COLLABORATIVE KNOWLEDGE-BUILDING: A LONGITUDINAL STUDY

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ABSTRACT

The focus of this paper is on knowledge-building in a technology-supported learning environment in higher education through a longitudinal study of a graduate course from 2003 to 2007. The primary question is: how do learning conditions designed into a graduate course contribute to collaborative knowledge building? In particular, two major issues -- theory acquisition and the ethics related to technology -- are explored. The result indicates that the blended learning approach has proved to be particularly helpful in enhancing students' learning of more abstract ideas such as theory and philosophy. In addition, a holistic design of the course and its assignment has fostered collaborative knowledge building. Two special concerns are identified. First, students' group work needs to be flexible enough in order to promote learning and motivation. Second, appropriate integration of threaded discussion should consider the amount of work involved.

Keywords: Collaborative Knowledge Building, Technology, Longitudinal Study, Graduate Course.

INTRODUCTION

The research study Constructivism is the philosophy that has been cited most frequently in the past 20 years in education. It has been argued that a constructivist philosophy of education offers a means of education that results in knowledge generation, and is therefore superior to traditional views or other views of education. Making the shift toward a constructivist philosophy, however, requires a fundamental change in which we need to consider knowledge-building communities rather than isolated classrooms (Scardamalia &and Bereiter, 2003). The focus of knowledge-building communities is on developing a collective knowledge base and enhancing learners' problem-solving skills.

Increasing attention has been given to the way technology can be used to support and facilitate collaborative knowledge-building. Technology is no longer perceived as hardware and software; rather, it includes instructional strategies and teacher-student interactions. It has been argued that appropriate technology "should be particularly effective in supporting knowledge-building learning communities" (Gilbert &and Driscoll, 2002, p.61), because it can extend learners' cognitive functioning and enable learners to build personal interpretations (D. H. Jonassen, 2000), and support, guide and extend the thinking process (Hannafin &and Hill, 2002; Li, 2005).

To date, technology-supported knowledge-building has been investigated in various forms but most of the studies are focused on school-students. Few studies have been conducted in the context of higher education (Gilbert and Driscoll 2002; Fischer, Rohde, & Woulf, et al. 2007; Gilbert & Driscoll, 2002). Within these limited offerings, even less are long-term studies that explore practical approaches to promote collaborative knowledge building.

This paper, therefore, focuses on knowledge building in a technology-supported learning environment in higher education through a longitudinal study. In particular, the primary question was: how did learning approaches designed into a graduate course contribute to collaborative knowledge building? That is, what effects, if any, did use of online discussions, collaborative groups, ownership & leadership in learning, and holistic design have on students' knowledge acquisition? Following, the author first outline the theoretical underpinnings of this

investigation and the learning strategies designed. Then she author examine the effectiveness of these learning approaches through a longitudinal study. Finally, she discuss implications and propose design guidelines.

Collaborative Knowledge-building

The key concept of knowledge-building communities is that knowledge is constructed as the collective goal of a learning community (Scardamalia, 2003). A critical principle to creating knowledge-building communities is that the learner-produced objects should become public materials that support the learning goals of the community and advance community knowledge, rather than as materials for grades to hand in (Lebow, Wager, Marks, & Gilbert, et al. 1996, June). In the last decade, interest has emerged in the way computers can facilitate the interaction of learners as well as the collective activity which is characterized by authentic, collaborative work (Pea, 2002). Highlights of the knowledge-building community included collaborative learning which focused on group projects instead of on lectures. Collaborative knowledge-building engages learners with the topic rather than leaving them on the outside as passive observers. The emphasis is on higher-order thinking and inquiry rather than rote memorization (Scardamalia, 2003). Knowledge-building, rather than knowledge replication or retrieval, is central and "knowledge in this environment is dynamic, and is changed and reconstructed over time" (Gilbert & Driscoll, 2002, p. 60). It has been argued that technology provides an effective means for implementing knowledge building strategies that would be difficult to accomplish in other media (Driscoll, 1994). Promoting discourse among community members and open access to shared information are two fundamental principles to support knowledge-building communities (Jonassen, 2006).

Perspectives

The study is grounded in theory from cognitive research (Bruer, 1993; McGilly, 1994), constructivist learning theory (Vygotsky, 1978; Young, 1997), and the development of new learning technologies (Scardamalia, et al., 1994).The study is grounded in theory from cognitive research (Bruer 1993; McGilly 1994), constructivist learning theory (Vygotsky 1978; Young 1997), and the development of new learning technologies (Scardamalia and Bereiter 1994). The focus is on constructivist learning environments with the notion that "a source of community coherence is the negotiation of a joint enterprise" (Wenger, 1998, p. 77).(Wenger 1998, p. 77). Before this course, the author had taught graduate students incorporating technology including online discussion for four years and the results always exceeded my expectations. Although she has learned that careful designed instructional approaches with consideration of the nature of technology are essential, her experience and previous research suggest that technology has a great potential to foster knowledge construction. Her passion and experience in technology led her to the wonderings and have conducted this study through a graduate course she taught yearly from 2003 to 2006. She wanted to explore several constructivist pedagogical strategies to facilitate a knowledge building community. For example, in reading student online discussions from her previous course, she found that the notion knowledge is constructed and advanced through social interaction (Kanuka & Anderson, 1998) is invaluable.(Kanuka and Anderson 1998) is invaluable. Combine this notion with the emphasis in constructivist learning environments on "collaboration, personal autonomy, generatively, active engagement, personal relevance, and pluralism" (Savery &and Duffy, 1995), she thought that integrating online discussion to facilitate communication could sustain knowledge generation. she expected that student collaborative group work would foster their social negotiation of meanings and provide multiple perspectives. Trying to support reflection on both content learned and learning process (Savery &and Duffy, 1995), she incorporated a holistic design of the course and the assignments. The author also believed that encouraging learners' ownership and foster authenticity may facilitate self-regulation (Duffy &and Cunningham, 1996) and motivation, and ultimately the development of a learning community (Savery & and Duffy, 1995). To accomplish this, she adapted an instructional strategy that required students to take a

leadership role by leading and facilitating their online discussions.

During the four years of teaching the course, she discovered much about collaborative knowledge building and pedagogy. She saw new aspects in usual topics such as the importance of authenticity of assignments. She also observed new issues emerging including workload of online work and anxiety with technology. The initial data and early experience had influenced her thoughts on what she was learning and the subsequent implementation of the approaches. These had resulted in her changed perceptions with evolved instructional practices and refined investigative techniques.

Method

This longitudinal case study explores collaborative knowledge-building communities through a graduate course offered every year from 2003 to 2007. "[C]ase study as a research strategy is preferred for investigating how and why questions regarding a contemporary phenomenon occurring in a real-life context. Once the case study's questions have been identified, the case is defined and sources of evidence from the case are determined that bear on the questions being asked" (Gilbert & and Driscoll, 2001).

Participants

Participants were 30 (21 females and 9 males) graduate students who enrolled in the graduate course. All students were either pursuing or wanted to pursue a graduate degree in educational technology. Twenty of them were working in educational settings (kindergarten to college), six in industry or military, and other four were full time graduate students. The students had diverse educational backgrounds: some technology experts who took this course as their final course for their master's program; others with no technology background who took it as an introductory to educational technology.

Learning Environment

The course was a mandatory course offered annually to all master students in educational technology program. The purposes of this course included introducing students to the goals, methods, trends, issues, and theory base of educational technology. Four learning approaches were designed into the course, each with a specific function based on research on collaborative knowledge building.

Using threaded discussion to facilitate communication for sustained knowledge generation

Throughout the course, the class was engaged in online discussion using WebCT ®. The students were required to read weekly textbook assignments and to contribute at least two messages to the online discussion per week, although the students often posted more messages than required. They were also required to read all the messages. The focus of the reading responses was to promote knowledge construction rather than knowledge replication; hence the reading response was required to be reflections, insights, thoughtful questions to the readings and its relationship with the real world. The incorporation of WebCT was not intended to replace either instructor-led or small-group discussions; rather, it was used to "complement these in ways that further promoted knowledge-building" (Scardamalia &and Bereiter, 1999, p.279). Further, students published all of their assignments, projects, and relevant materials online so they became public material supporting the learning goals of the community and each individual.

Taking leadership role to encourage ownership, responsibility, and authenticity in learning

To support more meaningful discussion and promote higher-order thinking, the online discussion was structured with weekly group leaders. Students took turns to be the online discussion leaders. Each week, one or two students were assigned as leaders. They posted initial questions based on their reactions to the weekly readings at the beginning of the week to jump-start the class discussion. During the week, the leaders facilitated and stimulated the discussion and dialogues online. The leaders finished the week by providing a detailed summary of the discussion. Students had the freedom to either respond to another's message and continue the discussion, or to start a new thread on other topics such as their own reflection on designated reading assignments.

Employing collaborative group work to promote social negotiation and multiple perspectives

The major project in the course was collaborative group work that involved planning, developing, delivering and evaluating an integrated unit of study related to an educational technology topic. Each group was required to first create a project proposal which outlined the goals, selected topic, related readings, objectives, intended strategies and technology integration. These proposals were published on WebCT and students were encouraged to provide feedback to each other. Building on the feedback, each group would then collaboratively complete their unit of study.

Holistic design to promote systematic learning and multiple presentation of knowledge

To tie all the components together, the final project was a 3-minute iMovie related to the whole process of learning including the plan, development, and delivery of the unit. Broad parameters were intentionally set out for the iMovie project so that students would have freedom to explore. The students also had the flexibility to choose the topic they preferred in order to encourage students to take more ownership. Basically, the movie could be an analysis, evaluation or reflection of the process of the development and delivery of the instructional units. Or there could be topics related to the issues we had learned during the course. In short, they were expected to develop ways to apply their newly acquired knowledge to assess their learning process through 3 examples of good/bad pedagogical strategies with technology integration.

Data Collection

The four learning approaches were incorporated into the design of the course before it started. Various data sources were collected for this exploration. The first data source was the whole corpus of the transcription of the online discussions. The second data source was authors' reflective journal recording, her actions and reflections on activities, administration issues, and the structure in general. This journal included lesson plans and summaries of a wide range of issues that arose from week to week. The third data source was the students' units of instruction and iMovies. The final data source was the anonymous course evaluation conducted by the university at the end of each term, which provided important information for the revision of her subsequent offerings. The focus of analysis, however, was on the first three data sources because they provided main evidences of how knowledge was constructed and changed.

Data Analysis

All the data were analyzed and summarized, with emergent themes identified. First, electronic files were created for all the data sources. Then the data relating to each source were aggregated, summarized, and in some cases, coded. For example, a profile was created for each student containing the summary information from the autobiography, confidential report, and final course reflection. Instructional units and iMovies were summarized as well as examined using the rubrics by learning group, with a focus on identifying the salient themes, patterns, or gaps in connection with students' confidential reports and final reflections.

The threaded discussion was designed to promote knowledge construction and higher-order thinking. It was expected students would provide reflection, critique, and analysis of their experience based on their readings. Further, it was anticipated that students would build on others' messages when they constructed their own responses. Thus, data from this source "pertaining to students' reflection on what they read, their referencing other resources, and evidence of high-order thinking" (Gilbert &and Driscoll, 2001). This has a good match with categories developed in previous research by Gilbert & Driscoll (2001). Hence, categories, codes, and definitions presented in their research were employed for the coding and analysis of all messages (details in Appendix).

To check reliability of coding, the researcher first coded all the messages using the coding scheme. These messages were grouped into each category. Then 60 messages which were representative of all messages were randomly chosen from each category. A graduate student was asked to code them. There was almost complete agreement (only one exception) between the two. The

discrepancy was discussed until an agreement was reached. Similar procedures were conducted for the coding of other data sources.

Previous research (Miles &and Huberman, 1994) suggests that several techniques need to be employed to insure reliability and accuracy of qualitative data. These techniques included data triangulation, collecting data from extreme cases explicitly looking for negative evidence; and reliability checking. Hence, in this study, cases that reflect the two extremes those who were very successful and who were unsuccessful were analyzed in-depth to provide unique perspectives on the course. Student messages, assignments, actual excerpts of their comments, and her perceptions are provided to explain and rationalize the findings.

Results

This section discusses the effectiveness of the learning conditions and how they supported knowledge building community in terms of the learning conditions designed into the course. This organizational structure was chosen because of the focus of the paper on how the learning approaches worked. It is worth noting that even though the guiding framework for the presentation of the research was the learning approaches, the findings reflected synergistic effects that are impossible to attribute to any single learning condition. The paper closes with brief discussions of implications.

Provoking Sustained Knowledge Building via Discourse

Discourse is key to the collaborative knowledge building (M. Scardamalia &and Bereiter, 1994). As indicated in previous research, even though free-wheeling classroom discussion usually generates a lot of good ideas and questions, these ideas and questions are often abandoned for reasons such as time constraints (Scardamalia & and Bereiter, 1999). Hence, threaded discussion was incorporated in the course as a space for students to develop ideas and questions, so that they were always available for people to discuss.

The students read and write personal reactions to the readings individually. To avoid repetition on reading reactions (i.e. key ideas usually appeared at the first 3 messages), students did not published these online. Rather, group leaders raised questions concerning critical issues, key topics, and controversial ideas based on readings for further discussion online.

Although the nature of CMC can "support reflection and other forms of higher-order thinking" (Hannafin, et al., p. 129),(Hannafin, Land et al. 1999, p. 129), it would be naïve to think that technology itself could lead to reflection, collaboration or higher-order thinking. A careless structure and the lack of detailed guidance could result in a collection of messages with little substance. Therefore, the importance of the content of a message was emphasized at the outset. Examples of both extremes one exceptionally good message with in-depth discussion and a superficial message were provided. Student feedback indicated that these examples were instrumental.

In the final reflections and final course evaluation, many students valued threaded discussion for it provided the opportunities to 'value others' opinions', such as "feel interaction with others gives [her] better understanding of various concepts (Student 3)". All but one student indicated that the discussions both online and face-to-face were the aspects of this course that were most beneficial to them.

The analysis of the messages further supported this. Almost every week, there were good discussions related to learning and students' personal experiences. A substantial number of messages had references to the others' work. No matter who raised concerns or questions, there were always people to provide support and suggestions. The following case of learning theory offered a glimpse on how the online discussion fostered collaborative knowledge building.

Theory or practice, how can I make sense…

At the beginning of the semester, educational philosophy and learning theories were introduced. Some activities were incorporated in face-to-face meetings to help students comprehend the rather abstract theories. One strategy was to try to bring the outside world into the classroom. Attempting to link abstract theories to real life,

students' misconceptions about constructivism surfaced. They struggled with questions such as how to use the theories in practice; and how the theories were beneficial to their job. Naturally, the threaded discussion became a very useful medium to further the learning process and it served as an extension of the classroom.

One such issue arose during in class discussions was about the anti-technology sentiments of many teachers in schools. Due to the limited time available, it was impossible to discuss this in detail in class. That night, the leader posted provocative questions that sparked a lively debate, extending in the class discussion. Everyone presented his/her ideas about the learning theories, and almost every learning theory was analyzed, examined and articulated to convince others. Students laid out a full spectrum of learning approaches using technology which would work for different teachers. It provided further opportunities for students to critically examine learning theories in the context of their own practice and daily life. One student shared her experience:

- *"Last year, a school-wide technology instructional vision was introduced…there was reluctance and some anti-tech sentiment evident from the on-set. Therefore, a plan was put in place to support teachers …Training and support was provided by in school and system specialists, in non-threatening learning environments. Flexible scheduling and substitute release time was provided…The more they were exposed to new technology, the more confident they were in using it with their students. Knowles introduced the Adult Learning Theory … The adult learners described above required time, training, support and they needed to see the applications for new learning. Their "fears" and "anxieties" needed to be treated with respect… when these issueissues were addressed, the resulting successful outcomes were teachers seeing the benefits of using technology with their students for teaching and learning" (Student 1).*

Putting theories into context allowed the students to reflect upon their instructional practices which, in turn, enabled them to internalize theories. This process enabled them to consider practical problems from different perspectives, which helped them to develop and refine goals and strategies. Verbalizing thoughts online also allowed them to understand theories more concretely.

In studying different educational philosophy and learning theory, it was natural for students to just apose these varied views. This led to a focused discussion on a very important issue: which is better, student-centered or learner-centered education? This resulted in another very interesting question: who should be in control of the tool (technology) --- learner or teacher? Some argued that teachers should control the tool because teachers are expected to use technology effectively in their teaching practice and guide students' learning. Others believed that the learners should control the tool because the ultimate goal of using technology is to improving students' learning. This online dialogue led the author to modify the in-class lesson by posing this question: "Is technology a tool for teaching, or a tool for learning, or both? What are the implications if you believe one or the other?" and drew a diagram (Figure 1).

A hot debate was conducted in class and the students were fully engaged in the discussion. Newly learned theories, previous experiences and personal beliefs were all extensively explored to formulate arguments in an attempt to persuade others. In this case, opportunities were created to trigger students' own thinking rather than the instructor's presentation of the sacred truths (Von Glasersfeld, 2000). The debate forced students to verbalize their thoughts and their understanding of the newly learned material. This process of verbalization inevitably required students to examine and reflect upon what was learned as well as their prior knowledge. The debate guided students' attention to conflicting theories

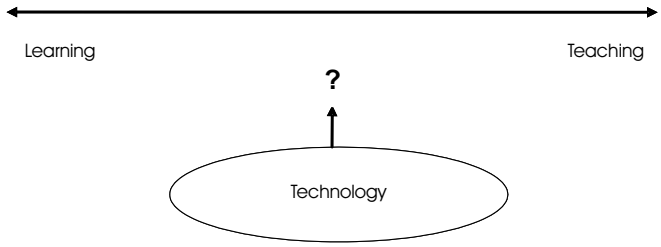

Figure 1. Original Model Teaching, Learning, and Technology

and increased the likelihood of bringing to the surface inconsistencies, gaps and misconceptions. These conflicts, inconsistencies, gaps and misconceptions, hence, were recognized, challenged, modified, corrected and reconstructed. This process engaged students in self-monitoring contradictory thoughts and constructing new knowledge, and therefore built coherent understanding of the learning. The recognition of these misconceptions also sparked further exploration after the face-to-face debate.

That week in the online discussion, messages flew back and forth, further exploring ideas and sharing insights. Students discussed confusions, compared multiple view points and reflected on both their individual and shared understanding of the theories and problems they encountered. For instance, a student posted the following message, questioning the problem itself:

- *"I wonder if the argument over technology being primarily learner vs. teacher centered isn't somewhat moot. Aren't we all learners? At my school we have recently adopted the learning community approach to organizing school life…Technology offers us a perfect opportunity to show our students that we are willing to take risks and learn something new. When my kids see me flailing around with new technology it's very clear to them that I'm on a steep learning curve. But they also see persistence and resolution (and occasional frustration) and hopefully the exhilaration of mastering something new and moving on… As we embrace change as enthusiastic learners, our kids learn it is possible to tackle new situations and to learn at any stage of life" (Student 2).*

It was evident from this question that the students' learning and their understanding of the theories had reached a much higher level. The threaded discussion before the face-to-face session had not only influenced students' perceptions of the materials being learned, but also affected the decisions considered by the author. The modified instructional activity (built on the online discussion) provided opportunities for students to further construct and reconstruct their knowledge. The follow up online dialogue led to an interesting exercise: to modify the original model presented in class. The students reached a consensus. In essence, everyone is a learner. Instead of presenting the teacher, learner and technology as a linear relationship, they saw that the relationship needed to be cyclic. In other words, they believed that the following diagram was a more appropriate presentation of the relationship, although they also realized that the relationships were dynamic, multidirectional and permeable and hence could not be adequately demonstrated by any two dimensional, static Figure (Figure 2).

This activity, the discussion and the exercise created an atmosphere in which students freely expressed their ideas. They openly identified their problems, discussed possible solutions, and participated in various learning activities. Their ideas were supported and nurtured by their colleagues and myself. The online discussion as well as the instructional activities based on the online discussion allowed individual students to: compare their own ideas with others, build their awareness, negotiate multiple perspectives, think carefully and critically about practice, connect both knowledge and experience; and extend the power of both. This resulted in enhanced understanding of theory and their relationship with practice. As indicated in the final course evaluation, students felt that "*interaction with others gives better understanding of various concepts*" (Student 3). The online and face-to-face activities offered different but complementary learning elements to support

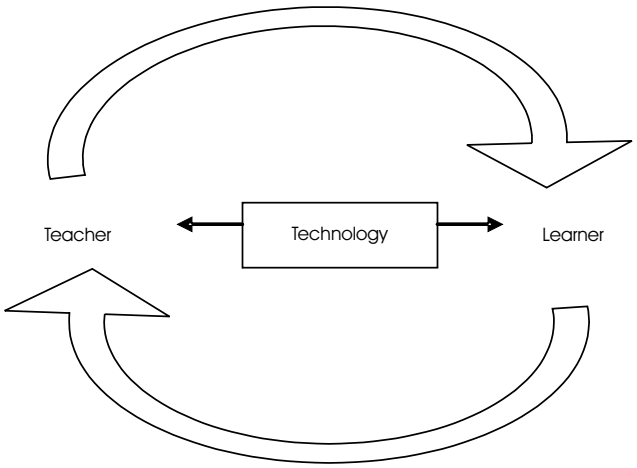

Figure 2 Revised Model of Teaching, Learning, and Technology

collaborative knowledge building.

- *"The use of Web CT as a supplement to the course was very valuable. The discussions were really interesting and thought-provoking. I thought the use of the WebCT really helped to "gel" the class and change us from a classroom of learners to a community of learners" (Student 4).*

It was evident that the high quality of this discussion added new perspectives, explanations, elaborations, critical analysis, and "solutions to the accumulating knowledge base showing evidence of the expertise of the community" (Gilbert & Driscoll, 2002, p. 74). Learning was fostered around student perceptions of what they were learning rather than the instructor's interpretation and, hence, knowledge construction was promoted. The events which evolved from this learning of theory indicated an important characteristic of the knowledge-building community " a circular growth of knowledge, wherein discussion among the community about what individuals have learned leads individuals to seek out further knowledge that they then share with the community" (Bielaczyc &and Collins, 1999, p.6).

Leadership & Ownership in Learning

Students in this course were required to read scholarly research, and respond to questions raised by the group leaders. By leading and facilitating these discussions, group leaders had to generate thought-provoking questions and to facilitate lively discussions. All students had to critically evaluate other's opinions, to reflect upon and defend their positions, and to elaborate, construct information to provide different perspectives. The explanation, elaboration, and defending of opinions to others enhanced students understanding (Brown &and Campione, 1990).

The quality of threaded discussion messages revealed that knowledge construction was evidenced for all students in the class. That is, every student had contributed messages that had been coded in at least one of the 3 categories. Most of the message fell into all 3 categories. The new perspectives, elaborations, and solutions provided in the messages added to the accumulating knowledge base which demonstrated the collaborative knowledge building efforts.

The strategy of students' taking turns to be group leaders was designed to promote ownership, leadership, authenticity, and higher-order thinking. The students were empowered to take more personal responsibility for their own learning. It also made the reading and responding tasks more authentic because the learning questions were coming from themselves so the key issues were evolving from their own practice and were related to their concerns. The authenticity of the tasks led to high levels of motivation which resulted in high levels of productivity (Keller, 1987). In addition, students were able to exercise leadership roles. This assignment also engaged students in higher-order thinking process such as synthesis and critical analysis which ultimately led to knowledge generation. The analysis of group leaders' messages revealed that all of them fell into at least one out of the three categories. The questions were all authentic, required students to exercise cognitive and higher-order thinking skills such as critical thinking, analyzing, generating, evaluating and integrating skills. Those facilitating messages indicated that the leaders were all required to think critically, respond thoughtfully, and embrace diverse positions. The summary messages provided students not only synthesis of what was presented and discussed over the week, but also new perspectives and positions raised above from these discussions.

One approach designed in the course to encourage student mutual engagement in learning was asking students to publish their proposals online and inviting them to critique on each others' work. A shared repertoire in the online discussion was created to support this collaborative effort. Despite the my encouragement and the creation of the shared repertoire, students did not seem to be engaged into mutual learning in this task. Only two students provided a "pat-on-the-back" sort of remarks with limited substances on others' proposals. Teaching the course the next time, the author integrated this process into the assignments with appropriate assessments. Each student was assigned to focus on 3 other students' project

proposals by providing in-depth feedback. Students were much more engaged through their critical examination and careful consideration of other people's ideas and multiple perspectives. Focusing on 3 particular projects, each student applied the newly learned design principles and learning theories. The sustained knowledge building was reflected not only in the mandatory proposal feedback, but more importantly, in their remarks to the final products something not required by the course.

Encourage Multiple Perspectives via Collaborative Work

The course started with students sharing their autobiographies online. This played several important roles: first and foremost, they served as an excellent introduction that allowed students to get to know each other. In addition, by reading each other's biography, students not only learned some history of educational technology, but also developed a more global perspective on technology through their international colleagues. They valued each person's experience and started to establish a rapport with each other. We shared the same jokes and stories; hence we shared a bond that was unique to our class. That bond made the class more of a learning community than a group of students.

Second, the biographies served as a wonderful means to assist student collaborative works. It allowed students to find partners who shared the same interests. Some of their collaborations went beyond this course and extended to their classroom teaching. Third, writing a learning biography stimulated students to reflect on their personal experience with educational technology. The writing process helped them to focus on their learning style as well as think about what succeeded and what failed. In addition, the writing process enabled them to take more responsibility for what went on in class. By writing their autobiography, unconscious events from their past that were influencing their attitudes began to surface. Their discussion of its impact on their attitudes toward technology, and most importantly their interpretation of how these events had influenced them, further enhanced their understanding of educational technology.

One approach to promote collaboration and authenticity of learning was establishing assessment tools with students, in this case rubrics for iMovies. When the rubric adapted at the beginning of the course, students did not show any unhappiness even though the author deliberately invited students for suggestions, comments, and feedback. The analysis of student final course evaluation indicated that everyone except one thought the assessment was fair: *"I know exactly what was expected and how marking was to go from the outset. Much appreciated*." However, towards the end of the course, two groups started to have trouble to collaborate (details in the following section "holistic design") and problems surfaced. In the final course evaluation, one indicated that the assessment was unfair. The student commented that the grading system was *"very strange. The students grade each other--bizarre!"* This suggested that incorporating collaborative effort into student evaluation do not necessarily guarantee the promotion of collaboration. In some cases, it might cause students anxiety if collaborative work was unsuccessful.

In general, the learning community appeared to be supported thought the collaborative work, especially the instructional unit project. This was demonstrated through the quality of instructional units created with all the components listed on rubrics included and articulated.

For example, Will's group decided to tackle the clone issue because they wanted to probe "not only the technology" but, more importantly, the ethics of technology. Their unit of instruction concerned cloning with an attempt to help students to understand the nature, history, methods of cloning, as well as enable them to take an informed stand and present their viewpoint in professional ways. Although the focus was on the ethics of using technology, various technology tools were seamlessly blended into every aspect of the unit. It was used to provide information, to foster motivation, to set learning tasks and to present learning outcomes. In this unit, cloning was introduced by an episode in a science fiction movie Gattaca "which depicts the near future where a person's genes are programmed at birth to determine how their lives will pan out" (group instructional unit). The movie provided not only the concepts needed

to understand cloning, but also raised questions regarding this controversial issue. The information sites were purposefully listed without bias for or against cloning. The intention was that students should be given the opportunity to form their own values, based on the information available to them. Clear strategies were given to teachers emphasizing that students needed to be challenged. Students were encouraged to think critically and learn constructively.

To accommodate different learning styles and the conditions in real classrooms, the central idea of the unit was presented in three formats: (i) multimedia presentation (including movie and interactive PowerPoint) with web resources; (ii) WebQuest; and (iii) the basic word processing tool, with appropriate tasks designed. Sample tasks ranged from creating a 30-second iMovie for a TV commercial to inform the general public of the students' stance on cloning, to writing an essay using MS Word. Regardless of the technology, the idea was clearly conveyed and the content was presented in creative and interesting forms. Various learning theories such as Gardner's multiple intelligence theory were carefully crafted in the instructional unit.

Fostering Systemic Learning through Holistic design

The final project for the course was creating iMovies with 3 purposes: (i) students could think systematically and holistically. They would have greater opportunity to reflect upon their learning process and engage in self-reflection and self-explanation activities. According to Jonassen (1999),(Jonassen 1999), reflection, or "standing outside yourself and analyzing your performance, is essential to learning. Requiring learners to articulate what they are doing,…the reasons for their actions, and to explain the strategies they use, supports knowledge construction" (p. 231). (ii) it would promote students' self-assessment using this media-rich tool; and (iii) students would be immersed in a technology-rich experience and exposed alternative representation methods.

Students' final reflections highlighted the value of the holistic design of the course which was evidenced in the iMovie project. They appreciated the assignments that provided opportunities and even forced them to reflect upon their learning experiences. They indicated that they needed "higher order thinking skills," and have to "plan, organize, and collaborate" (student final reflection) in this process. Although new ideas were constantly evolving, different cognitive and meta-cognitive skills were required and integrated into the development of the projects. Students had to think about the topics discussed, the instructional unit developed and delivered, and their colleagues' feedback. They needed to plan ahead of time to design and document their learning process. They had to come up with interesting ideas; organize information and reflect upon their learning; critically analyze their instructional unit product and the delivery process in order to identify strengths and weaknesses; summarize, evaluate, and build on their previous experiences; and consolidate their understanding about theories and connect them to practice.

Students did not just sit there and passively accept what they were taught. They critiqued different theories; identified multiple perspectives; examined advantages and disadvantages; compared diverse, ever contradictory realities; analyzed and articulated their prior experiences; and integrated theoretical ideas and concerns. This process not only allowed students to experience quality learning, but also provided a good model of the appropriate integration of technology into practice. The students were exposed to a pervasive modeling of technology in context rather than in laboratory exercises. They indicated, in their final reflection, that they realized, through this design experience, that multimedia can be used effectively to apply learning theories, such as the multiple-intelligence theory.

This multimedia project demonstrated to our students that the process of designing and creating an iMovie can push students to exercise higher-order thinking skills, such as reflection, synthesizing and critical analyzing and, ultimately, knowledge construction. Students thought that iMovie could help learners because it "forces learners to screen their ideas for the most important concepts. Also draws focus into the process of presenting information"

(Leo). The joyfulness of completing the final product and watching the movies further motivated students. Almost everyone indicated that she really enjoyed watching the movies. They thought that the iMovie development experience was a "tremendously valuable experience."

Among the four groups, two demonstrated frustrations to collaborate toward the production of iMovies. Their written products, their presentations, and their confidential reports indicated that they were successful in collaboration for the production of "instructional units". Problems started to surface during the iMovie project. The first group had three people. Right after iMovies were finished, two members of the group approached me and expressed their frustration. They indicated that the third person in their group refused to continue to work with them for the iMovie production. Rather she wanted to just get it done and get over with it. The second group comprised two members only. The confidential report from one member delineated that though her group worked well in the instructional unit project, they started to suffer at the iMovie project. She attributed this difficulty in collaboration to the fact that she and her partner had different learning styles and approaches to the project. She thought that they worked together well on the first project because they adapted some strategies (such as split tasks) and compromised. But they really "run out of energy" when they got to iMovie project. She also thought because there were only two students in the group, more time was dealing with the dynamics of two individuals rather than a group. She suggested that at least 3 people are needed for small groups. Consequently, the final iMovies of these two groups were modest with mostly quick assembled clips of episode of their group presentations, only to fulfill the quantitative requirement (e. g. 3 minutes) of the project.

In contrast, the other two groups demonstrated high satisfaction regarding the collaborative process of the projects. The analysis of their final reflections and confidential reports also supported this. Their learning outcomes were high quality artifacts of knowledge building that captured their perspectives and understanding of newly acquired knowledge.

For example, Will's group created an iMovie to present their understanding of the three most relevant practices they had seen in schools, based on: behaviorism, discovery-based constructivism and constructivism, respectively. They wanted to demonstrate to the class what they had learned in this course and put it into the context of teaching.

Their movie was about a cloning unit they developed for the course and how it could be implemented in three different ways based on different philosophies. They vividly presented the approaches of three teachers. By dramatizing three typical learning environments, they demonstrated the differences between the theories as well as the implications associated with these beliefs. The movie was divided into three sections: (i) presentation of rationales for choosing cloning; (ii) demonstration of distinctive teaching methods based on behaviorism, discovery-based constructivism and constructivism; and (iii) reflection of the three teachers.

A humorous theme was used throughout the movie which made it very entertaining. The movie started as "21st century Sux" mimicking "20th century Fox." The credits were: "Starring: Mel Gibson as Will, Julia Roberts as Ann, and Danny Glover as Glen." In the final credits, there were all kinds of funny little morsels, such as "Gaffer - I don't even know what this is," "Casting by Jobs for Parolees Inc." "Soundtrack available on most street corners or where vagabonds clean your windscreen. If you say you know Bob they will sell you a bootleg copy on the sly."

The holistic approach helped students to internalize their understanding of theory, to theorize their practice, and to develop more complex knowledge representations. The iMovie provided rich alternative ways to help students present their viewpoints of learning theory in the context of cloning. Students were able to articulate their reasoning and the decision-making involved in their learning process because iMovie made their covert learning overt, and hence fostered knowledge construction.

Conclusion

The authors initial experience of implementing the instructional approaches have convinced her that the

technology enhanced collaborative work, holistic design, promotion of ownership and leadership in learning contribute significantly to the development of a collaborative knowledge building community. The process of teaching and observation of students' behaviors also changed my perceptions. At the beginning of the project, the author thought that all students would prefer to interact in face-to-face setting. The analysis of students' feedback showed that almost all students felt that online and in-class discussion complement each other. Few students, often the shy ones or the ESL students, even preferred the online format because they could be relaxed, less intimidated, and had time to contemplate.

- *Right now, I am listening to the radio, have a text open in front of me, am typing this message, and am stopping to doodle when my thoughts stop. I have your message open to refer back to and have two programs opening on my task bar. It's great! I feel motivated and focused in this environment. In the physical world this would not be a positive way for me to have a conversation. In fact, I often feel guilty when I'm at a meeting and start doodling. Without the "information overload" I find it hard to stay focused! Crazy isn't it????! [Student 5]*
- *I share my thoughts and feel no fear in experimenting with my thoughts and ideas online. But do I find it nearly as easy to express my thoughts in person, in a physical world no way!!! One reason is that I feel a certain security in the digital world which allows me to throw out my best and take risks that I might not in person. As a result, I do prefer to learn [online] socialized, but physically isolated [Student 6].*

Another perception the author had was that it would be difficult, if not impossible, to convey emotions and other feelings online, especially through texts only. The students' online interactions, however, told a different story. For example, a student posted a long message expressing her frustration in schools. Another student responded: "Wow! They say that it's difficult to express emotions in the online forum but I must say your enthusiasm and excitement jumped right out of my computer monitor." In fact, the student's post had drawn everyone's attention, which attracted the highest number of responses within 24 hours.

As the course evolve, the approaches of implementing those learning strategies also refined. For example, the first time the author taught the course, the final project assignment did not ask students to work for real clients. Analyzing students' work, she realized some students took it as superficial work and the results were not impressive. Since the second offering of the course, therefore, she asked students to do the projects with real clients, who might be professors in the university with research projects, their colleagues who wanted to improve their teaching practices, or their companies that wanted to develop new e-training programs. The changing of her instructional choices made the learning more authentic. The authenticity of the learning experience, in turn, enhanced students' motivation and empowered them for learning and practice. In short, students had a significantly heightened understanding of the content through the process of solving of real life problems. As exemplified by a student's comment: "I highly believe in these application projects. It helps ground all the ideas and theories into a relevant item. As well, it allows me to really understand each of them."

A concern that emerged in the first 2 offerings was the amount of work involved in online discussion. Login twice a week, read all messages, and contribute 2 per week on top of regular class seminar and assignments were considered a heavy load, for both students and herself. Yet, to sustain a meaningful dialog for knowledge generation, it was important to have students to revisit a topic and share their advanced thoughts. Students' final evaluation indicated that they had learned so much from each other, especially from the online discussions. Authors' previous experience also confirmed that" students are pragmatic; they will do what is required for them and is assessed" (Collis, Winnips, & Moonen, et al. 2000). In later offerings, therefore, she reduced the workload through extending the length of discussion period for a topic (e.g. discuss a topic for 2 weeks rather than 1 week). She also gave more weight of this

assignment to appropriately reflect the amount of work. This saved the students and her time without compromising the quality of discussions.

She also learned from this experience the usefulness of the data collected for the exploration of collaborative knowledge building process. In the early offerings, she included a mid term survey attempting to examine students' perceptions about online collaboration. The analysis of the data demonstrated that it offered limited insights into student knowledge building. Another data set from the original design was students' autobiography of technology. Whilst this exercise provides background information enhancing student collaboration, the data contributed little to our understanding of the students' knowledge building, hence was not included in the data analysis.

The results of this longitudinal study indicated that the integration of the learning approaches provoked knowledge building. The holistic design of the course and the assignments exercised students' higher-order thinking skills such as reflection, critical analysis and synthesis. The approaches used in this course supported knowledge representation and linked annotations, which helped learners to organize their ideas from multiple perspectives and internalize them with personal knowledge. The students' learning process and products presented in this paper indicated a rich knowledge-building experience. Some issues, however, still need to be considered. One issue is that although many students enjoyed working in groups and the holistic design of the iMovie helped systematic learning, some were unsuccessful. One recommendation is that a holistic design is valuable for the whole course, but group work should be flexible enough to allow students to change partners from project to project. A balanced approach is both possible and beneficial, based on insights from this study, and is important in the creation of knowledge-building communities.

Implication for design

The results of this study indicated that the learning approaches designed in the course did support knowledge building but failed to some extent to promote collaborative knowledge-building discourse at the community level. This experience suggests useful information to others who are interested in designing this kind of learning environments. Following is a list of designing guidelines that the author learned from this study, incorporated with results of previous research (Gilbert &and Driscoll, 2001).

Create a sense of connectedness

Design activates to promote a sense of connectedness from the beginning of the course seem to support the establishment of a knowledge-building community. For example, asking students to share their learning biographies and interest proved to be effective to introduce them to learn from and each other.

Promote a shared vision

It is important to create and promote a shared vision and across group collaboration by designing proper learning activities and assignments. Negotiating a common learning goal can be used as a tool to promote this vision. In this study, the subsequent offerings integrating designing the final project asking each group to take one aspect of a large goal may allow students to share a common vision and hence foster a collaborative learning community.

Holistic design

Holistic design of the course can promote reflection and consequently foster establishment of a learning community. This way, students can think and learn systematically and apply their knowledge to various situations. Concepts, knowledge, and the real world are no longer "boxed" into separate mental compartments and presented into separate chapters. Rather, they are an integrated whole that are interact with each other and knowledge is to be advanced, applied to different situations and contexts.

Promote leadership and ownership

Asking students to be leaders help students to exercise higher order thinking and making learning more incentive and authentic. It fosters students' autonomy and freedom, hence facilitate the development of a knowledge

building community. This study also demonstrates that students can and enjoy taking the leadership role.

Foster collaboration

Try various strategies to foster collaboration amongst students is an important and vital aspect to establish a knowledge-building community. Group work is an effective way to facilitate collaboration, but the group needs to be flexible enough to allow students changing groups as suggested in this study.

Balance workload to reduce anxiety

Workload needs to be considered carefully to reflect student work and provide productive discomfort leading to knowledge construction rather than creating anxiety. In the second and third offerings of the course, the author used 2 weeks cycle rather than one week cycle for online discussions. Students were quite satisfied with both the depth of online interaction and the workload requirement associated.

Tracking the process

Using self report to tract students learning process and collaborative effects can be very useful. This information can provide guidelines for appropriate intervention. For instance, in this study, had the author known earlier about the 2 groups who had trouble with collaboration, the author could intervene by either change the group members or adapting other strategies.

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Appendix:
Reading Reaction Categories, Codes, and Definitions
(Gilbert and Driscoll, 2001)

Reflection Category:
Surface Reflection – ties into personal experience (relevancy) without offering any new perspective
Deep Reflection – ties newly acquired information from the readings into previous experience and restructures based on individual perspective
Referencing Category:
Reference Participant – references another participant (recognizes value of the work of the community)
Reference Author – references another author and adds another perspective
Reference Course – references course goals or structure (recognizes value and relevancy of course goals or structure)
Reference Course Plus – references course goals or structure and adds another perspective
Higher-Order-Thinking Category
Knowledge Synthesis – combines ideas together from the readings and restructures new information to provide a different perspective
Critical Analysis – critically analyze author, article, or participant; agrees or disagrees and provides rationale, identifies knowledge gap, offers suggestion, opinion, or new approach to the problem.