BUILDING A NETWORKED ENVIRONMENT IN WIKIS: 
THE EVOLVING PHASES OF COLLABORATIVE 
LEARNING IN A WIKIBOOK PROJECT

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ABSTRACT
Wikis, when used as an open editing tool, can have profound and subtle effects on students' collaborative learning process. Hailed as a collaborative learning and writing tool, many questions remain regarding the pedagogical impacts of using wikis in the classroom. Do students feel comfortable editing each others’ wiki articles? Do students learn collaboratively and construct knowledge for the community? What challenges did they experience in a networked environment? This study addressed these questions using qualitative methods, including multiple semi-structured interviews and student reflective journals, for analysis. The findings challenge idealistic hypotheses that wiki work, without careful design and implementation, is naturally beneficial. It was also found that collaborative writing and learning were the exception rather than the norm among participants in the early stages of wiki work. It is recommended that instructors provide highly supportive learning experiences to teach students how to use wikis and how to work collaboratively when implementing wikis to maximize the benefits of this emerging tool.

INTRODUCTION

Wikis Explained and Defined
The term wiki-wiki is a Hawaiian phrase meaning “quick” and has been added to the American lexicon, in large part because of Wikipedia, the world’s free source of “the sum of all human knowledge” (Wales, 2004). A wiki is a collection
of interlinked web pages (articles) that allows users to create and present content collaboratively in a hypertext system using open source software based on XML (extensible markup language). Because of browser-based access, passwords, permissions, special client software, and webmasters are unnecessary. Shared responsibility for the quality and accuracy of the content and building a reusable repository of knowledge are the goals of wikis (Godwin-Jones, 2003). Ward Cunningham, creator of the wiki, endeavored to build “the simplest online database that could possibly work” (Leuf & Cunningham, 2001, p. 15).

In practice, wikis have been touted as being simple and easy to use as the “line between the active content purveyors (authors) and the passive users is largely eliminated, resulting in the rapid appearance of a chaotic knowledge network of wiki pages and sites” (Fuchs-Kittowski & Köhler, 2005, p. 2). Wiki content is editable by anyone who has Internet access. A built-in editor frees users from having to know Internet programming language such as HTML, Java, XML, or Perl. The user accesses the site, clicks on the edit tab, makes changes to the content, and saves the document. Hyperlinks within the wiki document are added by placing double brackets around the text, for example [[link to my page]], and outside the wiki document by adding double brackets around the URL, for example [[http://educase.edu]].

A revert feature in the software allows users to delete vandalism by reverting the text to the previously saved version, thus discouraging spammers and vandals. In a study conducted by Halavais (2004, cited in Richardson, 2006), errors deliberately edited into several Wikipedia articles were corrected within a few hours. Lamb (2004) reported that the ethic of soft security kept vandals at bay since a wiki is a community endeavor and the “proportion of fixers to breakers tends to be high, and a wiki will generally have little difficulty remaining stable—assuming that people see value in its existence and have a genuine interest in keeping things tidy” (p. 40).

Given how a wiki is explained and defined in literature, wiki work seems naturally beneficial to collaborative writing and communities of practice. This study investigated how students interacted and collaborated in a wikibook project in a graduate course.

**Purpose of the Study**

The functionality of wikis have been discussed in the literature (Fuchs-Kittowski & Köhler, 2005; Godwin-Jones, 2003), but little explicit attention has been paid to the human interactions surrounding the collaborative features of wikis. Furthermore, many claims are made about the potential benefit of using wikis for collaborative learning (Schaffert, Bischof, Bürger, Gruber, Hilzensauer, & Schaffert, 2006; Wales, 2004), but few empirical studies exist to support these claims. While wikis have been lauded in the literature as being an ideal tool for collaborative learning because learners are able to write, edit, version, and discuss
next to the content, some questions remain: Do students take full advantage of the collaborative features inherent in wikis, which are not available in e-mail and discussion boards? How do students interact, communicate, and collaborate to achieve learning goals in wikis?

This study addressed the need for empirical evidence regarding student interactions when working collaboratively in a wiki by qualitatively exploring the evolving phases of using wikis to complete class assignments. The purpose of this study was to investigate:

1. how students communicated, wrote, and collaborated in an open writing environment; and
2. how students perceived collaborative learning in a networked environment such as wikis.

THEORETICAL FRAMEWORK

Providing collaborative learning opportunities is considered important to enhance student’s active learning. Collaborative learning is “an instructional method in which students at various performance levels work together in small groups toward a common goal” (Coutinho & Bottentuit, 2007, p. 1,787). The expected outcome of collaborative learning is shared construction of knowledge among students (Ravitz, 1997; Romiszowski & Ravitz, 1997). Collaborative learning asks learners not only to be responsible for their own learning, but also to be responsible for constructing new knowledge with other learners. Such responsibility on the part of learners is well documented in the literature as knowledge building or community knowledge. Scardamalia and Bereiter (2003) noted that knowledge building in collaborative learning is seen as creating or modifying individual and public knowledge, thus inhibiting continual idea improvement. Woodruff and Meyer (1997) indicated that the community dynamics help further foster knowledge advancement. Similarly, Bandura (1997) argued that people learn through observing others’ behavior, attitudes, and outcomes of those behaviors known as vicarious learning.

Consistent with theories on collaborative learning and knowledge building, the role of the instructor and students are expected to change as well. Harasim (2000) argued that knowledge transfer is not a one-way transmission in which the instructor is the only source of knowledge. Instead, instruction is student-centered and knowledge is viewed as a social construct which is enhanced by both the instructor and the peers. As such, the concept of learning shifts from instructor-oriented instruction to student-oriented collaboration, and students build a community of students when they are “learning with and for others” (Holmes & Gardner, 2006). In their article, Zhang, Scardamalia, Lamon, Messina, and Reeve (2007) summarized the roles of students as taking:
high-levels of responsibility for managing a process advanced through recording ideas in a public and collaborative space that then represents their idea diversity and the space of ideas to be continually improved. Through sustained and collaborative work they “rise above” to increasingly more coherent and sophisticated conceptualization. This process helps them negotiate the space of both personal and communal knowledge, of their personal theories and statements of what they need to know, of self-regulated experiments and interpretive conceptual artifacts, and of their own ideas and resource materials. (p. 121)

To align with theories about knowledge building, there is a growing body of literature that discusses using new technologies to foster collaborative learning in a networked environment. Such discussions focus on how technology infrastructure affects the social nature of learning. Stahl (2005, 2006) stated that the social and technological reconfigurations, which heavily involve group cognition, transcend the limits of individual cognition. His empirical studies showed that computers can provide active media for social group cognition, which results in shared understandings, new meanings, and collaborative learning. Suthers (2006) argued that in a networked environment people in groups make sense of situations and of each other—intersubjective meaning-making that emphasizes both individual and social agency.

Similarly, other researchers noted the advantages of using new technologies to create social and educational experiences beyond the classroom. Reigeluth (1994) and Romiszowski and Ravitz (1997) indicated that computer technology had changed a traditional “instructional” model to an information-age “conversational” model of learning. Jonassen, Peck, and Willson (1998) stated that new technologies make individualized learning more powerful, more important in that they support conversation and collaboration among learning communities. Similarly, Fishman and Pea (1994) noted that “the network’s true power comes from the synergy of many dispersed minds working together to solve problems and discuss issues” (Fishman & Pea, 1994). Pea (2004) continued to argue that computer technologies can scaffold complex learning that enables more advanced performances.

Following these discussions, wikis can be used to move learners toward a state of conversation and collaboration, where they are able to write, edit, version, and discuss next to the content in wikis. This was the motive for asking students to create an online textbook using a wiki interface and how the case was developed. The following section further reviews how computers support collaborative learning, and what literature documents wiki applications in the classroom.

Overall, literature about collaborative learning in a networked environment provides a framework for adopting wikis in courses. Our educational goal was not just to provide a medium in which to store and make available the knowledge created by the learners. Instead, our goal was to promote one-to-one,
one-to-many, and many-to-many interactions in wikis that would magnify learning opportunities for learners themselves and for others in the community (Holms & Gardner, 2006). As such, the following section takes a closer look at literature concerning computer-supported learning environments, pedagogical claims, and applications of wikis in classrooms.

**REVIEW OF LITERATURE**

**Computer-Supported Collaborative Learning (CSCL)**

The literature has a collection of definitions for collaborative learning. Brandon and Hollingshead (1999) defined collaborative learning as “an activity that is undertaken by equal partners who work jointly on the same problem rather than on different components of the problem” (p. 54). Moallem (2003) stated that “while learning is ultimately an individual enterprise, the support of a group with a common learning objective can produce a synergistic facilitation of learning by each member of that group” (p. 84). With the increased use of the Internet in educational settings, computer-supported collaborative learning (CSCL) has attracted much attention in education. CSCL takes advantages of Internet resources and online communication tools such as discussion boards, e-mail, video conferencing, and chat rooms to facilitate communication and collaboration. In these environments, students can access sufficient and just-in-time resources, reorganize their thinking, present new forms of knowledge, and be exposed to multiple views from groups (Uribe, Klein, & Sullivan, 2003).

Empirical studies that have investigated the CSCL environment from multiple dimensions have proliferated in the literature. Some researchers explored how learning is structured in a CSCL environment. For example, Suthers (2006) investigated technology affordance for intersubjective meaning-making among learners. Stahl (2005, 2006) explored the technological and social reconfigurations that are needed to achieve computer-supported collaborative knowledge building at the group level and at the individual level. He found that groups in a CSCL environment construct intersubjective knowledge that emerges from and appears in the discourse itself. Some researchers compared the effectiveness of individual and group performance in a CSCL environment. Lou, Abramin, and d’Apollonia (2001) examined 122 studies using meta-analysis and found that small groups outperformed individuals when learning with technology. In addition, some researchers examined whether certain instructional methods worked effectively in a CSCL environment. Murphy and Collins (1997) and Ertl, Kopp, and Mandl (2006) found that case studies work well in a computer-mediated environment and enhance higher order learning. Mergendoller et al. (2000) and Uribe, Klein, and Sullivan (2003) found that CSCL environments were not only suitable for project-based learning but also contributed to higher order learning.
Overall, these studies have provided evidence that a CSCL environment can enhance the learning process and outcomes. As such, instructors are placing greater expectations on the potential role of wikis as a recent computer-supported communication tool to enhance collaborative learning. The following section reviews pedagogical claims of wikis.

**Pedagogical Claims of Wikis**

Wikis have been credited with increasing democracy within groups by focusing on the community rather than the individual, thus increasing students’ skills in collaborative work (Holmes, Tangney, FitzGibbon, Savage, & Meehan, 2001). Collaboration is considered beneficial because learners must consider multiple perspectives, can rely on each other to reduce uncertainty during complicated activities, and enjoy increased participation in the learning activity. By using wikis, students’ learning is extended over time, across collective environments and people, and through open-natured projects that create public good (Ciffolilli, 2003). Wikis have the potential to maximize writing, reflecting, reviewing, and witnessing cumulative results (Fountain, 2005; Hammond, 2002). Fuchs-Kittowski and Köhler (2005) reported that wikis support “cooperative community knowledge generation” by allowing users to create and maintain a “community knowledge base, offering a quick, simple way to produce and review information that can be gathered and linked to other wiki pages” (p. 2).

While researchers and educators laud the use of wikis for supporting collaborative and inquiry-based learning (Engstrom & Jewett, 2005), improving critical thinking skills, and “empowerment of the individual in terms of life-long learning” (Freeman, Holmes, et al., 2001, p. 1,271), little empirical research has been conducted to test the pedagogical promise of wikis (Edwards, 2002; Freeman, Holmes, & Tangney, 2001; Hammond, 2002). The majority of the literature surrounding the use of wikis in educational settings is based on “speculative and aspirational stances rather than strong theoretical or empirical grounds” (Edwards, 2002, p. 1). An emerging literature, however, began to document wiki applications in the classroom. The following section discusses such studies.

**Wiki Applications in the Classroom**

Engstrom and Jewett (2005) studied 400 students with 11 teachers who used wikis for an inquiry-based project in a professional development teacher-preparation program. They found that students posted and edited insufficiently in their small research groups, which primarily reflected surface-level learning in the inquiry process and that the teachers did not model or facilitate an exchange of ideas, questions, or provide feedback to students required to build wiki articles. The study suggested that project developers model the wiki practice that prompts interaction, critical thinking, and thinking from multiple perspectives.
Wang et al. (2005) investigated students’ editing behavior and their performance in wiki. They explored the effects of students’ frequency of editing usage in wikis on their final exam performance and found that students with low usage on the wiki performed better than those with high wiki usage on the final exam.

Other studies investigated factors such as online environment and anonymous writing that affected effective collaboration. Bold (2006) incorporated wikis in a master’s online course to support collaboration. The study reported that wiki allowed students to be in charge of joint posting, editing, reporting, and maintained work without burdening individual students as the project coordinator. In this manner, students reported that the use of wiki increased their sense of connection in the online setting. Chong and Yamamoto (2006) investigated a group of 20 people who had not met prior to the study, yet felt comfortable in exchanging ideas in a wiki writing project. Their study suggested that anonymous writing gave students’ a private space; therefore, collaboration between strangers could facilitate independent thinking and clear understanding of the team members, as well as contribute to high quality outputs.

Hewitt and Peters (2006) asked their 15 students to construct wiki articles on an array of topics in a graduate-level distance education course. They found that the students considered building a knowledge base in a wiki project to be not only an authentic task for themselves but also a value-added activity for future classes. Coutinho and Bottentuit (2007) asked 16 students in a master’s program to build an enormous collaborative repository that could help future students with their theses. Their findings were inconclusive. On one hand, students enjoyed working with their group. On the other hand, they did not think team work was a better quality experience or helped them learn more than if they had worked alone. Similarly, Plowman (2007) provided his students with a wiki environment where they built a social justice forum. Through the very interactive forum, the participants went through the circle of construction—deconstruction—reconstruction several times so that their knowledge building experience was not linear. In contrast, Blank et al. (2004) reported students’ territorial needs prevented true collaborative work in a wiki environment.

These studies lay the groundwork for this study, which addressed the gap in the literature regarding how students communicated, whether communication affected their wiki writing, and whether the potential of wikis—effective collaborative learning—had been realized.

**METHODOLOGY**

**Research Questions**

1. How did students communicate, write, and collaborate in a wiki environment?
2. How did students perceive collaborative learning in a networked environment in wikis?
Context of the Study

The study was situated in a graduate level course about adult education, offered at a major land-grant university in the mid-south. The instructor, who was one of the researchers for the study, built the shell for a wikibook using Mediawiki® software (www.mediawiki.org) and posted it online, purposefully public and accessible. The study was conducted with 18 students who enrolled in the same course respectively in fall 2006 and fall 2007.

In fall 2006 semester, five students were required to write or edit five articles using wiki as the writing and presentation tool. Students were to work individually on two chapters, collaboratively on two chapters, and to edit another student’s article for the fifth assignment. In addition, students were given a detailed rubric for completing the assignments along with face-to-face instruction about the project. Students could create a chapter under the instructor-defined headings or create a new article. The teams were assigned by the instructor to increase heterogeneity in regard to culture, age, and discipline. The instructor met with student teams weekly to access the progress and cohesiveness of the team. In addition, students were asked to write reflective journals for each of the five articles.

In the fall 2007 semester, 13 students were required to write three wiki articles. Students were asked to work on one individual chapter and one collaborative chapter. Then they had their choice of writing the last article independently or collaboratively. All students chose to complete the third article independently. Similar to that of the fall 2006 cohort, students were asked to write one reflective journal for each article.

In addition to students’ wiki chapters and reflective journals, in-depth, face-to-face interviews were conducted to collect data. The advantage of in-depth interviews, as Van Manen (1990) indicated, is that a researcher, by conducting the interview and reading and rereading the interview texts, can discover, literally “hear,” the meaning of the lived experience from the experiencer’s perspectives. There is a paucity of empirical studies, even fewer qualitative studies, in the literature that examine collaborative learning in wikis. Therefore, a qualitative methodology based study will contribute to the literature.

Instruments and Interventions Designed and Redesigned

An original semi-structured interview protocol was created and reviewed by three researchers. The semi-structured interview protocol was used, which allowed the researchers not only to ask participants general topical questions but also to remain flexible so as to pursue follow-up questions that were not specifically covered by the interview guide. Such an approach of designing an interview guide, as Rubin and Rubin (1995) emphasize, “. . . is flexible, iterative, and continuous, rather than . . . locked in stone” (p. 43).
Interview questions asked questions not only about how students learned by themselves or with others, but also how they created knowledge for others. Examples of the interview questions were:

1. Did students work collaboratively to develop and distribute their work?
   a. How would you describe your experience in working in teams to build your wikibook chapters?
   b. How did the wikibook experience differ from other team projects you have participated in within other graduate courses?

After the interview protocol were designed, the instructor of the course carefully reviewed the course assignments and instructions of the wiki chapters for further revision.

Innervations from cohort one was critical for the improvement of cohort two (Santally & Raverdy, 2006). Taking into account the constraints and problems that were identified in cohort one, we reviewed the rationale of using wikis, the interview guide, assignments for the wiki articles, and the instruction for the reflective journals, and made revisions accordingly to improve learning outcomes. More importantly, based on students’ feedback, we reduced the requirement of writing five wiki chapters from cohort one to three wiki chapters for cohort two; instead, we set up a practice page so that cohort two started the semester with a better understanding of the use of wikis and class dynamics. In their reflective journals, cohort two indicated they adapted to the first wiki article more confidently after a rehearsal in the practice page.

**Data Collection**

After obtaining institutional review board permission and the students’ informed consent to participate in the study, data were collected from four sources: student interviews, students’ reflective journals, the content of the wiki articles, and observation notes taken by one researcher in the classroom.

We conducted interviews in April 2006 for the first cohort and December 2007 for the second cohort. Specifically, a total of 12 interviews were conducted after students submitted their wiki articles and finished the edits on those articles created by others. Each interview lasted 40-50 minutes. Among the 12 interviews, 10 were conducted face-to-face and two were over the telephone, and nine interviews were done with individual students while three were team interviews.

In addition, 64 reflective journals were collected and used as data to triangulate the interview findings. The reflective journals documented students’ learning experiences while creating wiki articles and were analyzed qualitatively. Additionally, classroom observation notes were taken by the researchers and were also reviewed for triangulation purposes.
Data Analysis

To answer the research questions, we triangulated data from four sources: interviews, reflective journals, wiki chapters, and observation notes in the classroom.

For the interview data, we followed the constant comparison techniques that were described by Glaser and Strauss (1967) and Strauss and Corbin (1990). Data analysis of the interview data involved two phases.

The first phase involved the free and open-coding technique. Open-coding is a strategy that involves “the naming and categorizing of phenomena through close examination of data” (Strauss & Corbin, 1990, p. 62) and constantly comparing the categories (Glaser & Strauss, 1967). This initial phase generated many ideas—units of analysis, but not in too much detail. We began by immersing ourselves in the interview transcripts, underlining key words and phrases in the transcripts and making notes on each section of each transcription. For example, in a paragraph in which one student described her way of communicating with peers, we wrote down “E-mail for the first Wiki chapter” and “the first time to use Discussion Board in wiki.” After this initial stage, we began to search for recurring words or themes with the transcripts, which are conceptually congruent (Glaser & Strauss, 1967) and could possibly be grouped together.

The second phase of the data analysis engaged axial coding. This method uses a series of procedures that make connections within and between groupings and allows for new combinations of data (Strauss & Corbin, 1990). With the help of the condensed list that was developed in the first phase, we sought common and related concepts from the list. For example, through a close examination of what the participants described, we found that units of “E-mail for the first Wiki chapter” and “the first time to use Discussion Board in wiki” could be combined and relabeled as “Communication Methods.” Following the axial coding method, some units of analysis were regrouped wherever necessary. At the end of the analysis, we had three overarching themes or categories of students’ experience with wiki: communication, writing, and collaboration.

We used the same coding method to analyze students’ reflective journals and constantly visited specific wiki articles mentioned in students’ reflective journals. We compared data from reflective journals (written) with the interview data (oral) in order to examine the connections across the data sets. At this point, patterns and composed themes that connected the students’ experiences in wikis began to emerge and repeat. Afterwards, we revisited the wiki website to trace students’ frequency and nature of contribution to the wiki chapters and the discussion board. Since wikis can document students’ writing, editing, and writing history, this approach ensured that we understood students’ evolving process, as identified in the interviews and reflective journals, matched their final learning products—the wiki articles in the website. Lastly, we reviewed the observation notes taken in the classroom by one of the researcher to make sure that the
emergent findings were consistent with the observation notes. Table 1 summarizes how data from four resources were analyzed and triangulated.

**Validity, Reliability, and Objectivity**

To ensure the accuracy of the findings, we followed Lincoln and Guba’s (1985) framework of trustworthiness: internal validity, external validity, reliability, and objectivity.

First, to ensure that internal validity—the congruence between the findings and reality—was achieved in this study, we prepared a synthesis of each interview and sent it to all the participants of the study to ensure that what was heard was indeed correct (member checking the data). In addition, we compared the findings of the 12 interviews with that of 64 reflective journals to verify categories and themes (triangulation). Second, to achieve external validity—transferability of research findings to other situations—we revealed thick (detailed) descriptions of the course structures and processes in this study for future adaptation (audit trail). Third, to ensure that reliability—replication of research findings—was achieved, we maintained detailed field notes and memos throughout the study process, which served as an audit trail to verify our findings. Similar to internal validity, triangulation by using multiple methods of data collection and analysis also strengthens reliability. Lastly, to ensure objectivity—“being fair to differing points of view” (Lincoln & Guba, 1985, p. 173)—was achieved, we created a research team (course instructor and external interviewer) for peer examinations.

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<tr>
<th>Data sources</th>
<th>Analysis</th>
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<td><strong>Interviews</strong></td>
<td>• Identify patterns of use of wikis to communicate, write, and edit.</td>
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<td>• Identify perceptions of collaborative learning in wikis.</td>
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<td>Reflective journals</td>
<td>• Compared patterns and categories with the interview findings.</td>
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<td>Wiki articles</td>
<td>• Traced students’ frequency and nature of contribution to the wiki chapters and the discussion board in wikis.</td>
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<td>• Compared evidence of collaboration in the wiki website with interviews and journal evidence.</td>
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<tr>
<td>Observation notes</td>
<td>• Ensured that emergent findings from other sources were consistent with classroom observations.</td>
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purposes. We carefully maintained data management and transcribing processes, transcribed the interviews verbatim, and documented write-ups of process notes, all of which contributed to the objectivity of the findings.

**Limitations of the Study**

The study was carefully and meticulously executed; however, like all studies, it was not without its limitations. First, the group size of two cohorts of students was different, cohort one being five students and cohort two being 13 students. In addition, the learning environment and the treatments for two cohorts were slightly different. Students in cohort one completed five wiki articles, and students in cohort two completed three wiki chapters. To address such limitations, the instructor focused on providing consistent course goals and objectives, expectations for wiki chapters, evaluation of learning activities, and technological assistance to both cohorts. The second limitation is that since the course was focused on adult education theory and stressed self-directed learning as a virtue, self-reported data that focuses on student likes and dislikes can sometimes be confounded by other factors such as like or dislike for an instructor, the learning content, or technology. Again, during the interviews, we restated the objective and importance of the study so as to help participants focus on their experiences in a wiki environment.

**RESULTS**

**Research Question 1: How did students communicate, write, and collaborate in a wiki environment?**

We found that students did not naturally take the opportunity of using wikis to enhance learning when they first started working in a wiki environment. The promise of wikis—co-authoring and co-learning—did not occur immediately. Instead, we found that students experienced three phases of emotional commitment in the wikibook project in order to take full advantage of wiki as an open editing tool. The phases were Exploration (a crisis of authority), Adaptation (a crisis of relationship), and Collaboration (a resolution of crisis). In the following section, we examined how students communicated, wrote and collaborated in these three phases.

**Phase 1: Exploration (A Crisis of Authority)**

*Communication*—The participants indicated that using an open editing tool such as wiki was difficult at the beginning of the project because it challenged their notions of group work. The primary difficulty involved ineffective communication within the group such as not knowing what to communicate to each other, frequency of communication, or how to use the wiki discussion board.
Participant 1 noted (Excerpt 1), “The first chapter was chaotic. We had the technology problems because things wouldn’t get posted in time, and because we didn’t know how to post it. We had to view the discussion board and there was a lack of communication because we weren’t all on the same page.” Participant 2 said (Excerpt 2), “At first it was hard to get it right. I didn’t know how to write [in the wiki].”

A lack of communication resulted in students doing separate work for a supposedly collaborative project. Participant 1 said (Excerpt 3), “For the first group project, our group didn’t communicate as much as we should have. When we got together, we just showed everybody our work.” Participant 6 said (Excerpt 4), “I can just do the chapter on Word, but to put it in the wiki format. It took a while for me to know [how to use the wiki].” Thus, students created work individually, and then put their writing together at the end of the project rather than the idealized co-writing that leads to improved critical thinking.

Writing—When asked about the impact of writing in the wiki in terms of increasing learning outcomes participant 1 said (Excerpt 5), “When developing this chapter, I’m not sure I learned a lot. It was mostly compiling all the information we had learned over the semester into a practical and useable format.” When asked if they felt comfortable about changing and editing other students’ work, all the participants were unanimous. They all said “not really” after the first project was completed. Participant 3 said (Excerpt 6), “I don’t know if I would like to change another person’s work. I could do some editing but I would want to go over things with them first. I figure that I should go to the individual person quietly first [before editing].” When asked further what made them uncomfortable, participant 1 stated, (Excerpt 7), “Because it’s their work, because it’s their tasks, and you’ve been taught to work on your own work. And it’s hard to kick that habit.”

The participants’ comments indicate that they were hesitant in editing others’ articles when the project began. The discomfort resulted from a feeling of a lack of ownership in the article and they needed time to explore feelings prior to editing, indicating a crisis of authority in co-creating a joint article. Students saw the assignment as pieces of a pie to be delegated and reassembled after the fact, rather than a whole pie for which they would all take credit.

Collaboration—Compared with first generation web tools such as e-mail and discussion boards, wikis are considered superior second generation web-based social tools because of the increased capacity for collaborative work. Collaboration, however, did not occur in the first phase of the project where students were asked to co-write an article in wiki. Rather, students decided to divide the assignment into smaller parts, complete their part, then cut and paste the article together after it was written individually. The wiki was used as a presentation tool rather than as a writing tool and the results were awkward at best. Participant 1 said (Excerpt 8), “At first, I didn’t really want to use wiki. It really intimidated me,
and so I did everything outside of it and just cut and paste [my finished article into
wiki]. Participant 6 noted that (Excerpt 9), “You can feel the rough transition
between each part [because it was created as separate pieces and merged at the
end]. There’s not a good flow in the chapter.”

None of the students had used a wiki prior to this assignment. During the early
phase of the assignment the participants had difficulty communicating with each
other in a timely manner. The participants also felt high anxiety and uncertainty
about authorship issues and feared editing their classmates’ work, even when they
knew it was unacceptable. The students felt territorial about their work and
respected the boundaries of others’ work when presenting their content in the wiki.
As such, wiki was not used as a collaborative writing tool. These findings do not
support the literature that wiki naturally encourages team writing and editing.

Phase 2: Adaptation (A Crisis of Relationship)

Communication—After the first wiki article was submitted and the work was
found to be of poor quality, the instructor provided more guided instruction on
how to co-write in wiki, including using the discussion board for communication.
New teams were established and a new article was required. Participants began to
communicate with their team members more effectively. The discussion board
feature in wiki was adopted by the teams as well as face-to-face meetings.
Participant 1 stated that appropriate communication with the discussion board
in wiki increased her comfort level with her peers. She said (Excerpt 10), “I think
that not being familiar with what to do was really what came at the beginning,
not being comfortable. Once we used the discussion board on wiki to com-
municate, we all got on the same page. I think basically my comfort level [with
using wiki] made a big difference.” Participant 6 described how communication
took place in her group and how it affected the relationship among team members
(Excerpt 11), “We had to be sure that we had at least two meetings for the
team. First of all, we had to work well with each other. It’s their timing and my
timing. It’s like any group project, how to fit and how to work well with the team
to get a good product.”

Gaining experience with wikis made a difference to the students. The first
article gave them experience in working in teams and working in wiki. The
second article allowed the students to practice communication skills, using both
face-to-face and the wiki discussion board. It is argued that such communica-
tion helped enhance relationships among the team members. The improved com-
munication positively affected the students’ writing quality.

Writing—Students moved from experiencing high anxiety and uncertainty
in the first article to improved communication and relationships in the second
article. Participant 2 explained, (Excerpt 12), “At first it was hard to get it. As
I’ve gotten better at it, I like it more.”
When asked about territorial boundaries when using the wiki as a collaborative writing tool, participant 1 said (Excerpt 13), “If I changed a whole bunch [of text on the article], I posted something about it on discussion board. If they didn’t like it, they could change it. It didn’t matter really.” Participant 1 continued to explain (Excerpt 14), “I think you are more inclined to edit everybody’s work on the wikis. It’s just there on the screen so I think the project would be a little bit better quality when it was in the wiki [because of open editing].” Participant 6 described the pleasant connection when seeing wiki projects when searching Google. She said (Excerpt 15), “Now, when I go to any search on Google and find wikis, I feel that is something I know. So it is nice for me. It is always nice to know more.” A better writing experience with wiki emerged during the second article assignment due to increased skill in using wiki and more explicit expectations regarding the quality of the articles.

Collaboration—Participants continued to test and adjust their relationship with their peers when working on the second article. In this manner, they became more familiar with using wiki and the collaborative writing process. As a result, they reported an improved experience with communication, writing, and collaboration. Participant 4 said (Excerpt 16), “The first time, I had a hard time. After that I got some information from my team members, I learned and I started to like [using wiki].” Participant 1 said (Excerpt 17), “Not understanding the wiki, we wanted to get everything situated before we posted it. I guess it’s just the mentality that when you post it on there and that’s the final product, you get it done. As we’ve learned more about wikis, we’re able to do everything in wikis.” Participant 6 indicated that (Excerpt 18), “I do feel that working with a partner in wiki allows for group collaboration on a more efficient level, and that I am able to brainstorm ideas more efficiently this way.” These comments indicate that when communication channels were open, writing was less stressful as collaboration was improved by knowing how to use wiki more effectively.

Phase 3: Resolution (A Resolution of Crisis)

Communication—During the course of the semester, the researchers documented that the participants’ communication moved from minimal, either via e-mail or discussion board on wiki, to maximum communication via the wiki discussion board and face-to-face meetings. Once students learned how to use the wiki, how to edit and co-write, and how to communicate with each other more effectively, they enjoyed using the wiki to complete the course assignments. Participant 4 said (Excerpt 19), “we don’t spend all the time talking, rather totally collaborative writing. We can exchange our writing through e-mail or via wiki. We have talked a lot on the wiki discussion board about what we are going to do, what our views are, and what categories we want to write our stuff in. I think that’s collaborative.”
Participants 6 and 5 compared communicating via the discussion board in wikis with e-mail and Blackboard® discussion board. Participant 6 said (Excerpt 20), “We used the discussion board in wiki, it was like we are online and we can do it faster than e-mail.” Participant 5 said (Excerpt 21), “Comparing with wiki, Blackboard®, the course management system, just has the discussion function. It’s just like talking in class. You can’t really go back and change your answers. With wikis, however, you can keep adding to it.” As identified by the participants, communicating with the discussion board on wiki became not only an addition to face-to-face meetings but also an integral part to the group assignments.

Writing—As a result of smoother communications, participants resolved the crisis of authorship and relationship, which was observed in the initial phases. Two participants summarized their writing experience from the first project to the last. Participant 6 said (Excerpt 22), “After doing five articles in wiki, I’m confident to write and edit [in wikis].” Participant 3 said (Excerpt 23), “With the first article, it really intimidated me so I did everything outside of it and just cut and paste. The second article I got more in the wiki and started typing in the actual wiki. I did a lot more in the third article. So it was just a matter of getting comfortable using the system, a big thing that I think affects whether you like it or not. I’ve enjoyed it as I’ve learned more.”

At the end of the course participants were asked if they felt comfortable editing others’ work. Participant 1 said (Excerpt 24), “Editing has become interesting to do. Editing someone else’s work was not hard in the wiki. I didn’t feel it was another’s work; it was just a web page that I felt I could add something to.” The participants indicated that they felt confident about writing and editing in wiki. To this end, wiki helped them gain a deeper understanding of the article topic.

Collaboration—Given the promise of wikis for open editing and collaborative learning, the researchers continued to investigate whether the students took full advantage of the wiki to learn personally and collaboratively. Participant 3 said (Excerpt 25), “I think that it’s really better than in class because it actually forces you to choose a research topic. I think I learned a lot better because you are actually forced to go out there and search for materials and then by letting your classmates know via wikis.” Participant 6 compared the unique collaborating experience in wiki with other tools such as encyclopedias. She said (Excerpt 26), “The idea of cooperation in wiki allows everybody else to read it online, and they are welcome to edit it. No other encyclopedias have this feature.”

Two participants pointed out that group collaboration helped generate ideas and enhance creativity. In addition, it was mentioned that different viewpoints and backgrounds were beneficial for learning. Participant 1 said (Excerpt 27), “In the group you’re going to have more ideas because you have more people, different viewpoints, and different backgrounds. I think I tend to be less creative working on a project individually.” Participant 5 said (Excerpt 28), “I thought it was great to see people from different backgrounds. It added new ideas.”
The results suggest that using wiki as a collaborative tool became more productive and constructive for the participants over time as they learned how to use wiki and the elements of a high quality article. If the initial phases of using wiki as a collaborative tool were underrepresented in the literature, the last phase began to unearth the promise of writing in an open environment constructively.

Research Question 2. How did students perceive collaborative learning in a networked environment in wikis?

Our educational goal of using wikis in the course was not just to provide a medium to store and make available students’ projects but to promote one-to-one, one-to-many, and many-to-many interactions in wikis that magnify learning opportunities for students themselves and others in the community by offering a resource available to the world (Holms & Gardner, 2006). Such a goal is consistent with literature regarding collaborative learning in a networked environment (Jonassen, Peck, & Willson, 1998; Stahl, 2005, 2006; Suthers, 2006). Table 2 provides examples of positive feedback and challenges experienced by students as they constructed knowledge by themselves and for the community.

Although Table 2 provided two excerpts respectively for students’ positive feedback and challenges in wikis, our data indicated that the majority of the participants had overall positive experiences in collaboration in a networked environment. Meanwhile, we found that students’ overall perspectives about a networked environment were influenced by their adaptation in the wikibook project, as identified in research question 1.

DISCUSSION AND IMPLICATIONS

The Evolving Phases of Using Wikis

Consistent with Blank et al. (2004), this study reported that when writing and editing wiki articles collaboratively, students experienced a crisis of authority and feared editing their peers’ work, even when the same grade was assigned to every member of the team, regardless of individual effort. This situation was especially evident during the initial phase of creating and editing a wiki article. Due to feelings of individual accountability, the students indicated that until they did their own reading and became very familiar with the material, they should not edit others’ work. As indicated by the students, this crisis of authority in the first phase directly resulted from not knowing the functionality of the wiki tools and from a lack of effective communication among team members. Not surprisingly, little collaboration occurred in phase 1; adjustment was dominant.

In the second phase, as the participants overcame the functionality of wiki, communication increased. Free editing behavior increased but it was not common. In fact, the participants were not comfortable editing their peers’ articles before
Table 2. Student Responses Regarding Collaborative Learning in a Networked Environment

<table>
<thead>
<tr>
<th>Collaborative Learning</th>
<th>Positive feedback</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge building for the students</td>
<td>1. “I found it very motivating mainly because other people were going to have the opportunity to see and edit my work. With traditional assignments you feel like you are just doing the work for the teacher; however, wiki projects let me do the work for my peers, which in my case was very motivating” (Excerpt 29).</td>
<td>1. “I have some reservations about wikipedia and the use of it for education. Although most is documented information, there is still the chance that the information is just bogus” (Excerpt 31).</td>
</tr>
<tr>
<td></td>
<td>2. “I hope that my wiki chapters will help others. I think this is a great project and one that I would like to add to my online classes that I teach” (Excerpt 30).</td>
<td>2. “I felt like I was one of those adult learners who was being subjected to a process that wasn’t applicable to what I am doing right now in my career, so it made the project more frustrating” (Excerpt 32).</td>
</tr>
<tr>
<td>Knowledge building for the community</td>
<td>1. “There is a wealth of knowledge available in our wiki chapters and that will only continue to grow for future students when they take this course” (Excerpt 33).</td>
<td>1. “Collaboration was not easy. I think if I hadn’t had a reliable partner that was interested in the same subject or maybe assigned to do the work together, I’d like to work alone” (Excerpt 34).</td>
</tr>
<tr>
<td></td>
<td>2. “Doing a wiki project is probably one of the best ways to help students to learn together and add up that knowledge to future students” (Excerpt 35).</td>
<td>2. “I had a problem with submitting anything to wiki that I do not see as perfect. I do not want the world to see anything till I am finished with it.” (Excerpt 36).</td>
</tr>
</tbody>
</table>
Dynamic and adaptive method of delivering new information

1. "I like that this is a work in progress and that it can be added to as more information is reported. New research is being completed all the time. The flexibility with the Wikibook is really amazing" (Excerpt 37).

2. "I like working on wikis. It is a break from the traditional term paper or project that most classes push. You can go in, change and edit as you want" (Excerpt 38).

Conversational rather than just instructional

1. "I think using the wiki chapters are above and beyond any conventional teaching methods I have experienced. I enjoyed being able to relay my own thoughts and knowledge on a subject while combining peer-reviewed information into the document. I believe my peers thought the same about their projects" (Excerpt 41).

2. "The wikibook project let us produce our own learning product. And this product can be added and revised in the future. I like it" (Excerpt 42).

1. "Although I really enjoyed working with a partner in wikis, my schedule is very random at some times, and it is easier for me to work on my projects at my own pace because there are some days when I can sit down and have my project done, while my partner may or may not be on the same page as me" (Excerpt 39).

2. "I am concerned someone will read it and think that it does not make sense" Excerpt 40).

1. "I understand and like the idea of working on team projects. The reality is it is time-consuming and sometimes not working. So I prefer the traditional way of teaching, which is often led by the instructor" (Excerpt 43).

2. "What complicated the process for me was the fact that is was going to be considered a 'working textbook.' It is intimidating to offer my work up for criticism (even constructive criticism)" (Excerpt 44).
they knew their team members’ working styles, reaction to interdependence, and attitudes on territorial limits. They experienced a crisis of relationship. In this phase, communication was improved, collaborative writing in wiki was visible, and collaborative learning emerged.

In the third phase, once trust and rapport were established within the student teams, the frequency of communication and co-writing increased. Positive interdependence occurred rapidly as students experienced a resolution of crisis. At this phase, they positively viewed writing in wikis as pair-share, peer-teaching, and peer-collaboration, which aligns with the promise that wikis hold for enhancing collaborative learning. Table 3 summarizes the evolving phases of using wiki in this study.

In summary, students’ communication and writing changed over the life of the course in which four wiki articles were required. The idealistic hypothesis that wiki work is naturally beneficial and contributes to collaborative learning did not occur. Instead, students worked through the crisis of authority and relationship, to resolution through negotiation. Such changes were influenced by their estimation of territorial boundaries and interpersonal interactions while working in small teams.

The Wikibook Project in a Networked Environment

When we examined students’ experiences in wikibook to see whether they benefited collaborative learning in a networked environment (Jonassen, Peck, & Willson, 1998; Stahl, 2005, 2006; Suthers, 2006), we found that the majority of the participants in our study had positive experiences, as illustrated in Table 2. At the same time, we also examined the challenges experienced by students in order to see whether students naturally took the networked opportunity in Wikis. Since 100% of the students in the study were first time wiki users, most struggled with the technology and the concept of open editing. The use of repetition

<table>
<thead>
<tr>
<th>Phases</th>
<th>Crisis of authority</th>
<th>Crisis of relationship</th>
<th>Resolution of crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactions</td>
<td>Lack of communication; anxiety of territorial limits</td>
<td>Improved communication; adjusting to different working styles</td>
<td>Trust and rapport were established; co-writing increased greatly</td>
</tr>
<tr>
<td>Use of Wiki</td>
<td>Cut and paste work from MS Word to wiki</td>
<td>Started to use wiki to communicate and work</td>
<td>Felt comfortable writing and editing in wiki</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Little; adjustment was dominant</td>
<td>Collaboration emerged</td>
<td>Pair-share, peer-teaching, peer-collaboration</td>
</tr>
</tbody>
</table>

Table 3. Three Phases of Using Wikis
(requiring at least three articles) resulted in greater comfort in using the technology as well as negotiating with teammates to write collaboratively. Once students overcame the dual crises of authority and negotiation, students reported that they enjoyed the assignment as meaningful and they experienced pride knowing that their original work would be reused outside of the confines of a university course and would be available for others. A sense of becoming a “teaching apprentice” was experienced by the authors of the wiki articles as they collaboratively constructed new knowledge and presented it on the wiki. Several months after the course was over the instructor received an e-mail about an error in one of the wiki articles, indicating that the student used the wrong gender when citing an author. This e-mail was forwarded to the student who created the article as evidence that their content was being used by others. Holmes’ theory of communal constructivism remains unchallenged by this study but not without design and implementation considerations as discussed in the next section.

**Design and Implementation Implications**

Wikis is a new computer-mediated communication tool that holds much promise and many challenges for collaborative writing projects in the educational setting. We found that our students experienced a learning curve which included technical operation of the software as well as knowing how to truly write collaboratively (Brandon & Hollingshead, 1999). Our students were anxious and uncertain about editing others’ writing initially, and required a paradigm shift to overcome a crisis of authority.

Consistent with the literature on using wikis (McKay & Headley, 2007; Qian, 2007), we suggest that the instructors design a practice article at the beginning of the course to teach students how to use the software and to encourage re-writing others’ text. A practice article will not only allow students to become familiar with wiki functionality, but will model the practice of interacting with peers on the wiki. Instructors are also encouraged to model collaborative writing to prompt students’ critical thinking and decision-making skills (Engstrom & Jewett, 2005). It is also recommended that instructors encourage students to use not only formal communication methods (e.g., class discussions), but also informal communication modes (e.g., discussion board in wiki, e-mails, phones, chat rooms) to collaborate. The informal communication was more student-driven, primarily task-focused, and occurred voluntarily; therefore, it helped students to brainstorm and make decisions for their projects (Han & Hill, 2007).

Repeated wiki article assignments were also necessary to obtain the benefits of collaborative writing in wiki. In this study, the benefits of using wiki as a collaborative writing tool were not realized until the third or fourth article assignment. During the repeated process, instructors should monitor and provide timely feedback to students on group well-being, parameters of participation, and interaction, as these factors are extremely important to foster collaborative behavior.
and knowledge building (Moallem, 2003; Shell, Husman, Turner, Cliffel, Nath, & Sweany, 2005; Zumbach, Reimann, & Koch, 2006).

As more educators explore and adopt the use of wikis, we hope that this study lays the groundwork for further study on team editing behavior and building a networked environment in wikis. As Perkins (1985), a pioneering thinker about computers as learning tools, concluded, the importance of innovative technologies is not “what you can do that you could not before.” Rather, the important question to ask is, “What difference will computers really make to learning?” (p. 11). In line with Perkins’ statement, this study was aspired to explore what wikis can really make to the process of collaborative learning in a networked environment.

REFERENCES


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