficult for students to accomplish web-based inquiry learning. Lyons (1997) researched how middle school and high school students learn through web-based inquiry. The researcher chose two pair of students from the sixth grade science class in the middle school and chose two pair of students from the ninth grade earth science class in the high school. The researcher created a website and provided the website with selected links for students to obtain background information about the topic and links of search engines. The paired students were assigned to explore selected websites to know the overview of the topic, create questions to answer by themselves, search for information on the Internet to answer their questions, and create some products. According to the researcher, students did not look at selected links or just explored the linked websites quickly for the

assignment of obtaining background information. The researcher found that students could not create open-ended questions for inquiry and could not plan the inquiry process. The researcher also found that students did not know how to search for information effectively by using a variety of keywords and could not assess whether information was appropriate for their answers or not. The researcher concluded that students needed a lot of scaffolding to accomplish web-based inquiry successfully.

Components of WebQuests

One of the strategies to implement web-based inquiry learning is a WebQuest. The WebQuest format was devised by Bernie Dodge with Tom March at San Diego State University in 1995. Dodge (1995) defined a WebQuest as “an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the Internet, optionally supplemented with video conferencing” (§ 2). The WebQuest itself is a web page (Young & Wilson, 2002) embedded with instruction and resources. Dodge (2001) indicated that “WebQuests are designed to use learners’ time well, to focus on using information rather than looking for it, and to support learners’ thinking at the levels of analysis, synthesis, and evaluation” (§ 2). WebQuest have been defined as a model (Doner, Wilmer, Stevens, & Hartmann, 2000; Jonassen et al., 2003; Molebash & Dodge, 2003), a web-based lesson, or a web-based instructional tool (Vidoni & Maddux, 2002).

WebQuests have five components including (a) an introduction, (b) a task, (c) a process, (d) an evaluation, and (e) a conclusion (Molebash & Dodge, 2003). The first component of WebQuests is an introduction. The introduction provides an activity

overview for students to go through in the WebQuest and scenarios to motivate students (Molebash & Dodge, 2003). The topics of WebQuests can be regarding environment, politics, and sociology (Yoder, 1999). WebQuests can provide a single discipline or interdisciplinary approach (Brucklacher & Gimbert, 1999; Dodge, 1997; Yoder, 1999).

The second component is a task. A task is a significant component in a WebQuest because it identifies what the students need to do (Dodge, 2001; Molebashi & Dodge, 2003). The task can be activities in which learners transfer information to a different form, such as problem-solving, journalistic reports, and creative performance (Molebashi & Dodge, 2003). The task can also be questions to answer (Vidoni & Maddux, 2002) or real world problems to solve (Yoder, 1999). Dodge (2002) introduced twelve tasks including (a) retelling, (b) compilation, (c) mystery, (d) journalistic, (e) design, (f) creative product, (g) consensus building, (h) persuasion, (i) self-knowledge, (j) analytical, (k) judgment, and (l) scientific tasks. For example, a compilation task is when students gather information and put it all together in publications. A creative product task is when students express both themselves and creativity into some formats, such as painting, a diary, and a play. A scientific task leads students to formulate hypotheses, gather information to test the hypotheses, and decide whether the evidence proves the hypotheses. These tasks provide goals for students to accomplish. Yoder (1999) recommended that the task needs to relate to students' real lives, such as hunting a job, purchasing an expensive object, and planning travel.

The third component is a process. The process section includes descriptions for students of each step to go through, a set of information sources to accomplish the task,

and some guidance. Dodge (1995) indicated that each step needs to be explained clearly. The sources that teachers have already selected can be links of websites, email addresses of experts, and books. Students retrieve most information from the Internet. WebQuests need some guidance including questions in order for students to organize gathered information from a set of sources (Dodge, 1995; Molebashi & Dodge, 2003).

Evaluation is the fourth component. As students are assigned to create products, such as paper, presentations, and artwork (Yoder, 1999), teachers can evaluate them. A rubric is used as an evaluation tool. Students can pay attention to what kind of performance teachers expect before they start the WebQuests (Vidoni & Maddux, 2002). The effective rubric needs to include multiple criteria and benchmarks (Yoder, 1999). The fifth component is the conclusion. The conclusion includes a summary of outcomes after completion of the process and provides some questions to have students reflect what they have learned.

Dodge (1995) noted that students basically use WebQuests in groups or communicate with people outside school through the Internet. Brucklacher and Gimbert (1999) indicated that teachers can conduct cooperative learning through WebQuests. For effective cooperative learning, teachers need to provide tasks and roles that allow students to have responsibilities and contribute to group members (Brucklacher & Gimbert, 1999). A student in a group will be identified as an expert on the specific topic during accomplishing the task, other members rely on that the student (March, 1998). March (1998) indicated that these roles and tasks in a group facilitate students' motivation. Similarly, Dodge (1997) indicated that WebQuests motivate students by

providing a role to play and a scenario. It is clear that WebQuests can be used cooperative learning and facilitate students' motivation.

Scaffolding for Students

It is important to note how WebQuests support teachers and students. The reason why WebQuests are effective tools is because they include "structure and guidance for both students and teachers" as scaffolding (Dodge, 2001, ¶ 3). WebQuests can scaffold students when they search for and use information. First, WebQuests help students avoid losing their focus during searching for information. WebQuests provide selected resources by teachers to scaffold searching skills for students. WebQuests also help students to use information without wasting their time (Doner, Wilmer, Stevens, & Hartmann, 2000). Milson and Downey (2001) indicated that WebQuests enable students to start using information instantly without spending much time searching because teachers are providing resources from the Internet for students. WebQuests are time-effective tools and help students focus on scholarly skills, not searching skills (Vidoni, & Maddux, 2002). As WebQuests also provide the task, students can search for information without losing their focus (Yoder, 1999). Maddux et al. (2001) indicated that a WebQuest is a framework to support investigation and guide students through the ill-structured Internet well. In addition, Lockard and Abrams (2004) indicated that schools do not have enough time to have students do time-consuming assignments without ensuring the outcomes. Providing selected resources avoids consuming time during searching for information.

Second, WebQuests enable students to avoid inappropriate websites (Milson and Downey, 2001; Vidoni, & Maddux, 2002) because WebQuests provide resources which teachers have already examined. WebQuests are appropriate for teachers who feel uncomfortable having students learn freely (Molebash & Dodge, 2003). Vidoni and Maddux (2002) indicated that WebQuests are great formats of web-based learning to provide structured and safe environments for students.

Third, well-designed WebQuests can discourage students from plagiarizing information from the Internet. Students sometimes just copy information from the Internet when they do not read it (Foster & Padgett, 1999). Zukas (2000) indicated that well-designed assignments avoid plagiarism when the assignments require students to compare information and draw conclusions. For example, an analytical task in a WebQuest requires students to find similarities, differences, and correlation in the information they gathered (Dodge, 2002). A judgment task leads students to create criteria for their evaluation and decide from the selections. These tasks can be combined in a WebQuest (Dodge, 2002). WebQuests have students think deeply through analysis, synthesis, and evaluation (Doner et al., 2000). As students use and analyze information to accomplish tasks during a well-designed WebQuest, students have little chance to plagiarize information.

In addition, even if students do not know the inquiry process, WebQuests provide the steps for students to go through. Molebash and Dodge (2003) indicated that WebQuests are appropriate for students who do not have inquiry skills because WebQuests provide the problem to start inquiry and the inquiry process. Hunkins (1989)

indicated that teachers need to help students to acquire skills to understand and identify problems, and ultimately students can go through the inquiry process without any support. Similarly, Molebash and Dodge (2003) mentioned that teachers remove the scaffolding in WebQuests gradually. As WebQuests are scaffolds to learn the inquiry process by using the Internet, teachers need to provide the questions, resources, and directions. It is clear that the purpose of WebQuests is to scaffold students to acquire inquiry skills.

Scaffolding for Teachers

WebQuests also provide scaffolding for teachers. First, WebQuests help teachers integrate inquiry learning into the classroom. Teachers have had difficulty in conducting inquiry learning until the Internet spread in the classroom (Milson & Downey, 2001). As mentioned in an inquiry learning section, even though teachers should prepare a significant structure with lots of resources for inquiry learning (Windshitl, 1998), teachers had difficulty in creating materials for inquiry learning. WebQuests help teachers create materials for web-based inquiry learning. As the structure of WebQuests is easy to create, they are suitable tools for teachers who rarely integrate the Internet into the classroom (Doner et al., 2000; Jonassen et al., 2003). WebQuests answer teachers' requests to use inquiry learning, even with high quality (Molebash & Dodge, 2003). WebQuests help not only teachers who cannot use the Internet in the classroom, but also support teachers who have not conducted inquiry learning for many years.

Second, even though teachers cannot create WebQuests, they can obtain WebQuests, which other teachers have already created, from the Internet easily and utilize them. There are many WebQuests for different subject areas and grade levels

available (Young & Wilson, 2002). WebQuests help to provide scaffolding for teachers who do not have computer skills including creating a webpage. The teachers retrieve WebQuests that are tied to the curriculum and provide the WebQuests to students without creating them. In addition, teachers who had computer skills could apply WebQuests created by other teachers to their own web-based activities (Maddux et al., 2001; Young & Wilson, 2002).

Third, even if computer access is limited in the classroom, it is possible to conduct WebQuests (Dodge, 2001; March, 1998; Milson & Downey, 2001). As students gather information and work together in small groups while doing WebQuests, they do not need many computers (Milson & Downey, 2001). This allows teachers that do not have enough computers to integrate web-based activities into the classroom.

The implementation of WebQuests

It is important to note how teachers conduct web-based inquiry learning by using WebQuests. In order to integrate WebQuests into the curriculum effectively, teachers should consider the current curriculum and tie WebQuests to previous activities (March, 1998). Doner et al. (2000) conducted an interdisciplinary project including science, social studies, and language arts in a middle school. Students investigated global warming through the use of WebQuests for four to six weeks. In the beginning of the project, teachers had students create questions about what they wanted to answer. Then, students gathered information from the Internet, and teachers had students summarize the sources and explain how the sources supported the group's perspective. Finally, students in a group presented what they learned in a large class. The researchers found that

students learned about global warming by using WebQuests, and that questioning and reflecting had great roles in leading students' inquiries. Students not only learned about global warming itself, but they also appreciated the authentic issues. WebQuests contributed to their learning effectively.

Teacher Training to Implement WebQuests

To implement web-based inquiry learning, teachers need to know issues regarding the integration of technology. Teacher training is essential in order to integrate technology into the classroom effectively (Cuban, 1986; Healy, 1998; Maddux, 2002; Zhao, 1998). Teachers need knowledge and skills to accomplish web-based inquiry learning. First, when teachers use the Internet in the classroom, critical evaluation and appropriate use of the resources are necessary skills for teachers (Hargis, 2001). Similarly, Zukas (2000) indicated that teachers should prepare appropriate resources from the Internet to tie with the curriculum and support learning goals. As web-based inquiry learning requires using information on the Internet, teachers need to know how to evaluate resources and how to use the Internet to support learning appropriately.

Second, teachers need to improve their technical skills through training. Even though many WebQuests are available on the Internet, the available WebQuests do not necessarily teach the curriculum that teachers want to use. Vidoni and Maddux (2002) indicated that teachers should learn the basic skills of creating web pages to produce WebQuests. Teachers who have technical skills modify and create WebQuests. Becker (2000) found that teachers who had technical skills integrated computers in the classroom more frequently than teachers who did not have the skills. That is, teachers with

technical skills can provide web-based assignments, WebQuests. Teacher training is significant to facilitate teachers' skills and confidence for computer use (McCannon & Crews, 2000).

Third, training related to curriculum integration is essential. Maddux (2002) indicated that teachers need to know pedagogical concepts to integrate technology into the curriculum effectively. Yoder (1999) mentioned that teachers should consider the topic, support, motivation, materials, and assessment for students' learning when they create WebQuests. Teachers also need to consider students' interests, prior experience, and reading level for preparing WebQuests (Yoder, 1999). Hughes (2003) researched how the training influenced four English/Language teachers to integrate technology effectively into the classroom. Hughes found that knowledge and experience related to technology were significant in order for teachers to integrate technology into the classroom. Teacher training is important for integrating technology into the classroom. As web-based inquiry is a combination of inquiry learning and the Internet, it is important for teachers to know what inquiry is and how the Internet supports inquiry.

The Elements of a Well-Designed Inquiry-Based WebQuests

WebQuests have become popular in the classroom (Jonassen et al., 2003; Lockard, & Abrams, 2004; Maddux, 2002; Molebash & Dodge, 2003; Young & Wilson, 2002). Molebash and Dodge (2003) suggested that the reason for the popularity might be the organized structure of WebQuests. This format provides a system for students to acquire inquiry skills and in order for teachers to facilitate the implementation of inquiry learning. There are thousands of WebQuests which were created by teachers on the Internet

(Molebash & Dodge, 2003), however, the content and quality of the available WebQuests varies (Dodge, 2001; Jonassen et al., 2003; Vidoni & Maddux, 2002). Maddux (2002) indicated that many WebQuests do not have aspects of philosophy and learning theory and do not relate to the curriculum of the grade level. When researchers discussed the effectiveness or benefits of WebQuests, they limited the condition of WebQuests to what they called well-designed or well-constructed WebQuests. Dodge (2001) and Jonassen et al. (2003) emphasized the importance of the design of WebQuests. Dodge indicated that some WebQuests do not fulfill the accepted structure of a WebQuest and are just “worksheets with URLs” (§ 4). Similarly, Jonassen et al. (2003) indicated that some WebQuests are “nothing more than electronic worksheets that serve only the purpose of filling time” (p. 48). It is clear that the design of WebQuests influences their effectiveness in learning.

Authors mentioned keys that a well-designed WebQuest needs to include (Jonassen et al., 2003; March, 1998; Vidoni & Maddux, 2002; Yoder, 1999). First, well-designed WebQuests should assign students to analyze and synthesize information. Well-designed WebQuests need to include tasks that facilitate synthesis, analysis, problem solving skills (Jonassen et al., 2003; Molebashi and Dodge, 2003), creativity, and critical thinking skills (Yoder, 1999). Second, well-designed WebQuests should include open-ended questions that promote higher order thinking skills, and the answers to the questions should not be easy to find in the resources (March, 1998). Yoder (1999) emphasized that a question is significant component for WebQuests to be effective. Third, learning for students in various contexts and from different perspectives is

essential for well-designed WebQuests (Jonassen et al., 2003; Vidoni & Maddux, 2002). Well-designed WebQuests require the five components including (a) an introduction, (b) a task, (c) a process, (d) an evaluation, and (e) a conclusion (Molebash & Dodge, 2003), and these three attributes to facilitate learning effectively. The authors emphasized the importance of the WebQuest's design because a well-designed WebQuest can contribute to effective learning.

The Inquiry Process and the WebQuest Format

As WebQuests promote inquiry-oriented learning, it is important to consider how inquiry learning is integrated into the WebQuest format. As mentioned before, inquiry learning has four components including (a) identifying problems, (b) formulating a hypothesis, (c) confirming the hypothesis including gathering data, and (d) drawing the conclusions. At first, students find problems, or teachers provide questions to start inquiry. Based upon the problems or questions, students formulate a hypothesis by using their knowledge and the limited data they are provided from teachers or textbooks. Students keep questioning or answering questions during inquiry learning. In order to prove the hypothesis, students gather information and analyze the data. Finally, students identify the solutions for problems and state the conclusion.

Presenting questions or problems as the first component in the inquiry process is integrated into the task section in the WebQuest format. These questions lead students to the inquiry process (Molebash & Dodge, 2003). The task also includes directions for students to analyze, synthesize, and evaluate information, which are represented by analytical, judgment, and scientific tasks. The phase of gathering data to answer

questions is integrated into the process section of a WebQuest format. The process section also shows the process and some guidance of how to analyze information and also provides resources for students to answer questions. The phase of drawing a conclusion in the inquiry process is applied to the conclusion section in the WebQuest format. Students present what they find, how they conclude, and how the data support the conclusion (Molebash & Dodge, 2003).

The most suitable task for the inquiry process is the scientific task in WebQuests. Dodge (2002) indicated that the scientific task includes making hypotheses, testing the hypotheses by using data they gathered, and drawing the conclusion. The analytical and judgment tasks are also part of the inquiry process. The WebQuest format is a framework, not a process. It is clear that the tasks determine whether the WebQuests promote the inquiry process or not.

The WebQuest format is not complete (Vidoni & Maddux, 2002). Dodge (1995) introduced the six components of the WebQuest format, and Molebash and Dodge (2003) showed the five components. Some researchers (Yoder, 1999; Young & Wilson, 2002) identified six components; however, some items were different from the format which Dodge introduced in 1995. The WebQuest structure is still changing. Young and Wilson (2002) showed the revised WebQuest format in two aspects. As mentioned previously, the task section of WebQuests provides problems or questions. The authors suggested that students need to identify possible solutions by using their prior knowledge after reviewing the task. In other words, they recommended students to formulate a hypothesis. Another aspect that the authors also suggested was that students need to share what they

found and also compare the final solution after accomplishing the task with the possible solution which has already identified. They recommended students verify the hypothesis and draw a conclusion. WebQuests need to include the key component of the inquiry process, formulating and testing a hypothesis to solve a problem.

CONCLUSIONS AND RECOMMENDATIONS

This review has discussed WebQuests from both inquiry learning and web-based learning perspectives. The inquiry process involves (a) identifying problems, (b) formulating a hypothesis, (c) testing the hypothesis including gathering data, and (d) drawing a conclusion. The inquiry process improves students' critical thinking skills. Many researchers reported the effectiveness of inquiry learning; however, teachers have rarely implemented inquiry learning because of overall difficulty. Students also feel difficulty with inquiry learning. Researchers pointed out that students need support during inquiry learning.

Web-based learning provides opportunities for students to explore a variety of information on the Internet, and students use the Internet as communication tools, such as email, a discussion board, and chat. The Internet also facilitates students' motivation and interest. The Internet can support learning; but teachers have not integrated the Internet into the classroom well. Even if teachers have students use the Internet, information on the Internet is not always accurate. Students also feel frustrated because they can not find information which they need to use.

One of the strategies used to implement web-based inquiry learning is the WebQuest. The WebQuest structure provides scaffolding for students and teachers. As WebQuests provide selected resources, they can prevent students from inappropriate websites, and students use information immediately without searching for it from thousands of websites. For teachers, as WebQuests provide a simple structure, it is easy to create WebQuests in order to implement web-based inquiry learning. Providing

questions, gathering the data to answer the questions, and drawing a conclusion in the inquiry process are integrated into the task and the process sections in the WebQuest format.

From what has been discussed, this reviewer concludes that WebQuests can be a solution for teachers to integrate inquiry learning and web-based learning into the classroom effectively. Since a WebQuest is an inquiry-oriented format with simple structure, WebQuests can provide scaffolding for teachers in creating materials for web-based inquiry learning. WebQuests can be used by students to go through the inquiry process supported by using the Internet effectively. As mentioned before, students felt difficulty in the inquiry process and felt frustrated to find out appropriate information. WebQuests as the inquiry process contribute to effective web-based inquiry learning.

Dodge (1995) defined a WebQuest as an inquiry-oriented activity and demonstrated the structure; however, WebQuests do not always use the inquiry process. Dodge (2002) provided twelve tasks, and the tasks are key components to show the inquiry process. Based upon the comparison of the tasks of WebQuests and the inquiry process, the components are different. The difference is a hypothesis. The inquiry process in WebQuests does not always include formulating a hypothesis or testing the hypothesis, but the inquiry learning does include the steps. Only the scientific task includes the inquiry process. Also, analytical and judgment tasks apply to the inquiry process because the inquiry process requires analysis and judgment. The most important component of inquiry learning is the process. Inquiry learning requires students to (a) create a hypothesis, (b) gather data to test the hypothesis, (c) judge whether the evidence

support the hypothesis, and (d) state the solution. This process contributes to the learning outcomes. Young and Wilson (2002) identified that the revised WebQuest format needs to include the process of formulating and testing a hypothesis. This reviewer suggests that all WebQuests should include the inquiry process of using a hypothesis. Dodge (2001) and Jonassen et al. (2003) mentioned that some WebQuests are just online worksheets with URLs. They emphasized the importance of the design because the design influences students' learning. When WebQuests do not include the inquiry process, the WebQuests are not inquiry-oriented activities.

The benefit of using the WebQuest format is the framework. When WebQuests include the inquiry process, WebQuests can promote web-based inquiry learning. The key elements of a well-designed WebQuest are the task, questions, and context. The task should include the inquiry process, especially formulating a hypothesis and testing the hypothesis processes; because this process facilitates students' thinking skills. As inquiry requires thoughtful questions from students or teachers, teachers should include appropriate questions in WebQuests to facilitate students' thinking skills. A well-designed WebQuest is a key to support web-based inquiry learning effectively.

The Internet itself cannot be a learning tool. A learning tool requires instruction. A WebQuest format combines the Internet and inquiry learning. The combination between inquiry and technology can facilitate effective learning and provide fully-integrated technology into the learning environment.

Creating effective WebQuests requires knowledge of the inquiry process, the Internet, and production for the web. WebQuests are learning aids with simple structures

that can help students use the Internet appropriately; teachers who cannot integrate the Internet in the classroom effectively need to use WebQuests. Many WebQuests are available on the Internet, and teachers can obtain them easily and apply them to their own WebQuests. Teachers, however, need to learn how to judge the quality of WebQuests critically because some WebQuests do not have appropriate structure, accurate websites for the subject, and thoughtful questions which are significant for inquiry learning. Teacher training is essential to implementing web-based inquiry learning effectively.

The effective outcomes of WebQuests as web-based inquiry learning materials remain as a matter to be discussed further. Further research on web-based inquiry learning would clarify the effectiveness of WebQuests.

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