The Promise of Technology to Confront Dilemmas in Teacher Education: The Use of WebQuests In Problem-Based Methods Courses

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Abstract

This qualitative study examined the use of WebQuests as a teaching tool in problem-based elementary methods courses. We explored the potential of WebQuests to address three dilemmas faced in teacher education: (a) modeling instruction that is based on current learning theory and research-based practices, (b) providing preservice teachers with sufficient knowledge and appropriate skills for teaching and solving instructional problems given the limited time allocated to methods courses, and (c) preparing preservice teachers to integrate technology in their classrooms. We found that WebQuests, by design, support a problem-based approach to instruction, introduce students to multiple perspectives related to science and literacy teaching/learning, develop pedagogical and content knowledge and skills, and provide learning experiences that integrate technology within the contexts of science and literacy instruction.

The last several decades have seen substantial changes in all aspects of life, including the ways individuals communicate, access information, use technology, and conduct business. As a result, students need to be prepared to function in a very different working world than has existed in the past, and it has been suggested that educators at all levels are "obligated to rethink how we teach and what our students need to learn" (Duch, Groh, & Allen, 2001, p. 3). Indeed, there have been repeated calls for reform in education in response to overwhelming criticism from parents, educators, scientists, business and industrial leaders, and public figures. It is generally agreed that schools and schooling are failing to develop the skills and abilities necessary to function successfully in society (Boyer Commission, 1998; Czujko, 1994; Wingspread, 1994).

As teacher educators, we recognize the challenge of modifying our practice to more appropriately prepare teachers for today's classrooms. To accomplish this, we identified three dilemmas: First, we must base our own teaching on current learning theory and research-based practices, modeling the kind of instruction we would want our students to implement with public school children. Second, we are obliged to help our prospective teachers construct sufficient pedagogical knowledge and develop the appropriate skills required for teaching and solving instructional problems within our discipline given the limited time allocated to a single methods course. And third, we are charged with adequately preparing preservice teachers for the integration of technology into their classrooms.

In an effort to resolve these dilemmas, particularly the first, we elected to adopt a problem-based learning/teaching model in each of our elementary education methods courses. The origins of problem-based learning can be traced to early forms of instruction wherein teachers, specifically Socrates and Aristotle, exacted diverse kinds of problem solving from their students. Dewey (1938) also described the acquisition of knowledge as a problem-solving process and proposed that effective teachers require students to attend to complex, real-world issues and problems. More recently, a problem-based model of instruction was popularized during the 1960s at a medical school in Canada as a means of providing a more engaging and authentic way of learning the content and process of "doctoring" (Rhem, 1998). Today, problem-based learning is commonly understood to be a teaching model that engages individuals in a process of learning by examining problems connected to real life and finding meaningful solutions (Delisle, 1997; Duch et al., 2001). It seemed logical, then, that implementing this model of instruction in teacher education methods courses would expose prospective teachers to the problem-solving process in a supportive environment and would, at the same time, introduce them to ways of accessing the extensive body of knowledge and resources available to teachers, thus addressing our second dilemma.

As we examined our efforts to integrate technology and to prepare our students to effectively use technology in their teaching, our third dilemma, we sought learning activities or methodologies that would engage students in the process of problem solving while requiring them to utilize available technology. Thus, we considered the use of WebQuests in our methods courses because they allowed us to address the technology issue while maintaining an inquiry-based learning environment. A WebQuest is "an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet" (Dodge, 1997, p. 1). WebQuests may be either "short-term" (requiring 1–3 days for completion) or "long-term" (typically taking from 1–4 weeks or more to finish) (Schrock, 2002). Like problem-based learning, Dodge explains, these Web-based activities also "focus on using information" and "support learners' thinking at the levels of analysis, synthesis and evaluation" (cited in Arthur, n.d., ¶ 1). Additionally, as a directed Web search, the teacher (a) becomes acquainted with the sites students will use, (b) ensures that each site is safe and of high quality, and (c) saves instructional time, focusing on the research or problem-solving rather than spending learning time searching for information (Arthur, n.d.).

Although the use of WebQuests to teach and integrate academic content at all grade levels has been well documented (Abruscato, 2000; Watson, 1999; Yoder, 1999), little empirical data has been collected to verify their effect on learning, and there is minimal evidence that these types of learning activities have been used in teacher education methods courses to teach pedagogy. The current study, which focuses on the second and third dilemmas, investigates the role of WebQuests as instructional tools in preservice teacher education. Specifically, we focused on the following questions:

- How does the use of WebQuests as an instructional tool support students' construction of knowledge about teaching science and literacy?
- How does the use of WebQuests prepare prospective teachers for the integration of technology in their teaching?

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The Study

Because our focus was on the use of WebQuests as teaching tools by two teacher educators in their elementary methods courses (one in science and one in literacy) and the effect of this use on the preparation of novice teachers, we employed a qualitative research methodology, collecting naturalistic data (Bogdan & Biklen, 1998) from both courses. These data allowed us to consider how the WebQuests were used and to evaluate their appropriateness and usefulness in helping to address the issues raised by our dilemmas. Data sources collected at various times throughout the semester included (a) student- and teacher-produced artifacts, including WebQuests created by the teacher educators and by the students, as well as graphic organizers constructed by the students in completing the initial WebQuest activities, (b) student questionnaires, (c) teaching journals (field notes and reflections recorded throughout the study by each of the teacher educators), (d) free response portions of the university course evaluations, and (e) focus group interviews. Artifacts, student surveys, and lesson plans were analyzed using national science (National Research Council [NRC], 1996), literacy (International Reading Association [IRA], 2000), and technology (International Society for Technology in Education [ISTE], 2000) standards as analytical frameworks (Miles & Huberman, 1994). Additionally, the instructors' journal entries were examined to determine the teacher educators' perceptions of the effectiveness of the use of the WebQuest activities (based on the different national standards) in their courses. The student surveys, course evaluations, and focus group interviews were analyzed for common themes in the response of the preservice teachers to the use of WebQuests as learning activities (those they experienced as students) and as instructional tools (those they created for use in teaching others) in each of the methods courses.

Participants

The participants of the study were 41 undergraduate elementary education majors (all females) enrolled in either a literacy methods course (20 students) or in a science methods course (21 students) during the first, second, or third semester of their four-semester professional preparation program. The literacy course was the second of two methods courses designed to prepare prospective teachers to teach literacy to elementary children and emphasized the pedagogical skills and knowledge necessary to teach literacy in the intermediate grades. This class is offered to students during the third semester of the teacher preparation program. The science methods course is the only class in the program that focuses on the pedagogical knowledge, skills, and dispositions requisite to teaching science to elementary children, and teacher candidates may elect to enroll in the course during any semester prior to student teaching. Thus, this class is a mix of students from the first, second, and third semesters of the program.

Data Collection

Primary data sources for this research were artifacts created by the teacher educators and the teacher candidates, field notes and reflections recorded by each instructor following weekly class sessions, and student responses to questionnaires at midterm and at the end of each course. Artifacts included the WebQuests developed for each methods course by each of the teacher educators (see http://education.byu.edu/ted/webquests.html), the group-created graphic organizers that were produced as the students completed these WebQuests, and the WebQuests that were constructed in teams by the teacher candidates (see samples at http://education.byu.edu/ted/webquests.html). Each of these artifacts is described in more detail in the following sections. The teaching journals kept by the course instructors outlined lesson plans for each class period; described the learning activities, whole-class discussions, and small group conversations for each session; and included personal reflections about the effectiveness of what was taught as well as the instructors' response to student reactions.

Table 1. Questions from Student Questionnaires that Targeted WebQuests.

Which assignments or activities in this course did you find most useful?
Which assignments or activities in this course did you find least helpful?
What did you learn by completing the "How do I teach science to children?" WebQuest? or What did you learn by completing the "What is balanced literacy?" WebQuest?
What did you learn through the experience of creating a content-based science WebQuest for elementary children? or What did you learn through the experience of creating a content-based literacy WebQuest for your peers?
What do you consider to be the strengths and weaknesses of using WebQuests as an instructional tool?

The research reported here is part of a larger study, therefore only those entries that related to the use of WebQuests were used in the data analysis for this study. The student questionnaires also prompted the teacher candidates to respond to the course as a whole as well as to individual class activities and assignments. Again, only those questions that either specifically targeted the use of WebQuests or those that might include responses about WebQuests were used for the current study. These questions were identical for both courses and are listed in Table 1.

Additional data sources included the free response sections of the university course evaluations for both methods courses and the focus group interviews, which were audiotaped and later transcribed. These data focused on each course as a whole and were used primarily to explore the students' affective response to problem-based learning and the use of all of the instructional tools and methodologies employed in teaching each course. As a result, not all of the students made specific reference in interviews or through university course evaluations to the use of WebQuests. Therefore, only those comments that applied to Web-based inquiry as a learning activity or as an instructional tool were used as part of the data set.

Science Methods Course

WebQuests were used in the science methods course in two ways: (a) to introduce students to the content of the course and prepare them for further, in-depth exploration of current issues, methodologies, and ideas related to elementary science instruction, and (b) to provide students with guided practice in creating their own WebQuests for use with elementary-aged children as Web-based, inquiry-oriented learning activities designed to teach science concepts. First, Smith (the instructor of the science methods course) constructed a WebQuest (see http://education.byu.edu/ted/webquests.html) that was created as a Microsoft Word document and posted on Blackboard for student access and completion outside of class. This WebQuest was assigned during the second week of class and was designed to provide the preservice teachers with an overview of the appropriate knowledge and skills they should acquire as they begin to think about teaching science—those topics and issues that would be examined more closely throughout the semester. Due the following week, the Web-based inquiry also introduced the prospective teachers to a number of varied perspectives on what constitutes effective science instruction and required them to consider these views as they relate to their personal notions of what it means to teach and learn science. As is typical of the WebQuest format, the 21 teacher candidates in the class were asked to work collaboratively in teams of 3–4 to examine 18 specific Web sites selected by the instructor to answer the following questions: (a) What is involved in teaching science in elementary schools? and (b) What do you

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need to know about science and science instruction to provide children with quality science learning experiences? After exploring the Web-based literature, each team was then required to create a poster-sized graphic organizer of their choice using Microsoft Word or Inspiration illustrating what they had identified (based on readings, personal reflection, and group consensus) to be the key issues involved in acquiring an understanding of science education in the elementary schools and teaching science effectively to children. Because the end product of the learning activity was a group-created graphic organizer, the assignment also required students to visually display their perceptions of the relationships that exist between these key issues. Class time and other course assignments were later devoted to more in-depth investigations surrounding each of the major ideas that were introduced through the WebQuest and associated skills and methodologies were modeled and practiced.

Later in the semester, different teams of 3–4 students created their own WebQuests. The purposes of this assignment were (a) to model an effective constructivist learning activity and (b) to encourage these teacher candidates to work successfully with peers in an exploration of how they might engage elementary children in meaningful inquiry-based science learning activities using technology in their future classrooms—in essence, to use the WebQuest as an instructional tool. Through this assignment, Smith (a) introduced the students to a sampling of the multiple Internet resources available to help teachers construct Web-based learning tasks that encourage critical thinking and problem-solving, and (b) encouraged the students to explore a sampling of the Web-based resources that align with current science education standards (American Association for the Advancement of Science [AAAS], 1990, 1993; NRC, 1996) and are readily available to support science instruction.

Although the students had completed an instructional technology course prior to enrolling in the science methods course, and had been superficially introduced to HTML authoring, the major purpose of the assignment in the methods course was not to devote time to building computer skills. The focus, rather, was to provide an opportunity for teacher candidates to learn how to use a WebQuest format to foster problem-solving and encourage inquiry as a way of teaching/learning science concepts. Thus, the use of the Internet as a learning tool was emphasized. As a result, Smith provided a general WebQuest template for students that had been adapted from the WebQuest Page (Dodge, 2002) and created as a Microsoft Word document. Teams of students were then asked to create a content-based inquiry lesson, or Web-based learning activity in the form of a WebQuest that would be appropriate for elementary students and would meet state and local curriculum goals. In preparation for this task, the teacher candidates were initially introduced to content-centered WebQuests during one three-hour class period. During this period, teams were asked to complete *A WebQuest about WebQuests* (Dodge, 2002), the class discussed the attributes of a good WebQuest, and teams developed a question or task and outlined responsibilities for the individual team members. Meeting times were also scheduled to create the WebQuest outside of class. During the next two weeks, the teams created and submitted their Science WebQuests, posting them on Blackboard, enabling both the instructor and other members of the class to access their work (see samples at http://education.byu.edu/ted/webquests.html).

Literacy Methods Course

In the literacy methods course, the WebQuest was also used in two ways: (a) to expose students to the content of the course, and (b) to allow students to create their own WebQuests for their peers to complete to further explore issues related to literacy instruction. Sabey (the course instructor) created the first WebQuests as a Microsoft Word document and posted on it Blackboard (see http://education.byu.edu/ted/webquests.html). Its purpose was to deepen the students' understanding of Balanced Literacy Instruction (ideas that had been introduced the previous semester in a course that emphasized literacy instruction for children in the primary grades) by focusing on its application in the intermediate grades. Although students were given 15–20 minutes of class time each week to organize their efforts (addressing such questions as: Where are we? What do we know thus far? What do we need to do next?), this Web-based inquiry was completed predominantly outside of class during the course of four weeks. Teams were asked to complete four tasks, each building on the previous task to answer the question, "What does Balanced Literacy Instruction look like in an intermediate grades classroom?" Prospective teachers worked in teams of three and were asked to examine multiple instructor-selected Web sites and other media sources (CDs) to complete the following tasks:

Task #1—Create a graphic organizer illustrating the components of a Balanced Literacy program.

Task #2—Create a balanced literacy classroom map and daily schedule.

Task #3—Create an E-File of literacy strategies. Use this information in constructing a chart of activities aligned with the sixth grade language arts state core curriculum standards and Balanced Literacy components.

Task #4—Develop lesson plans for one day's literacy lessons in a Balanced Literacy classroom. Use one of the sixth grade language arts state core curriculum standards listed in Task #3.

The goal of the second WebQuest experience, during which the students were asked to create WebQuests, was two-fold: (a) to provide an opportunity for students to learn pedagogical content knowledge related to teaching literacy skills, and (b) to allow students to experience the use of WebQuests as an instructional tool. Like the students in the science methods course, those enrolled in the literacy methods course learned about the development of WebQuests during one three-hour class period. Again, Dodge's *WebQuest about WebQuests* (2002) served as a teaching tool and sparked discussion about the characteristics of a good WebQuest. Following this introduction, teacher candidates were asked to work in groups to create a WebQuest based on questions that arose in their four-week field experience. Upon returning to campus from the field, the students constructed a list of questions that were sorted into categories: comprehension, diversity of learners, spelling, writing, motivation, and phonics/phonemic awareness. The students then broke into groups of 3–4 and chose a topic area they wanted to research. Finally, each group created a WebQuest that would answer the question they posed and would teach their peers about their topic (see samples at http://education.byu.edu/ted/webquests.html). The guidelines for the student-constructed WebQuests were that they should be based on a real-life context, require higher-order thinking, and take approximately an hour to complete.

The second part of the student-generated WebQuest assignment required the students to complete each other's WebQuests. Examples of the tasks written by the students were: modifying a shared reading lesson for diverse learners, creating a lesson plan focusing on one comprehension thinking strategy, writing a philosophy for teaching spelling, and responding to a classroom scenario related to motivating students. Time in class was used to discuss what they were learning as they completed the WebQuests created by their peers.

Data Analysis

Data analysis proceeded in three phases: (a) analysis of the student- and instructor-produced artifacts using national standards as analytical frameworks (IRA, 2000; NRC, 1996), (b) analysis of student-developed WebQuests and response to student surveys using the ISTE standards (2000) as an analytical framework, and (c) examination and analysis of the journal entries, questionnaires, and focus group interviews for common themes in the perceptions of both the instructors and the students

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as to the effectiveness of WebQuests as learning and instructional tools. The first phase examined the degree to which the WebQuest activities, as Web-based inquiries, helped to address the challenge of providing preservice teachers with the pedagogical content knowledge necessary to teach science or literacy to elementary children based on national teaching standards (our second dilemma). The second phase assessed the extent to which the use of Web-based inquiry as an instructional tool helped prepare these preservice teachers to use technology to support student learning (our third dilemma). The third phase explored the perceived usefulness of WebQuests as teaching/learning tools.

Phase I: Pedagogical content knowledge

First, the instructor-produced lesson plans, WebQuests, and accompanying graphic organizers for each of the courses were read and re-read by at least two members of the research team. Representative terms and quotes were identified for each document. These characteristic expressions and terms were then examined using the six strands of the National Science Education Teaching Standards (NRC, 1996) for the science WebQuest and the Standards for Reading Professionals (IRA, 2000) for the literacy WebQuest as frameworks for analysis. This phase of analysis involved a process of matching language and/or ideas described in the standards documents to that used in the instructor-developed WebQuest and the Web-based literature included within each WebQuest as well as by each of the student teams in creating their graphic organizer. Thus, the degree to which the Web-based inquiry appeared to help prepare the preservice teachers to implement the tenets found within the standards documents was established. For example, Standard A from the National Science Education Teaching Standards states, "Teachers of science plan an inquiry-based science program for their students" (NRC, 1996, p. 30). This standard focuses on planning, constructing, and choosing science curricula (activities, lessons, units, etc.) that meet the "particular interests, knowledge, and skills of their students and build on their questions and ideas" (NRC, 1996, p. 31) in an effort toward "deepening the understanding of scientific concepts and the nature of scientific endeavors" (NRC, 1996, p. 32). Words or descriptions related to an inquiry approach to teaching science used in the standards documents and other related literature (i.e., inquiry, experimentation, problem-solving, problem-based, learning cycle, guided-discovery, or investigation) indicated an understanding on the part of the preservice teachers that inquiry-based practices were central to teaching science to children. Indeed, the notion of inquiry as a preferred method of science instruction was one of the issues that had been emphasized in the Web-based literature included as part of the initial WebQuest activity, "How do I teach science to children?" The same process was involved in analyzing the graphic organizers created in conjunction with the literacy WebQuest against the Standards for Reading Professionals (2000).

After each graphic organizer was examined individually for evidence to suggest that the students recognized or had begun to develop some understanding of the content and methodologies identified under each strand within the standards documents, the individual analyses were compiled for each methods course. This compilation enabled us to obtain an overall indication of the extent to which the initial WebQuest activity, which was created by the teacher educator in each methods course, appeared to help students develop an understanding of the pedagogical issues, methods, and strategies represented in the teaching standards.

The second stage in the first phase of analysis focused on the student-developed WebQuests. For this learning activity, the students were expected to implement what they had previously learned about using Web-based inquiry as an instructional tool. Recall that for the literacy methods class this assignment required the preservice teachers to produce WebQuests to increase the pedagogical knowledge of their peers. In the science methods course, however, teacher candidates were asked to develop content-based science WebQuests that were designed to teach science concepts to elementary children. Therefore, although the analysis of these student-produced artifacts proceeded in the same manner as described above (with the instructor-produced WebQuests and resulting graphic organizers), the Science Content Standards (NRC, 1996) were added to the analysis of this second WebQuest assignment in the science methods course.

Phase II: Technology integration

The second phase of analysis targeted the effectiveness of the WebQuest activities in supporting the integration of technology in meaningful ways into the classroom. As with the first phase of analysis, instructor-produced and student-produced artifacts served as the primary data sources for this portion of the analysis. For this phase, however, these data were examined using the National Educational Technology Standards and Performance Indicators for Teachers [Technology Standards] (ISTE, 2000) as a means of determining whether the use of WebQuests was effective in addressing the third dilemma. The analysis process was similar to the one used to determine the pedagogical content knowledge. However, instead of looking for words or phrases that described major content-related ideas or concepts, artifacts were examined for evidence that the preservice teachers had developed some level of understanding or expertise in relation to each of the technology standards. For example, the first of the performance indicators for teachers states, "Teachers demonstrate a sound understanding of technology operations and concepts." This includes basic technology knowledge and skills as well as continued progress in learning more advanced skills. Thus, the creation of graphic organizers using Microsoft Word or Inspiration indicated that the teacher candidates demonstrated some understanding of basic technology skills. In addition, the student-created WebQuests were examined for more complex skills, such as successfully downloading and using a template for the creation of their WebQuests, adding URLs, inserting Web images, including special effects (e.g., animation), or incorporating a video clip. After analyzing the artifacts from each methods course individually, the results from both methods courses were combined and evaluated for the degree to which the national technology standards were addressed through the WebQuest learning activities.

Phase III: Perceived effectiveness of WebQuest activities

In order to examine the perceived effectiveness of the use of WebQuests as teaching/learning tools, the remaining data sources for each methods course (transcripts of journal entries, student surveys, university course evaluations, and focus group interviews) went through a series of data compressions. First, they were read and re-read by at least two members of the research team, using an open coding (Strauss & Corbin, 1990) of the data. Specific themes were identified and described, using particular incidences or quotes from the data to support the interpretation (Miles & Huberman, 1994). At this stage of the analysis, each course was first examined and analyzed as a separate phenomenon, distinct in the trends and patterns that emerged. In the final stage of this process the interpretations of both courses were compared and common themes were isolated and described. During this analysis both confirming and disconfirming evidence was actively sought.

Results

We found that the use of WebQuests as an instructional tool helped us to contend with the three dilemmas we had previously identified in preparing teachers to teach within an increasingly diverse and complex society. As indicated in the introduction, the selection of a problem-based approach to teaching and learning (with WebQuests as one of multiple instructional tools) addressed our first dilemma of basing our instruction on current learning theory (Bransford, Brown, & Cocking, 2000) and research-based practices (Cambourne, 2002; NRC, 1996), which are those we would want our students to implement with public school children. The results described in this paper address our remaining dilemmas:

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- To provide our students with sufficient knowledge and appropriate skills needed for teaching and solving instructional problems given the limited time allocated to a single methods course.
- To prepare preservice teachers for the integration of technology into their classrooms.

Sufficient Knowledge and Appropriate Skills

Our second dilemma related to the knowledge and skills needed to teach and solve instructional problems and served as the focus of our first research question: How does the use of a WebQuest as an instructional tool support students' construction of knowledge about teaching science/literacy? Our analysis suggests that the use of WebQuests effectively supported students as they individually constructed the content and pedagogical content knowledge that would traditionally be introduced in a methods course designed to help preservice teachers implement national content and technology standards. Moreover, these understandings were developed by means of an innovative instructional tool that encouraged creativity and collaboration. In addition, the WebQuest provided opportunities for students to develop skills such as (a) the ability to explore multiple perspectives on a given topic, (b) the ability to think critically as they evaluate information, and (c) the ability to apply that information to solve real-world instructional problems.

In combination with other learning activities offered as part of problem-based courses throughout the semester, the WebQuests enhanced student learning and served as a motivating learning tool. In both classes, the products (graphic organizers and student-developed WebQuests) that were submitted indicated that our prospective teachers in these courses were constructing an understanding of teaching science and literacy to elementary children in ways that are consistent with each of the corresponding national standards (see Tables 2–4 for a summary of the analysis and how each standard was addressed). This is not surprising given the nature of WebQuests, which allow the professor to direct students toward specific sites that include content he or she wants students to use and consider—sites that were, in these courses, chosen because of their relevancy and accuracy of content, based on national curriculum and teaching standards. At the same time, Web-based inquiry activities grant students the choice and encouragement to access a variety of other sources—an experience that was exciting and liberating for many of our students. One student summed this idea up when she wrote, "I really enjoyed the freedom given to search out different sources of knowledge and information. It helped me to realize that subjects can be taught through more than a single text" (Questionnaire [Q]:Smith, 12/10). Indeed, the detailed products that were created and rich classroom discussions that occurred as a result of the WebQuest assignments suggested that because of the varied sources of information, the students had a deeper understanding of what is involved in teaching and learning science (Teaching Journal [TJ]:Smith, 9/12) and literacy (Q: Sabey, 12/30) than students enrolled in other sections of the same course (TJ:Smith, 10/23). Moreover, as students were engaged in the WebQuest problem-solving experience, they began to trust their own abilities to find answers to questions and to access necessary and appropriate information (Q:Smith, 12/10; Q: Sabey, 12/20).

The WebQuest activities were also inquiry-based learning experiences that were new to virtually all of the students enrolled in the literacy and science methods courses, and they recognized the Web-based activity as a potentially valuable teaching tool. Students' comments suggested that, in part, the "newness" of the experience made the assignments more meaningful and engaging. "It's a very creative process. I had never heard of [WebQuests] before, so I thought experiencing them was very useful and motivating," (Q:Smith, 12/10) commented one student. Students also recognized the value of using WebQuests to teach children. One student related that "creating a WebQuest helped me to learn principles of collaboration and new principles of instructional design. I loved this project and found it to be very motivating! It is a way to set the students free to explore, yet keep the purpose and task structured" (Q:Smith, 10/21). Another student wrote, "Creating a WebQuest forced me to think about how children really learn rather than how I think they learn. [WebQuests] are interactive and fun. They allow students to work in groups, allow for student inquiry and choice, and connect ideas taught to real life situations" (Q:Smith, 12/10). Overall, 90% of the students stated that they found the WebQuest activities to be both meaningful and enjoyable learning opportunities. Eighty-five percent indicated that they plan to use them in their future classrooms to augment their instruction (Q:Smith, 12/10).

In addition, through the completion of the WebQuests, the preservice teachers in both courses had the opportunity to explore a number of preselected Web sites that represented multiple perspectives related to the issues of literacy and science instruction. Students were able to discover that consensus can be a rarity in the field of education (Focus Group [FG]:Smith, 12/3) and specifically in the fields of science and literacy education. Through their exploration of the instructor-selected Web sites, our preservice teachers were exposed to multiple sides of an educational issue. This, in turn, encouraged them to ask questions themselves, and to consider the possibility of multiple "right" answers. For some, this seemed to be an epiphany. A student in the literacy class, for example, said, "I've been looking for THE right answer all this time. Why didn't anyone tell me this sooner?" (TJ:Sabey, 10/14).

The introduction of multiple perspectives and a wide range of information related to science or literacy instruction also led students to develop the ability to critically evaluate the information provided on the Web sites and make connections between the various ideas presented. The WebQuest tasks asked students to collect information that was often substantial and generally related to the overall topic, yet not always easily applicable to the required task. In order to decide what information was useful and to use the information to solve the problem, the students established criteria—either formally or informally—and then used those criteria to evaluate the information. The criteria included issues related to accuracy, currency, acceptability in the profession, agreement with the students' existing beliefs, and utility for completing the required task. Additionally, because multiple perspectives were suggested, the students were required to clarify their own beliefs and understanding of the subject before they could complete the task. Noted one student, "The WebQuest really helped me to process and think about all of the information I have been taught and have learned in this class and throughout my life about teaching and learning science. It helped me realize the importance of personal inquiry and choice" (Q:Smith, 12/10).

Finally, the WebQuests asked students to apply their new understandings of the information to solve real-world problems. Initially, the use of WebQuests provided a scaffolded experience with the steps of the problem-solving process. The students were guided through the process of identifying the problem, determining what questions needed to be answered, locating resources and collecting the information, and using the information to determine an appropriate solution. Additionally, the WebQuest experience allowed for the distinct and probable possibility that each WebQuest team could end up with a different product and yet all would be completely acceptable, as is often the case in real life. Indeed, as the teams of students worked together to solve the problem, they generally generated new questions of their own. As a result, extended conversations related to the topic occurred both in and out of class (Q:Sabey, 12/12; TJ:Smith, 10/16). Students began to answer their own questions with the knowledge gained through the WebQuest experience.

Some students, however, identified pitfalls in the WebQuest experience. First, several students felt there was the temptation of procrastinating the completion of the WebQuest. The flexibility of the WebQuest in relation to the time and location of its completion may encourage students

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Table 2. Analysis of Literacy WebQuest Activities and How Each Addressed The International Reading Association Standards for Reading Professionals (IRA, 2003).

Teaching Standard	WebQuest Experience 1		WebQuest Experience 2
	Instructor-developed WebQuest	Student-created Graphic Organizer	Student-developed WebQuest
Standard I: Candidates have knowledge of the foundations of reading and writing processes and instruction.	- WebQuests required students to examine Web sites focused on literacy processes.	- All groups made appropriate connections between various literacy concepts/processes - 3 of 7 groups included models of the reading process	- All groups created WebQuest learning experiences focusing on a different literacy process (comprehension, vocabulary, spelling, etc.).
Standard 2: Candidates have knowledge of a wide range of instructional practices, approaches, methods, and curriculum materials to support reading and writing instruction.	- Completion of WebQuest resulted in exposure to multiple instructional practices. - Selected Web sites exposed students to best practices in the field.	- All groups listed names of various instructional practices (e.g., cooperative learning, use of various texts) on their organizer.	- All groups included a listing of instructional practices that support the acquisition of reading and writing skills (e.g., guided reading and writing, Language Experience Activity, Writing Workshop) - All WebQuests directed users to Web sites that emphasize supporting students' acquisition of the literacy process of focus
Standard 3: Candidates use a variety of assessment tools and practices to plan effective instruction.	- WebQuest modeled the use of scoring rubrics.	- All groups included assessment and evaluation of literacy development.	- All groups directed users to Web sites related to the assessment of a specific literacy focus - Students did not include assessment as part of their final tasks
Standard 4: Candidates integrate knowledge and dispositions of instructional practices, curricular materials, assessment and evaluation to create a literate environment that fosters both reading and writing.	- Students completed WebQuest in collaborative groups.		- One group's focus was creating a motivating literacy classroom. All other students used this WebQuest, viewed the various sites, and completed the accompanying task.
Standard 5: Candidates view professional development as a career-long effort and responsibility.	- Not addressed	- Not addressed	- Not addressed

to leave the work until the last minute (TJ:Sabey, 12/12). Second, our preservice teachers could see the potential for some students to miss the depth and breadth of learning in WebQuests by exerting only a minimal effort. Their concern was that students might not fully explore the Web sites or evaluate the material completely, resulting an inferior product (Q: Sabey, 12/19). As we considered the students' concerns, we concluded that these possible pitfalls are no different than more traditional assignments in classroom instruction. The same safeguards (i.e., periodic monitoring of students' progress, evaluation guidelines, group sharing in class) used to prevent such occurrences in more traditional classroom assignments would work with Web-based coursework as well.

Technology Integration

Our third problem was how to adequately prepare preservice teachers for the integration of technology into their classrooms, which is related to our second research question: How does the use of a WebQuest prepare prospective teachers for integration of technology use in their future classrooms? Although our analysis indicated that the implementation of all but one (Standard IV) of the National Educational Technology Standards and Performance Indicators for Teachers [NETS•T] (ISTE, 2000) was evident in the WebQuest assignments, the intent of using WebQuests as a tool of instruction in our courses focused on Standards II, III, and V. Our goal was not to develop an understanding of technology operations and concepts (Standard I), for example. Rather, we assumed that because our students had all successfully completed an Instructional Technology in Teaching course as a prerequisite to our courses, they would already have the basic computer skills required to complete their assigned tasks. However, students may have incidentally learned new technology skills through their collaboration with peers and as a result of completing the various assignments. Similarly, Standard VI (Social, Ethical, Legal, and Human Issues) was not directly addressed. Instead, as issues were raised by students regarding ethical practices or ensuring children's safety on the Internet they were discussed and resolved in class discussions. As a result, we found that the use of WebQuests in the methods courses we taught significantly addressed three of the six standards and performance indicators (See Table 5) recommended in the NETS•T (ISTE, 2000).

According to the NETS•T, preservice teachers should be able to "plan and design effective learning environments and experiences supported by technology" (ISTE, 2000, p. 9). The requirement that our students create WebQuests supported their progress toward this standard in two ways: First, the preservice teachers were asked to plan and manage the use of technology within the context of a learning activity, thus using technology to support learning of some content (i.e., science concepts, literacy methods) rather than planning lessons that directly teach how to use technology. Second, the requirement to create their own WebQuests provided opportunities for the preservice teachers to consider issues related to appropriateness of various Internet sites in terms of content accuracy and suitability of the site given the intended audience (TJ:Smith, 10/29). Thus, our students became better consumers of the Internet, particularly with respect to educational sites. This was reflected in the comments offered on questionnaires: "Through this assignment I learned more about using technology and that Internet sites don't stay there forever. They won't always be there!" "I learned that there are lots of Internet sites that are not appropriate for kids. Although there are many good sites, you have to be careful and really understand age-level abilities as you select them" (Q:Smith, 12/10).

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Table 3. Analysis of Science WebQuest Activities and How Each Addressed the Teaching Standards Outlined in the National Science Education Standards (NRC, 1996).

Teaching Standard	WebQuest Experience 1	WebQuest Experience 2	
	Instructor-developed WebQuest	Student-created Graphic Organizer	Student-developed Science WebQuest
Standard A: Teachers of science plan an inquiry-based science program for their students.	- WebQuest designed as a Web-based inquiry - Specific Web sites address process and importance of inquiry in learning of science for all children	- All groups included inquiry as a major topic of science instruction - All groups emphasized meeting the needs of all students in teaching science	- All groups selected science content based on state curriculum - Science concepts selected appropriate to abilities of targeted age group of children
Standard B: Teachers of science guide and facilitate learning.	- Use of WebQuest models teacher-facilitated learning - Specific Web sites target teachers as facilitators - Requires students to participate equally and accept responsibility for their own learning	- All groups described learning as constructed and teaching as a facilitation of this process	- All WebQuests orchestrated discourse about science concepts among children - All WebQuests required children to participate in inquiry
Standard C: Teachers of science engage in ongoing assessment of their teaching and of student learning.	- Specific Web sites address self-assessment and different forms of student assessment	- All groups included various types of assessment of student learning - 3 of 6 groups included self-assessment as major topic	- All WebQuests included student assessment - Students complete a self-assessment of the science WebQuest assignment
Standard D: Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.	- Students organized into groups for completion of Web-based inquiry - Specific Web sites to access materials and other resources for science teaching	- All groups identified online resources (lesson plans, activities, inquiries) for teaching science	- All WebQuests were extended inquiries - 5 of 6 groups identified age-appropriate websites for Web-based inquiry
Standard E: Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.	- Nurtures collaboration among students - Structures formal discussion among students - Models the process of inquiry	- All graphic organizers produced collaboratively - Group discussion among all group members about content and relationships among issues and topics	- All WebQuests nurtured collaboration among children - All WebQuests structured to facilitate formal discussion - 5 of 6 WebQuests emphasized higher level thinking in inquiry process
Standard F: Teachers of science actively participate in the ongoing planning and development of the school science program.	- Specific Web sites describe opportunities to enrich science programs - Specific Web sites emphasize on-going teacher development and learning	- 2 of 6 groups identified on-going teacher learning and development - All groups included names of programs to enrich science instruction	- Not addressed.

Other students noted the challenges associated with the sheer volume of information found on the Internet: "It is hard sometimes, to be patient enough to find the best information … Sometimes you just want to complete the task and be done with it" (Q:Sabey, 12/23). In addition, our preservice teachers were able to actually use technology—Microsoft Word, Dreamweaver, or other similar software—to create their WebQuests. For some students, this was a novel experience (TJ:Smith, 10/1). Others viewed the creation of a Web-based lesson/unit plan as an opportunity to improve their technology skills. For example, one student stated, "I learned a lot this semester. I discovered how to hyperlink in our WebQuest. I was really excited about this" (Course Evaluation [CE]:Sabey, 12/17). And while the WebQuests created by the students varied in the presentation, in general they demonstrated the preservice teachers' abilities to include links to sites, images, and organize their WebQuests in a visually appealing way. For many preservice teachers, this was a way for them to improve their technology skills and knowledge as well as become familiar with how they might use technology to teach children. Students' comments indicated that they recognized this potential: "Technology standards are less frequently addressed than others in our [teacher preparation] courses. I think this is a great activity to do with children." "I became more proficient with the computer as we created our WebQuest, and I learned how to integrate technology—and that it takes time!" (Q:Smith, 12/10).

The NETS•T also indicate that preservice teachers should be able to "implement curriculum plans that include methods and strategies for applying technology to maximize student learning" (ITSE, 2000, p. 9). This standard suggests that preservice teachers use technology to support standards-based curricula and learner-centered strategies. Again, the WebQuests created by the students supported this standard. In the case of the science WebQuests, the preservice teachers were required to consult state and national standards to guide the content of their WebQuests. Furthermore, the WebQuests created in both courses required the students to create problems, tasks, and evaluation guidelines that would move the user of the WebQuest through an inquiry-based learning activity.

Finally, the NETS•T contains a performance indicator that includes the use of technology "to enhance [teachers'] productivity and professional practice" (ITSE, 2000, p. 9). This standard suggests that preservice teachers use technology to consider and improve their own knowledge and practice. The WebQuests completed by the preservice teachers that focused on science and literacy methods allowed the preservice teachers access to content, but they also acquainted them with the large amounts of resources available for teachers on the Internet. Frequently students made comments in class and through the questionnaires that indicated that prior to the WebQuest they completed for the courses, they did not know about the amount and kind of educational information available on the Internet to support teachers. One literacy student summed it up

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Table 4. Analysis of Science WebQuest Activity #2 and How It Addressed the Content Standards (Grades K–4 and 5–8) Outlined in the National Science Education Standards (NRC, 1996).

Content Standard	Description of How Standard was Addressed
Standard A: Science as Inquiry - Abilities necessary to do scientific inquiry - Understanding about scientific inquiry	- All WebQuests engaged children in Web-based inquiry - 1 of 6 also engaged children in hands-on investigation
Standard B: Physical Science - Properties of objects and materials (K–4) or Properties and changes of properties in matter (5–8) - Position and motion of objects (K–4) or Motions and forces (5-8) - Light, heat, electricity, and magnetism (K–4) or Transfer of energy (5–8)	- 1 of 6 WebQuests based on physical science concepts (Heat, light and sound WebQuest)
Standard C: Life Science - The characteristics of organisms (K–4) or Structure and function in living systems (5–8) - Life cycles of organisms (K–4) or Reproduction and heredity (5–8) - Organisms and environments (K–4) or Regulation and behavior (5–8) or Populations and ecosystems (5–8) or Diversity and adaptations of organisms (5–8)	- 2 of 6 WebQuests based on life science concepts (Organisms and environments—Animals WebQuest) (Populations and Ecosystems WebQuest)
Standard D: Earth and Space Science - Properties of earth materials (K–4) or Structure of the earth system (5–8) or Earth's history (5–8) - Objects of the sky (K–4) or Earth in the solar system (5–8)	- 3 of 6 Webquests based on earth and space science concepts (Properties of earth materials—Rocks and Minerals WebQuest) (Earth in the Solar System WebQuest) (Objects of the sky—Weather WebQuest)
Standard E: Science and Technology - Abilities of technological design (K–4 and 5–8) - Understanding about science and technology (K–4 and 5–8) - Abilities to distinguish between natural objects and objects made by humans (K–4)	- All of the earth and space science WebQuests (3 of 6) emphasized science and technology concepts (Understanding about science and technology and Abilities to distinguish between natural objects and objects made by humans)
Standard F: Science in Personal and Social Perspectives - Personal health (K–4 and 5–8) - Characteristics and changes in populations (K–4) or Populations, resources, and environments (5–8) - Types of resources (K–4) or Risks and benefits (5–8) - Changes in environments (K–4) or Natural hazards (5–8) - Science and technology in local challenges (K–4) or Science and technology in society (5–8)	- 3 of 6 WebQuests emphasized science in personal and social perspectives (Rocks and Minerals WebQuest—Types of resources) (Weather WebQuest—Changes in environments and Natural hazards) (Populations and Ecosystems WebQuest—Populations, resources, and environments)
Standard G: History and Nature of Science - Science as a human endeavor (K–4 and 5–8) - Nature of science (5–8) - History of science (5–8)	- 1 of 6 WebQuests emphasized science as a human endeavor (Earth in the Solar System WebQuest)

by stating that, "I learned that there was a lot of material and resources out there for teachers. We were able to find usable material" (Q:Sabey, 12/20). Similarly, a science student stated, "Most of all I learned how to find information I needed if a problem or question came up in the schools during teaching" (Q:Smith, 12/10).

Again, the students shared some concerns related to the use of WebQuests as an instructional tool. First, as they created their WebQuests, they found that it was easy to become caught up in the "bells and whistles" and to lose sight of the learning goals of the experience. Their emphasis shifted away from the content of the learning and moved toward highlighting the instruction tool—WebQuests (Q:Sabey, 12/26). Second, the students occasionally found themselves contemplating whether this was a worthwhile experience. The students in the science methods course questioned whether schools would have access to all of the technology they were using to create the WebQuest and whether their students would have access to the Internet or computers with which to experience Web-based learning activities (Q:Smith, 12/10). What was the point in expending all this effort to integrate this technology when it was unlikely it would be available in the schools? While recognizing the validity of the students' concerns, we feel there are solutions available. Scoring procedures and working in groups can help keep the students focused on the content rather than the "bells and whistles." Through the assignment of points for each aspect of the assignment, the students can clearly see where the emphasis should lie. In addition, working in groups can increase the chance that at least one in the group keeps the learning goals in mind. The second concern could easily be addressed through expanding the students' understanding of the realistic possibilities of using Web-based inquiry in the schools—that the technology involved in a WebQuest is readily available in most elementary school settings. It is likely that asking teacher candidates to try their WebQuests during a field experience with elementary children would help address this concern.

Conclusion

WebQuests provided a vehicle for us to address our three dilemmas. First, they allowed us to base our instruction on current learning theory and the research-based practices we would want our students to implement with public school children. WebQuests are also consistent with problem-based methods of teaching and fit nicely within our current classroom contexts. At first, we were concerned that the WebQuests were too structured to provide the kind of flexibility for students during their problem-solving activities. However, as our students indicated that they had not experienced problem-based learning in the past, we changed our thinking about the amount of structure provided in a WebQuest. Rather, we came to see WebQuests as a way to guide the students through the problem-solving process and prepare them for less structured problem-solving activities later in our courses. This was particularly true in the science methods course, which emphasized an inquiry approach to science

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Table 5. Analysis of WebQuest Activities and How Each Addressed the National Educational Technology Standards and Performance Indicators for Teachers (ISTE, 2000).

Teaching Standard	WebQuest Experience 1		WebQuest Experience 2
	Instructor-developed WebQuest	Student-created Graphic Organizer	Student-developed WebQuest
Standard I: Teachers demonstrate a sound understanding of technology operations and concepts.	- Incidental Exposure	- Incidental Exposure	- Incidental Exposure
Standard II: Teachers plan and design effective learning environments and experiences supported by technology.	- Previewed Web sites provided information related to effective instruction in science and literacy - Use of WebQuest models effective learning experience supported by technology	- All groups included instructional issues related to the use of technology in content area instruction	-Students utilized technology to support learning of content (science concepts/literacy methods) - Specific criteria used (applicable to content and technology) to select appropriate Web sites for WebQuests
Standard III: Teachers implement curriculum plans that include methods and strategies that apply technology to maximize student learning.	- Use of WebQuest models a Web-based inquiry activity - WebQuest allow access to learning in multiple contexts (home, school, library, computer lab)	- Use of Microsoft Word or Inspiration to support students as they organized and displayed concepts learned	- Students created a learning activity that would be appropriate for Web-based inquiry - State and national standards accessed to guide the selection of content
Standard IV: Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.	- Not addressed	- Not addressed	- Not addressed
Standard V: Teachers use technology to enhance their productivity and professional practice.	- Selected Web sites introduced students to a sample of the wide variety of teaching resources related to content and pedagogy found online	- All groups identified online resources (lesson plans, activities, inquiries) for teaching science or literacy	- Science students researched and evaluated multiple Web sites for public school children - Literacy students researched and evaluated multiple Web sites for extended professional learning in literacy instruction
Standard VI: Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PreK-12 schools and apply those principles in practice.	- Incidental exposure	- Incidental exposure	- Incidental exposure

instruction based on the National Science Education Standards (NRC, 1996). In previous semesters, when WebQuests were not included as part of the course, students had struggled to understand what inquiry-based instruction was all about. However, although it was necessary to drop one of the two previously required guided inquiry lesson plans to fit in the WebQuest assignment, the students suggested that completing the WebQuest and constructing another clarified inquiry-based instruction (FG: Smith, 12/3). Indeed, the guided inquiry lesson plans that were developed and submitted after the students had completed the WebQuest experiences were much better than those created by other students during earlier semesters. The structure of a WebQuest particularly helped the prospective teachers who had not experienced inquiry in their K–12 science experiences better understand how to organize hands-on inquiry-based learning activities and lessons for children. Furthermore, teacher candidates found that WebQuests provided a supportive way for them to learn and experience the problem-solving process.

Our second dilemma was to provide sufficient pedagogical knowledge and appropriate skills needed for teaching and solving instructional problems given the limited time allotted in a single methods course. This has become increasingly problematic given the shear volume of knowledge about what it means to teach any discipline effectively and the decreasing time devoted to each content area in teacher preparation programs as these programs continue to include additional required courses. For example, although The International Reading Association [IRA] recommends that academic preparation should include a minimum of 15 credit hours in basic reading and language arts courses, children's literature, and developmentally appropriate literacy practices (2000), many teacher education programs across the nation are unable to offer this extensive time commitment to literacy preparation. Because we recognized that teaching prospective teachers all the requisite knowledge related to our content area was an impossible task, we elected to implement a problem-based model of instruction wherein these preservice teachers could experience real-life problem solving related to teaching literacy or science while being exposed to the resources available to assist teachers. In this regard, the WebQuests allowed us to provide students with an engaging learning activity, outside of regular class time, that required them to consider multiple perspectives related to issues of teaching science and literacy. Furthermore, because we had chosen the sites we wished students to consider, our students did not have to spend large amounts of time culling through the information on the Internet related to science and literacy teaching.

Finally, the use of WebQuests in our methods courses helped us to address our third dilemma, which relates to preparing preservice teachers to include technology in their classrooms. Although the WebQuests did not allow us to consider all kinds of technology and the full scope of issues related to technology use in elementary classrooms, they did provide a motivating learning context within which our students were able to consider important issues related to science and literacy education. The learning experiences also prompted specific, in-depth discussion about the content, quality, and quantity of resources available on the Internet and the appropriateness and usefulness of those sites for students and teachers. Even though these discussions generally take place in preservice technology courses, we believe it is necessary for these conversations to occur within the contexts of specific content-area instruction. Ultimately, we found the WebQuest to be a beneficial instructional tool. We felt the experience enhanced and expanded our students' understanding, skills, and dispositions related to teaching literacy and science.

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