Developing Higher-Order Thinking Skills through WebQuests

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Abstract

In this study, 32 teachers participated in a year-long professional development project related to technology integration in which they designed and implemented a WebQuest. This paper describes the extent to which higher-order thinking skills (HOTS) and levels of technology implementation (LoTI) occur in the WebQuests that participants designed. WebQuests provided teachers an opportunity to integrate technology into their teaching. However, most of the tasks in the WebQuests included lower-level thinking skills and low levels on the LoTI scale. The authors also discuss implications related to the findings and ways to support teachers' integration of technology.

Introduction

Although countless dollars have been pouring into the purchase of educational technologies and development of infrastructure in schools, teachers still lack the necessary knowledge and skills to adequately integrate technology into their instruction (Culp, Honey, Mandinach, 2003; Lawless & Pellegrino, 2007; Ringstaff & Kelley, 2002). The integration of technology requires teachers to design and facilitate learning experiences that develop students' higher-order thinking skills (Wenglinsky, 1998). To this end, technology-related professional development programs must assist teachers' construction of skills and knowledge required to successfully teach with technology (Loveless & Pellegrino, 2007; Schrum, 1999).

One common approach in professional development programs is for teachers to complete tasks that are similar to those they are expected to use in their own classrooms, discuss the tasks, and then design activities they can implement with their own students (Fishman, Marx, Best & Tal, 2003; Wilson & Berne, 1999). This approach allows learners to experience learning with technology, observe modeling about how to teach with technology, and then design content-specific technology-rich activities to use in their classroom (Loucks-Horsely, Love, Stiles, Mundry, & Hewson, 2003). This paper focuses on a study in which teachers who were primarily novice technology users were supported by participating in professional development about designing and teaching with WebQuests.

WebQuests, Higher-Order Thinking, and Levels of Technology Integration

Bernie Dodge develope WebQuests at San Diego State University in 1995 (Dodge, 2007) as a vehicle for utilizing the vast information on the Internet in an organized and meaningful manner. Dodge (1997, 1998) characterized WebQuests as inquiry-oriented activities, dependent upon Internet resources, centered on group work, and focused on higher-order thinking skills (HOTS). WebQuests should "help students construct a deeper understanding and move through a crucial transition phase toward a more autonomous, learning-centered education process" (2003, March). WebQuests have become an increasingly popular way for teachers to integrate the use of the Internet into their curricula. Maddux and Cummings (2007) noted, "A brief scan of the first 1,000 Google hits [out of over a million], as well as an informal review of current introductory textbooks on information technology in education, revealed that nearly everyone writing about WebQuests is highly supportive of their use" (p. 118).

Both Dodge (1997) and March (2004) discussed how a WebQuest should be organized in order to meet the criteria stated above. A WebQuest should include an introduction (to describe the goals of the WebQuest), a task (an authentic assignment that requires students to use the Internet and HOTS), a process (a description of the steps needed to complete the task, including resources), a conclusion (to provide a summary of the project and bring closure), and an evaluation (to help students assess and reflect on their learning). Dodge and March also emphasized the transformative thinking processes that are so important to a WebQuest. This transformative thinking is a critical part of the WebQuest task and requires students to use the information in meaningful ways. Further, WebQuests should give students opportunities to solve problems and answer questions by connecting information, categorizing information, manipulating information, and putting information together in new ways.

WebQuests are valuable tools for various reasons. First, they have the ability to contextualize learning in a variety of meaningful ways (Vidom & Maddux, 2002). WebQuests also guide students' understanding of knowledge by immersing them in multiple resources that often have varying perspectives (Peterson, Caverly, & MacDonald, 2003). Lastly, as students take ownership during the WebQuest, they are likely to retain this information because they have control over the information to which they are exposed and presumably are interested in learning the information (Gee, 1990; Sankaran & Bui, 2000; Smith & McNelis, 1993; in Vidom & Maddox, 2002).

Higher-Order Thinking Skills

HOTS have been defined in the literature as "occurring when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations" (Lewis & Smith, 1993, p. 136). Crawford and Brown (2002) further defined HOTS as being composed of three categories: "content thinking, critical thinking, and creative thinking" (p. 6). Using Bloom's Taxonomy, we can identify HOTS as working at the levels of application, analysis, synthesis, and evaluation (Bradshaw, Bishop, Gens, Miller, & Rogers, 2002, p. 276). Using the North Carolina Levels of Thinking that were adopted from Marzano (Houghton, 2008), applying, analyzing, generating, integrating, and evaluating would be considered higher-level thinking skills (see Appendix, p. 34).

One of the important characteristics of a WebQuest is that it is organized so students must use HOTS to complete the task. Bradshaw et al. (2002) noted that many of the features of the World Wide Web are promising for the "development of complex thinking skills" (p. 276). The features they noted (motivation, unlimited, authentic and up-to-date resources, authentic problems, and the hypertext environment) are also applicable to the WebQuest model and to HOTS. They also noted that the Web "allows for individual pacing, a very powerful element of learner control. Students must analyze [sic] and synthesize, using critical thinking skills to develop meaning as they explore" (p. 278). These statements characterize WebQuests as well. Even though the Web affords our students these opportunities for making meaning and using HOTS, Bradshaw et al. (2002) stated:

> Neither the web nor books will affect the use of complex thinking skills until appropriate use is made of them... We must design or provide learning environments so students will receive the full benefit of the WWW. We may learn more efficiently and at a higher level if we have help and guidance through those surroundings. (p. 279–280).

WebQuests do just that; in fact, they provide structure for students as they access and process information, transforming it into a meaningful product as they use HOTS. Further, WebQuests provide an authentic context for learners to develop their HOTS as they synthesize information and apply it to either address real-world problems or complete relevant tasks.

Levels of Technology Implementation (LoTI) Framework

The Levels of Technology Implementation (LoTI) Framework was conceptualized in 1994 by Dr. Christopher Moersch. LoTI is based on the Concerns-Based Adoption Model (Hall, George, & Rutherford, 1977; Hall & Loucks, 1979; Hall, Wallace, & Dossett, 1973, in Moersch, 2001), the research from Apple's Classroom of Tomorrow (ACOT, 1995, in Moersch), and Moersch's own "observations of hundreds of classrooms nationally" (Moersch, 2001, p. 23). LoTI was "an effort to create a consistent set of measures that accurately reflected the progressive nature of teaching with technology" (Moersch, 2001, p. 23). The LoTI Framework has been used nationally and internationally to assess teachers' level of technology use in the classroom. "The LoTI Framework focuses on the delicate balance between instruction, assessment, and the effective use of digital tools and resources to promote higher-order thinking, engaged student learning, and authentic assessment practices in the classroom––all vital characteristics of 21st Century teaching and learning" (The LoTI Connection, 2008, paragraph 1). Although the LoTI scale was influenced by the idea of HOTS, it represents an intersection of HOTS, technology use, and authentic learning tasks. Therefore, a technology-rich activity that includes higher-level thinking skills may rate high or low on the LoTI scale based on the way that technology is used and the authenticity of the task.

The LoTI Framework consists of eight levels:

1. Level 0: Non-use
2. Level 1: Awareness
3. Level 2: Exploration
4. Level 3: Infusion
5. Level 4a: Integration (Mechanical)
6. Level 4b: Integration (Routine)
7. Level 5: Expansion
8. Level 6: Refinement

These levels progress from no digital technologies being used in the classroom to a seamless utilization of digital tools in the classroom. The instructional focus in the levels moves from teacher-directed instruction with lower levels of thinking and unauthentic tasks to student-centered tasks that extend beyond the classroom, involve authentic problem solving, and include higher-level thinking skills.

The design of a WebQuest, specifically the WebQuest task, reflects the level of technology implementation of the designer. Therefore, WebQuest tasks that are authentic and develop students' higher-level thinking skills, should rate high on the LoTI scale. Conversely, a WebQuest task that lacks authenticity and does not challenge students at the higher levels of thinking will probably have a correspondently lower level on the LoTI scale.

Certainly, the very definition of a WebQuest includes an emphasis on higher-level thinking. However, there is a lack of research studies that have explicitly investigated the processes involved in implementing WebQuests to facilitate these higher-level thinking skills. Studying the links between WebQuests, the LoTI Framework and HOTS is a beginning step in understanding the link between WebQuest tasks, higher-level thinking, and teachers' implementation of technology in their classrooms. This study examined WebQuests that teachers developed as part of a year-long professional development project. We analyzed the WebQuests in light of both the level of HOTS and Level of Technology Integration in order to examine the extent to how WebQuests addressed students' HOTS and utilized technology.

Methodology

Research Questions

This study was informed by the following research questions:

- To what extent are teacher-created WebQuests designed to develop students' higher-level thinking skills, as described by Marzano?
- To what extent are teacher-created WebQuests designed to meet effective levels of technology implementation, as described by the LoTI scale?
- What associations exist between WebQuests on Marzano's Levels of Thinking scale and the Level of Technology Integration (LoTI) scale?
- To what extent do teachers' views of their WebQuests' Levels of Thinking and LoTI levels align to actual levels?

Setting and Participants

The study took place in a Title I intermediate school (Grades 5 and 6) in a small school district in the southeastern United States. The school holds all 730 of the 5th and 6th grade students in the entire district. The school's scores on statewide tests have been below the state average in both reading and mathematics since the school opened in 2005. Approximately 63% of the students qualify for free or reduced lunch.

The school employed 32 teachers at the time of the study; 16 in 5th grade and 16 in 6th grade. All teachers reported that they had basic technology skills and routinely used technology to check their e-mail, find lesson plans, and use word processors in various ways. Out of the 32 teachers, only two teachers had used a WebQuest before. Both participants reported finding a WebQuest on the Internet and using it without modifying it at all. Further, only eight teachers reported that they had incorporated the Internet into their teaching in some way prior to the project.

Description of Professional Development

All classroom teachers created and implemented WebQuests as the culminating task in a year-long professional development project during the 2007–2008 year. In August 2007, teachers participated in two half-day workshops concerning integrating technology into the curriculum. Researchers then asked participants, the school's technology coordinator, and the school's administrators how they would like to use technology in their classroom.

Due to low test scores on statewide tests, the school was in the process of completing their Title 1 Continuous Improvement Plan. Two of the identified needs in the needs assessment were "effective differentiated learning strategies designed to increase student proficiency in technology" and "to effectively use technology as a tool designed to increase student proficiency" (Kannapolis Intermediate School, 2007). One of the strategies designed to meet these needs included increasing the use of technology to access information and demonstrate knowledge. The professional development chosen to help the school satisfy this strategy was monthly inservice with the researchers centered on integration of technology, differentiation, and curriculum planning through the use of WebQuests. As most participants were novice technology users, focusing on WebQuests provided a tangible product that could be designed and implemented within the scope of the school year.

During the monthly 60-minute workshops, teachers participated in working through a WebQuest, analyzing the various components of WebQuests, evaluating WebQuests, and discussing ways to modify WebQuests they found online. The researchers repeatedly emphasized the potential of WebQuests to develop students' HOTS based on the nature of the task. Using various resources, including Marzano's levels of thinking (Houghton, 2008), researchers introduced teachers to ideas concerning choosing effective WebQuest tasks that would develop students' thinking skills. The outcomes of the workshops were for teachers to create a WebQuest, either by writing their own or modifying one found online, and teach it in the spring of the school year.

Data Sources and Analysis

In order to examine each research question, researchers collected and analyzed teachers' WebQuests and data from a five-item online survey. The WebQuests provided insight into the content, tasks and the extent of HOTS that the teacher-partcipants had designed. These data sources provided insight about the HOTS and LoTI level for each of the WebQuests. The surveys asked teachers to provide a description of the WebQuest and their perception of both the HOTS and LoTI level of their WebQuest.

Data were analyzed using an inductive approach (Bogden & Biklen, 2003; Patton, 2002). The WebQuests that teachers created and implemented were analyzed in terms of their higher-level thinking skills and their LoTI. For HOTS, we used the North Carolina Department of Instruction's Levels of Higher-Level Thinking, which have been adopted from Marzano's (Houghton, 2008) levels. To determine LoTI levels, we referred to Moersch's scale (1994). For each WebQuest, the researchers examined each part of the WebQuest, focusing primarily on the task, as that component greatly influences the extent to which HOTS are developed.

Both researchers met to discuss the levels of Marzano and the LoTI scales. Researchers then independently analyzed each WebQuest using both the Marzano and LoTI scales. The researchers subsequently met to discuss the WebQuests and the ratings. In the 11 WebQuests, there were a total of 18 tasks. There were 36 ratings: a HOTS and a LoTI for each of the 18 WebQuests. The researchers agreed on 33 of 36 ratings (91.67%). For the three ratings that the researchers disagreed on, they reached consensus after discussing and referring back to the scales.

After each WebQuest was coded, the data was compiled to address each research question. Researchers analyzed the WebQuest data to examine HOTS, the LoTI levels, and the relationships between HOTS and LoTI levels. Researchers examined data from the five-item questionnaire to compare teachers' perceptions of the HOTS and LoTI levels in their WebQuests with the researchers' analyses. The researchers used a Microsoft Excel spreadsheet to organize and analyze the survey data. Researchers analyzed data related to the HOTS, the LoTI levels, and the relationship between both as one data set, using each WebQuest task as the unit of analysis. To compare participants' perceptions of HOTS with the researchers' analyses, researchers used participants as the unit of analysis, matching up participants' responses to the researchers' analyses.

Table 1: WebQuests Analyzed According to Marzano's Levels of Thinking

Level of Thinking	Number of Tasks (18)
Knowing	1 (5.56%)
Organizing	0
Applying	11 (61.11%)
Analyzing	0
Generating	0
Integrating	2 (11.11%)
Evaluating	4 (22.22%)

Findings

This section presents data in terms of the four research questions: higher-order thinking skills (HOTS), levels of technology integration (LoTI), the relationship between HOTS and LoTI levels, and the comparison between teachers' perceptions of HOTS and the researchers' analyses.

Marzano's Higher-Order Thinking Skills

In the 11 WebQuests, there were a total of 18 tasks. Two WebQuests had two tasks for students to complete. In three WebQuests, students had a choice of tasks to complete. Table 1 shows the data for the WebQuests based on Marzano's scale for HOTS. Three of 18 tasks (16.67%) involved the evaluation of knowledge (evaluating). Evaluation tasks included writing persuasive papers about ecosystems, writing an essay on the industrial revolution and justifying why a specific poet made important contributions to society. In 2 of the 18 tasks (11.1%), students synthesized information (integrating). In one task, participants invented a piece of playground equipment that included at least two simple machines. Students applied information they gathered during the WebQuest (applying) in 12 of the 18 tasks (66.67%). These applying tasks involved making posters and PowerPoint presentations, writing reports, and creating an educational game or a fictitious room in a museum using the information that they had learned. Lastly, one task had students recite a poem they found during the WebQuest (knowing).

In two of the three WebQuests, the tasks involved only the application of content. The Poetry WebQuest included one lower-level task where students recited a poem, and a higher-level task where students justified why their poet made a significant contribution to society.

Level of Technology Implementation

Researchers coded 16 of the 18 tasks (88.89%) designed in WebQuests on the Exploration Level of Technology Implementation (Level 2). Exploration uses of technology focus on supporting direct teaching of content in tasks that lack authenticity. All of the tasks were at least at the Exploration level, as students used the Internet to gather information during the WebQuests. Researchers coded 2 of the 18 tasks (11.11%) at the Infusion Level of Technology Implementation (Level 3). Infusion uses of technology use technology to facilitate the completion of authentic tasks that also develop students' HOTS.

The two WebQuests at the infusion level allowed students to synthesize information and create newspapers based on content about the Revolutionary War and the solar system. Both tasks situated students in a

Table 2: Comparison of Data Analysis to Teachers' Ratings of Levels of Thinking

WebQuest	Level of Thinking Based on Data Analysis	Level of Thinking Reported by Teachers (Number of Teachers)
Revolutionary War	Applying	Evaluating (1), Integrating (1), Generating (2)
Solar System (4 WebQuests)	Applying	Integrating (2), Analyzing (3)
Weather	Applying	Analyzing (1), Evaluating (1)
World War II	Applying	Integrating (1)
Water Cycle	Applying	Analyzing (1), Applying (2)
Simple Machines	Integrating	Integrating (2), Generating (1)
Biomes	Evaluating	Applying (1), Generating (1)
Industrial Revolution	Evaluating	Applying (2)

context in which they had an audience or authentic purpose for creating their product. The 16 WebQuests at the exploration level included tasks that summarized or compiled information without providing students opportunities to analyze, synthesize, evaluate, justify, or employ HOTS. Further, these Exploration tasks lacked authenticity.

Associations between Higher-Level Thinking and LoTI s

Both of the tasks determined to be at the infusion LoTI were rated on the Evaluating level on the HOTS scale. The 16 WebQuest tasks that included Exploration uses of technology were distributed across Marzano's scale about levels of thinking. Twelve of the tasks involved the application of content: Students compiled the information that they had gathered during the WebQuests into posters, brochures, or PowerPoint presentation. The evaluating task that was also coded at the Exploration level asked students to justify why the poet they researched should be in the Poetry Hall of Fame. Although students used technology to complete the WebQuests and in some cases generate a work product, the lack of authenticity among the tasks resulted in low levels on the LoTI scale.

Teachers' Perceptions

Twenty-two teachers completed the online survey. This accounted for 11 of the WebQuests. All of the authors of one WebQuest chose to not complete the survey. As indicated in Table 2, there was discrepancy between the levels of thinking reported by teachers and the levels identified during data analysis. Sixteen of the 22 teachers (72.73%) rated their WebQuest at a higher level of thinking than the researchers. Two of the teachers (9.09%) who created the Biome WebQuest rated their WebQuest at the same level of thinking as the researchers. Lastly, three of the teachers (13.64%) rated their WebQuest at a lower level of thinking than the researchers.

Discussion

This study examined the extent to which WebQuests created by novice technology-using teachers included HOTS and innovative technology use (LoTI). Several findings warrant further discussion.

WebQuests as a Vehicle to Support Technology Integration

Literature regarding teacher change indicates that changes in instructional practices requires ample time learning knowledge and skills (Banilower et al., 2006; Loucks-Horsely et al., 2003) and opportunities to implement what they are learning in their classroom (Ball & Cohen, 1999; Putnam & Borko, 2000; Sherin & van Es, 2005). Although this project was extended over the course of a school year, teachers received only 6 hours of professional development related to WebQuests. Despite the brief duration, teachers were able to successfully design or modify a WebQuest. For the quality of WebQuests to increase, it is reasonable to expect that more time is needed.

Each of the participants was able to effectively design a WebQuest that met the criteria established during the professional development. Although WebQuests have been in the educational technology field for nearly two decades, they still have value as an instructional tool for students to gather and examine Internet-based content. In this project, the WebQuest served as a vehicle to support teachers' use of educational technology in their classrooms. All teachers reported using their WebQuest with their studentsTwenty-four of the teachers (75%) reported this was the first time they had integrated the Internet into their instruction, and 30 teachers (93.75%) reported that this was their first time using a WebQuest with students. For the two participants who had used a WebQuest prior to the project, this was the first time that they had modified or created a WebQuest to meet their students' needs.

Tasks Focusing on Lower-Level Thinking and Technology Integration

In line with previous work (e.g., Becker & Ravitz, 2000; Mann, Shakeshaft, Becker, & Kottkamp, 1999; Polly, 2008; Polly & Shepherd, 2007), participants' uses of educational technologies focused on lower-level thinking skills and basic knowledge. The findings are supported by empirically based models related to the integration of technology (e.g., Moersch, 1994; Hooper & Rieber, 1995; Ringstaff, Yocam, & Marsh, 1995) that have found teachers need ample time, support, and experiences learning how to use technology, plan technology-rich lessons, and teach with them before becoming adept at integrating technology. More such experiences will be needed for teachers to produce and implement quality WebQuests that require students to use HOTS.

Although the professional development successfully supported teachers' design and implementation of WebQuests, the analysis of the tasks indicated that 13 of 18 tasks (72.23%) focused on lower-level knowledge, neglecting the development of students' HOTS. Likewise, 16 of 18 tasks (88.89%) were coded on the Exploration level, where the focus of student activity was using technology to support basic knowledge. As stated earlier, teacher-participants designed application tasks that provided opportunities for students to identify Web-based information and apply that information in PowerPoint presentations, brochures, educational games, and other projects. These projects provided students with opportunities to make use of what they had learned but lacked components needed to develop their HOTS. This indicates teachers need more experience working with instruction that uses HOTS. It may be that teachers need more professional development experiences with instructional strategies other than WebQuests to help them understand HOTS and be able to implement them in the curriculum.

Uncertainty about High-Level Tasks

Based on previous work (Becker & Ravitz, 2000; Fishman et al., 2003; Stein, Henningsen, & Grover, 1996), teachers' ratings of their instruction do not match researchers' interpretations of their teaching. There are two possible explanations for this. First, there could be a lack of agreement between researchers and teachers about what effective instruction looks like (Cohen, 1990; Schneider, Krajcik, & Blumenfeld, 2005; Stein, Henningsen, & Grover, 1996). Second, teachers may overrate their instructional practices (Mullen, 1987; Polly & Hannafin, under review; Ravitz, 2003) in order to appease researchers, administrators, or others.

Regardless of the teachers' reasons, future professional development projects should support teachers' understanding of HOTS.

Sixteen of the teachers (72.73%) rated their WebQuests at a higher level of thinking than the researchers. All of these participants had designed tasks that were coded at the application level on Marzano's scale (North Carolina Department of Public Instruction, 1999). This discrepancy highlights a need to more explicitly focus on the levels of thinking in future professional development opportunities. Participants were successful in designing a WebQuest, and according to the survey data, they believed they had designed tasks that would develop students' HOTS.

Implications and Limitations

The findings from this study confirm and raise design principles for effective technology-related professional development. Several researchers (Garet et al., 2001; Penuel et al., 2007) indicated that teachers reported a higher adoption of instructional practices when professional development was ongoing, involved active learning experiences, and covered specific content. The findings from this study confirm these recommendations. In this study, the year-long nature of the project allowed teachers to receive ongoing support, design a WebQuest for their classroom, teach with it, and then collaboratively discuss implementation. The workshops provided teachers with opportunities to explore, locate, and design WebQuests. Lastly, although the professional development did not address one specific content area, participants were guided to address student learning by using a WebQuest to help students explore concepts that are typically difficult to understand. Further, in line with prior research (Banilower et al., 2006; Loucks-Horsley et al., 2003), findings indicate that providing teachers with ownership of both the professional development activities and how they would apply their new knowledge in their classroom led to teachers' self-reported implementation of WebQuests. Future projects should incorporate these characteristics of active learning, duration, connection to a specific content area, and teachers' ownership of professional development activities.

The nature of this study was to explore the extent to which teachers' WebQuests addressed HOTS and LoTI. Although the findings indicate that professional development can provide opportunities for teachers to begin to implement technology-rich activities, we must address some limitations.

First, as in the case of qualitative studies, the goal of this research was to gain a deeper understanding of the WebQuests that participants designed as well as the comparison between teachers' perceptions and researchers' analyses of HOTS. Findings from this study should be used to direct future studies related to supporting technology integration and designing technology-related professional development, rather than making broad generalizations about the impact of these types of professional development projects.

Second, the data that was collected was limited to only participants' WebQuests and the questionnaire about participants' perceptions. We did not collect data regarding implementation. Although the present study provides insight about the HOTS and LoTI levels in the WebQuests, future work should examine implementation through the analysis of WebQuests, observations of lessons, and analyses of student work samples.

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Appendix

Revised Bloom's Taxonomy (Church, 2007)