THE EFFECT OF SUPPORT TOOLS ON STUDENT KNOWLEDGE BUILDING IN A VIRTUAL UNIVERISTY COURSE: SUMMARIZATION, EXPLANATION, AND PLANNING/MONITORING PROMPTS

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ABSTRACT

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The purpose of the study was to investigate how support tools facilitated active knowledge building processes, primarily convergent knowledge building in a WWW-based virtual university engineering course. Support tools are prompts, which were developed to incite students to summarize and identify the main ideas of a lecture, explain concepts, and plan/monitor their own learning processes.

This study used a quasi-experimental design. The research site was an undergraduate engineering class of a virtual university and the students were randomly assigned to two different environments: 1) one without support tools, and 2) the other with support tools. The virtual engineering course was "Introduction to the Internet" which taught students about broad aspects of the Internet. The study was specifically involved in the "Design of web pages" unit which ran for two weeks. In the unit, the students formed groups in order to discuss and write the strengths and weaknesses of two different university homepages and to make recommendations on how to improve one university's homepage.

The study analyzed the frequency and types of online discussion in order to understand student knowledge building processes, evaluated group reports in order to see

the extent of students' knowledge integration, and analyzed the self-reports to find out about students' satisfaction and convergent knowledge building experiences in taking the virtual university course.

The study's results indicate the use of support tools enhanced student performance in integrating concepts in report writing. Students in the treatment condition, who used the support tools and engaged in social interactions in the online virtual university course, integrated significantly higher numbers of concepts and ideas in their group report than students in the control group who simply engaged in social interaction. In addition, many students in the treatment group stated that the most valuable part of their learning experience was their convergent knowledge building experience whereas none of students in the control group reported a convergent type of learning experience.

These results appear to support the idea that the use of summarization, self-explanation and planning/monitoring prompts facilitates convergent knowledge building in a networked virtual university learning environment, thereby increasing students' knowledge integration.

Dedicated to my mother and my family
who always love and encourage me continuously.

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CHAPTER 1

INTRODUCTION TO THE STUDY

Problem Statement

The virtual university is an emerging type of networked distance education in higher education. The World Wide Web (WWW) and computer-mediated communications (CMC) such as email, computer conferencing, and chat have made it possible for students of a virtual university to communicate easily with their teachers and peers at a distance. These technologies provide avenues for interactions and multiple perspectives which are critical to effective learning because they facilitate students' knowledge construction (Hillman, Willis, & Gunawardena, 1994; Keegan,1990; Moore, 1989; Reeves & Reeves, 1997; Wagner, 1994).

In recent years, learning has been viewed as the process of knowledge construction mediated by social interaction and tool use (Vygotsky, 1962) rather than a reproduction of knowledge presented by the teacher. As a result of this change, the educational paradigm in some institutions has been shifting from classroom lectures to individual exploration, from individual work to team learning, from stable to fast-changing content (Reinhardt, 1992), and from exploration to construction (Salomon, 1995).

Exploration and construction represent divergent and convergent aspects, respectively, of knowledge building. On one hand, divergent knowledge building entails exploring and sharing of diverse ideas which can lead to convergent knowledge building.

On the other hand, convergent knowledge building involves linking ideas (Harasim, 1990), constructing explanations to close a knowledge gap (Chan, Burtis, & Bereiter, 1997), making connections among different ideas, and bringing ideas together (Hewitt, 1997).

In classroom or group discussion situations, students' exposure to many different ideas does not automatically lead them to new levels of understanding, construction of new concepts, or problem solving. Students learn new concepts or reach new understanding only if they engage in both divergent and convergent knowledge building activities. These knowledge building activities are facilitated by using self-explanation and self-monitoring strategies (Palincsar & Brown, 1984) and are enhanced by interacting with advanced learners (Vygotsky, 1962).

In distance education, a learning environment in which students and their teacher are physically separated, the learning paradigm shifts from self-study to group learning, and from a learning environment with no interaction to one in which interactive learning is present. The quantity and quality of interactions among students or between students and instructors affect learning. Moore (1989) even emphasized that "the learner to learner interaction is a new dimension of distance education that will be a challenge to our thinking and practice in the 1990s." In addition, a number of other researchers mentioned the significance of interactions in distance education (Devries & Wheeler, 1996; Zhang & Fulford, 1994). Students identified lack of interaction as one of the major causes of unsatisfactory learning experiences when they took a virtual course in 1997 (Hyemi, Personal communication, 1997 fall).

Problems may arise even when interactions do occur between students in distance learning. The types and qualities of interactions matter. Many students in a virtual university simply tend to post their ideas or read others' ideas without engaging in deep thinking processes, such as analyzing, evaluating, and synthesizing ideas. For instance, students often merely browse the WWW superficially and do not engage in thoughtful and active learning (Ritchie & Hoffman, 1997).

Moreover, in the fall of 1997, I investigated related issues pertaining to virtual university classroom (Chung, 1999). After analyzing the nature and patterns of communications, I observed that students did not actively participate in content-related online discussions. Most student communications centered around scheduling meeting times for group projects. In addition, even though students formed groups, and shared search results about their sub-topics, they simply put their individual writings together as part of the group report. They did not discuss lecture topics or conceptual issues about their projects. Neither did students argue about their ideas, try to make connections between different ideas, nor synthesize ideas into one.

In the same study, student interaction patterns indicated that students spent 50% of the interaction time in idea sharing, 40% in planning, and only 10% in convergent knowledge building processes. Most of the student interactions included dividing workload, deciding individual roles, and working on them, and submitting the collection of students' work as a group report. As a result of the lack of meaningful interaction, students did not often engage in explaining or evaluating concepts and bringing ideas together, which are key features of convergent knowledge building (Chung, 1999).

Students who rarely engage in convergent knowledge building in a virtual university environment are unable to complete their knowledge building process, construct new understandings, nor build new concepts. Researchers identified this lack of knowledge linking and structuring activities in the online learning environment (Chung, 1999; Harasim, 1990; Harasim, Calvert, & Groeneboer, 1997; Hewitt, 1997) as a problem in the networked learning environment. This problem can have a negative effect on both the students' efforts to synthesize ideas and group collaborative processes (Hewitt, 1997). Research findings indicate that the factors contributing to a lack of convergent knowledge building in a networked learning environment are: 1) lack of support tool such as concept map (Harasim, 1990; Harasim et al., 1997), and 2) lack of systematic support, which can facilitate easy access to other students' ideas and the display of relationships between different ideas (Hewitt, 1997).

To promote convergent knowledge building processes in a networked learning environment, researchers suggested 1) developing support tools such as concept maps (Harasim, 1990), 2) using linear message systems while rejecting threaded message systems, 3) appointing a leader or moderator for the group to make a centralized decision, and 4) developing a networked structured message (Hewitt, 1997). These suggestions, which are based on the system development approach, can be implemented as means of supporting software development (improvement).

However, instead of looking for the solutions through the system development approach, I believe it is worthwhile to seek for solutions by implementing the learning strategies to prompt learners to summarize, self-explain, and self-monitor.

Purpose

To address the lack of convergent knowledge building activities and the lack of support for convergent knowledge building in a networked learning environment, I developed support tools to facilitate convergent knowledge building activities. The support tools consisted of prompts to guide self-explanation and self-monitoring strategies. The rationale for selecting the various kinds of prompts is discussed later.

The purpose of this study was to characterize how support tools facilitate knowledge building, primarily convergent knowledge building in a WWW-based virtual learning environment. The study investigated how the support tools mediated the knowledge building of students in a virtual university course.

Specifically, the first objective of the study was to identify the kinds of interactions students engaged in with and without the support tools and to assess the effects of such interactions on students' knowledge integration. In extending past research on students' interactions in a networked learning environment (Harasim, 1990; Chung, 1999), I also examined how interaction patterns changed with the use of different support tools. Interactions were assessed based on students' written communications with other group members during the group project. It was hypothesized that students who used the support tools would engage in more convergent knowledge building activities than those who did not receive them. It was also predicted that students using the support tools would interact more than students who did not have the support tools.

The second objective was to assess the effect of students' support tool use on their performance. Thus far, research findings indicated how using learning strategies, such as

self-explanation, summarization, and planning/monitoring, fosters students' knowledge construction, and enhances comprehension of the lecture and performance. Students' performance was assessed based on their written recommendation submitted at the end of the group project.

The third objective was to explore how students evaluated the support tools and their interactions with peers. It was hypothesized that students would believe that the support tools and their interactions with peers were helpful in enhancing their understanding of the concepts involved.

Research Questions

The following questions were posed to guide the design of the study.

1. How do students using the tools to support their learning in an electronic learning environment differ from those who do not use these tools in the knowledge building processes?

   a) There will be different participation frequencies in online group discussion between students with the support tool and those without it. Students in the treatment group will interact more often than those in the control group.

   b) There will be different participation patterns (divergent vs. convergent) in online group discussion between students with the support tool and those without it. Students in the treatment group will participate more in convergent interaction than students in the control group.

2. How do students who use the tools differ in the ways they write recommendation and comparison reports from students without the support tools?

a) Students using tools to support their learning in an electronic learning environment build more integrated knowledge (i.e., number of ideas, concepts, examples, and new ideas) than students not using the support tools.

3. How do students using tools to support their learning in an electronic learning environment differ in their evaluation of their learning from students not using such tools?

a) Students who studied with the tools will report higher satisfaction with their group activities than those without the tools.

b) Students who use the support tools will report more convergent knowledge building experiences than those who do not use the tools.

Significance of studies

Few studies have been conducted on how students build their knowledge in a virtual university context, whereas many studies are available on face-to-face learning environments. In this study I intended to extend the present knowledge on virtual environments by exploring the issues on developing a virtual course from the perspectives of design and learning.

With regard to design issues, if the study's findings confirm that the selected support tools facilitate convergent knowledge building, this situation would indicate that use of such tools contribute in convergent knowledge building in a virtual university

course. In addition, this finding would clarify the design issues involved in using support tools to promote convergent knowledge building, and inform the design of future virtual learning environments for active learning, discussion, and instruction.

As for the learning perspectives, this study will contribute to understanding how selected support tools contribute to learning and knowledge building in a virtual university course. The research will contribute to a more theoretical account of convergent knowledge building through the use of cognitive support tools.

Organization of the Dissertation

Chapter 1 contains the introduction to the study. The problem was stated and the purpose of the study was explained. The research questions and hypotheses were set forth and the significance of the research was explained.

Chapter II contains a review of the studies, which provide theoretical background and context for the study. Chapter III includes a review of studies about design guidelines and design frameworks, and explanations on how I developed the virtual unit.

Chapter IV consists of descriptive aspects of the research methodology, which include the research design, setting of the study, selection and assignment of subjects, development of instruments and the intervention, data collection procedures, coding procedures, and test statistics used for the data analysis.

Chapter V contains the results of the investigation and the findings related to the research questions and hypotheses. Chapter VI consists of a summary of the study, a

discussion of the findings, conclusions drawn from the findings, implications, and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

This chapter contains a review of the literature on topics pertinent to the study. These topics include: 1) Knowledge building processes, 2) Virtual university learning environment, 3) Interaction and learning, and 4) Researches on interaction and learning.

Knowledge building Processes

This research views learning as a knowledge building process through the mediation of social interaction, tool use, and reflection. According to Harasim (1990), knowledge building consists of three processes: idea generating, idea linking, and idea structuring. Idea generating is a divergent thinking process (which includes conceptual activities, such as exploration, brainstorming, and idea sharing), whereas idea linking is a convergent thinking process (like associating related ideas). Idea structuring, which involves organizing new ideas into an existing or hierarchical knowledge structure, can be used for problem solving and used for writing a report or paper. Knowledge building is similar to knowledge integration (Linn & Elyon, 1996 cited by Davis, 1998) which refers to the process of expanding a repertoire of ideas, discriminating between ideas, and reorganizing the links among them.

However, learning does not proceed sequentially accordingly to the components of knowledge building processes; idea generation, idea linking, and idea structuring. A learning process is dynamic, recursive, and iterative (Chung, 1996). Students constantly define problems or the purposes of their learning, explore different information and ideas, evaluate their relevance, and accept or reject ideas to be used for one's purpose. During this dynamic process of learning, students' capabilities to plan and monitor their whole learning processes are crucial. A learner's mental activity to plan and control one's learning processes is called reflection, which is a trait of experts (Ertmer & Newby , 1996). Students who received explicit instruction about planning/monitoring and self-explanation strategies (Bielaczyc, Pirolli, & Brown, 1995) develop a higher understanding than those who received implicit instruction do.

As discussed earlier, knowledge building entails a learner to be mentally and socially engaged in order to make sense of an internal conceptual conflict in processes, such as identifying a problem, looking for plausible explanations, and seeking connections among different explanations. Convergent and divergent knowledge building processes are not competing concepts, but are a part of a continuum of knowledge building processes.

Divergent knowledge building which involves activities like exploring and sharing of different ideas, can lead to convergent knowledge building. Convergent knowledge building entails constructing explanations, making connections among different ideas, and bringing these ideas together. If students do not recognize a problem or the ways to deal with it, it would be hard for them to evaluate or make connections between different ideas; thus no convergent knowledge building can occur. On the other

hand, if students recognize the nature of a problem and utilize their reflection skills, they would be able to make connections between ideas and thus build new knowledge.

Students' awareness of weaknesses in their knowledge or of conceptual inconsistencies is crucial in knowledge building. Students need to be able to monitor and plan their own learning processes. According to Chan et al. (1997), knowledge building activity is an activity in which students realize conflicting ideas, identify inconsistencies, construct explanations to reconcile knowledge conflicts, and seek connections among diverse pieces of information. A knowledge building activity mediates between conflict and conceptual change. Without the knowledge building activity, students would not attain conceptual change or a new understanding, even though students encounter contradictory information causing a conceptual conflict.

Participants who work together on a group project exchange numerous ideas and suggestions. As students discuss these divergent ideas, some may realize that they would need to use the ideas which others have shared in order to explain their own concepts or to write their papers. When these conceptions occur, a congruent idea gets formed from one or a group of divergent ideas. In addition, it is possible that, while a group brainstorms, the participants generate many useful ideas. At this point they are divergent ideas. If learners do not incorporate these ideas in a paper or use them as part of a new concept, the generated ideas remain divergent.

To help understand how students build their knowledge in a web-based virtual university course, the context of learning in a virtual university is discussed in the following subsection.

Virtual University Learning Environment

The virtual university is a WWW-based networked learning environment designed for college students and adult learners in a higher education setting. In a virtual university learning environment, students can access class materials and communicate with teachers and other students beyond the limits of time and space. Students in a virtual university are not required to be on campus and have no fixed time to attend classes. Because of this flexibility and the no-residence requirements, the virtual university is an attractive option for students who have full-time jobs, families, or who travel a lot.

The WWW seems to be the ideal medium for one to develop a virtual learning environment because it supports multimedia format data transfer, platform-free, distributed systems, and hyper-linking. Data transfer capability in a multimedia format such as text, graphics, sound, and video enables teachers and students to represent and explain concepts in various ways. The WWW is a platform free system, which allows students easily access to online information resources on the web regardless of the platform (like PC, Mac, Unix) they are using. In addition, the WWW is a distributed system. Because of this, instead of a central organization, people on the Internet are the ones responsible for creating and maintaining WWW pages. This distributed nature of the WWW system makes it easy for students to contribute or publish their works on the web. Moreover, the hyper-linking capability, which is designed to support concept-based linking rather than sequential linking, makes it possible for teachers and students to relate concepts in various ways rather than just linearly. Human thought is organized as a web rather than as a line. The related concepts in the lecture can be linked with hypertext, and students find it easy to choose their own learning sequences.

The WWW-based virtual classroom provides communication capabilities such as email, computer-conferencing, chat, file transfer protocol, and a shared workspace on the web. Communication facilities such as email and electronic public space, provide asynchronous communication, whereas computer-conferencing and chat facilities provide synchronous communication.

The advantages of asynchronous communication are time and space flexibility and the time to reflect (Mason, 199*). Due to time and space flexibility, students can access lecture and course materials, classroom discussions, and other communications at any time and from any location. In addition, students have time to reflect on ideas, check references, go back to issues, reread messages, and prepare responses. This type of communication provides students with more opportunities to participate in virtual discussions and ponder on a wider variety of issues, whereas a traditional face-to-face class is limited in time, allowing only a few people to participate in discussions. In Open University classes, students considered time to be one of the factors which contributed to their failure to participate in group discussions. Students expressed that the absence of spontaneous and real-time exchange was a great disadvantage (Grint, 199?). The disadvantages of asynchronous communication are that students cannot get an immediate response to their questions and are not clear on when they will get the response.

The advantages of synchronous communication such as chat and video-conferencing are motivation and immediate feedback (Mason, 199?). Real time communication provides virtual class students with motivation to keep up with their peers and their studies, avails students quick feedback on ideas, and supports decision making in group activities. However, it is difficult for virtual course students to participate in

synchronous communication because of time constraints. Many students enroll in a virtual course in order to take advantage of its time independent flexibility because they find it difficult to come to close at a given time and participate in real-time communication.

At Michigan State University (MSU), the WWW-based virtual university predominantly uses asynchronous communication for coursework; This type of communication has allowed students to communicate with their teachers and classmates any time and anywhere. Most of the class communications are text based and posted to all the members of the group. Students in WWW-based virtual classrooms are expected to interact frequently with the other members of their learning community, to have the time to reflect, to review past issues, to reread postings, and to actively construct knowledge.

To understand how interactions facilitate learning from a theoretical point of view, I examined the cultural-historical learning theory.

Interaction and learning

According to the cultural-historical theory which propounded, Vygotsky and Luria, learning occurs through the mediation of a person's environment and tool use. To illustrate, when a child was asked to get a piece of candy from a high cupboard, the child talked to himself, and then used a stool and stick to get the candy (Vygotsky, Mind in society). According to Vygotsky, in this situation, the self-talk and use of the stick mediated in the child's problem-solving processes. In describing the mediation of tools in

a problem solving process, Luria (1928, cited in Cole and Engelstrom, 1993) also indicated;

> instead of applying directly its natural functions to the solution of a particular task, the child puts between that function and the task a certain auxiliary means... by the medium of which the child manages to perform the task.

The term "tool mediations" used by Luria and Vygotsky includes mediations of both physical tools and signs (language). Mediation by physical tools meant to be more outwardly oriented, and mediation by psychological tools such as signs meant to be more inwardly oriented, toward the self (Cole, 1993).

According to Vygotsky (1962), the mediation of signs (or language) involves social interactions. He explained the relationship between self and others in the process of development as follows: " The sign originally is always a means of social contact, a means of influence upon others, and only subsequently does it find itself in the role of a means for influencing oneself" (p. 192).

The following paragraphs are about the theoretical issues related to 1) social interactions and learning and 2) mediation of support tools and learning.

Social Interactions

Vygotsky (1962) emphasized the interdependence of social and individual processes in the construction of knowledge. Higher psychological functions such as reflective thinking and self-regulated learning are formed in socio-cultural practice (or interactions). Student learning begins with interactions with more knowledgeable persons, such as parents, teachers, and other adults. Internalization occurs first on an inter-personal (or social) plane, and later on an intra-personal (or individual) plane.

On the inter-personal (social) plane, students get involved in discussions, give feedback, and ask questions. Through social interactions, such as observation, conversation, and negotiation, students externalize their thoughts and engage in a meaningful process.

Recent studies indicated the positive effects of the joint process of knowledge building through social interactions, namely student to teacher interactions and student to student interactions in face-to-face classrooms. In an elementary school classroom, interactions between students and the teacher mediated mathematics learning (Ball, 1992), and student to student interactions in a third-grade classroom mediated the understanding of mathematical concepts (Yackel, Cobb, & Wood, 1991). Another example is reciprocal teaching which is a mediation of student to student interactions in a classroom for meaningful learning in reading (Palincsar & Brown, 1984). Through student interactions, such as asking questions, clarifying and predicting ideas, students attained higher levels of reading comprehension than those who did not receive the reciprocal teaching methods.

In a virtual learning environment, student interaction enhances understanding. Ideally, interactions enhance connectivity and socio-emotional engagements in learning processes, as well as facilitate active constructions of meaning (Harasim, 1990). Hiltz (1986) found that the more students actively participate and interact in a class, the more they receive valuable online learning experiences. He also reported that the nature of interaction in a virtual classroom is different from that in a face-to-face classroom. In a virtual classroom (Hiltz, 1990),

> students share their thoughts, questions, and reactions with professors and classmates, using computers and software that enables them to send and receive

> messages, interact with professors and classmates, read and comment on lecture material, take tests, and receive feedback without having to attend scheduled classes (p. 133).

Hsi (1997) reported that electronic discussion in the Multimedia Forum Kiosk supported knowledge integration processes: "expanding the repertoire of models available to students, identifying criteria for distinguishing between models, and illustrating links among ideas" (p. 135).

Mediation of Support Tools

In addition to social interaction, tool use helps students solve problems and develop new understanding. Knots for counting, tables or diagrams for problem solving, and physical space for counting the crates used by the milk deliveryman (add ref.) are examples of tools used in learning.

Another example of a tool found to be effective in promoting student learning is prompt. Prompts are questions or cues, which ask for explanations. Students who provide explanations to other students or teachers seem to reflect on their own thoughts and make better connections among different ideas. Researchers have found that students who received prompts showed improved understanding in text comprehension (Chi et. al., 1989, Palinscar & Brown, 1984). Students in which the teacher, peers, text, or group discussion provided prompts brought about reflective thinking and improved student understanding (Davis, 1998). To design meaningful interactions in a virtual course, it seems worthwhile to provide prompts to encourage reflective thinking processes.

Prompts come in different forms such as direct questions, commands, and incomplete sentences. People provide prompts in order to direct students to think about

the task on hand and provide them with clear directions for student thinking. Some examples of prompts used in the Computer Supported Intentional Learning Environment (CSILE) is: "My theory is... ," "I need to do ...," and "What I do not understand is....."

People use prompts for different purposes. According to Bell and Davis (1996), there are two kinds of prompts: meta-cognitive scaffolding and conceptual scaffolding prompts. Taking the first kind of prompts, meta-cognitive scaffolding prompts can be classified further into two sub-categories: self-monitoring and activity prompts. Self-monitoring prompts support students to plan for or reflect on their learning processes, while activity prompts support students to justify their decisions. The second kind of prompts is conceptual scaffolding prompts which instructors use to help students support their arguments with evidence. An example of a conceptual scaffolding prompt is the prompt used in the project "Searchlight Photo" (Bell & Davis, 1996). Students received hints in the form of questions, such as, "What makes the searchlights look like this?" "What might it look like from a plane flying over the searchlights?" Prompts like these questions help students identify aspects of the evidence that are particularly important to think about (Bell & Davis, 1996).

In a classroom, the instructor, students, or the text materials can provide prompts. In Ball's (1992) classroom, the instructor prompted students to think about their own mathematical concepts. In reciprocal teaching, students prompt each other to explain and clarify the ideas from their reading (Palinscar & Brown, 1984). In the CSILE learning environment, the prompts were embedded in the computer-supported learning

environment. Students had the choice to select prompts from the computer system and respond to them.

In the network learning environment, various prompts were employed in order to promote students' knowledge building processes among studnets. These processes include: prompting procedural facilitation (Scardamalia & Bereiter, 1985), prompting users to construct alternative representations (Sticht, 1992, cited in Ritchie & Hoffman, 1997), and prompting students to develop artifacts of their own learning by using a variety of strategies (Dodge, 1995). These strategies include comparing, classifying, inducing, deducing, analyzing errors, constructing supporting arguments, making abstractions, and analyzing perspectives which students encounter in the course of their learning activities. Another strategy, which supports knowledge building is to use analysis and evaluation methods to prompt students to write a critique (Davis & Bell, 1995).

Using prompts had positive effects on knowledge building. The following studies reflect this finding. Bell and Davis (1996) studied the effect of activity prompts and self-monitoring prompts. Activity prompts asked students to justify their decisions or to explain them scientifically. Self-monitoring prompts asked students to plan ahead (e.g., "Specific things we need to think about as we work on our argument include...") or to reflect back on their work (e.g., "Pieces of evidence we don't really understand include..."). The researchers found that students who got activity prompts were able to complete the projects, whereas students who got self-monitoring prompts produced more integrated knowledge. Bell and Davis also studied the use of conceptual prompts, which asked students for evidence to support their ideas. Findings from this research indicated

that "students are capable of creating new frames to represent their understanding of the evidence. " (p. 17).

Learning Strategies for Convergent Knowledge Building.

In this subsection, I explored ways to develop prompts (or support tools) which would promote convergent knowledge building in a virtual university. To do this, I examined the instructional strategies which promoted convergent knowledge building.

In a WWW-based virtual learning environment, which instructional strategies or tools can help students engage in convergent knowledge building processes? To address the question, I examined how students learned in a WWW-based learning environment. Chung (1996) observed four adult learners in order to understand the cognitive processes involved when learners seek information using WWW. The study was based on Kuhlthau's (1991) theory. According to her, in an information searching process, a user builds meaning from information in order to extend his or her current knowledge of a particular topic. Information need was viewed as the gap between a user's knowledge about a topic or the problem and a user's needs to solve the problem Belkin, et, al. (1982). The information seeking is a form of problem solving process (Marchionini, 1992).

In Chung's (1996) study, the task was to research about the "Shoemaker's Comet" on the WWW. The findings from the study indicated that students were able to build their knowledge about the Shoemaker's Comet by going through the following processes: 1) identifying the purpose of the task and planning what needed to be done, 2) exploring new information or ideas, 3) identifying the main ideas of the new information, 4) evaluating the information and its relevance, and 5) monitoring ongoing

activities to verify that the progress is appropriate with regard to their information seeking goal. The information seeking process did not occur sequentially, but rather in a dynamic, recursive, and iterative manner. When students could not find relevant information, they redefined their problem and went back through the process again. Sometimes, they changed the scope of a search by changing the information sources. The information seeking process was monitored by students' prior experiences, task requirements, and their understanding level of the problem.

Of the above five knowledge building processes mentioned, items 1 (i.e., identifying the purpose and planning) and 5 (i.e., monitoring) can be categorized as characteristics of the reflection process. Item 2 (which is exploring for new information) is more of a divergent knowledge building process and the items 3 (i.e., identifying the main ideas) and 4 (i.e., analyzing and evaluating the relevance) are characteristics of convergent knowledge building processes.

As I mentioned earlier in this study, I was interested in developing support tools to support convergent knowledge building. I decided that students would receive prompts in three activities, namely, summarizing, explaining, and reflecting. I selected them because these three activities would activate background knowledge. And thus would encourage students to engage actively in knowledge building. For instance, self-directed summarizing helps in knowledge construction by enhancing student comprehension of the lecture and at the same time by having them check their own comprehension (Palincsar & Brown, 1984). Self-explanation and self-regulation activities foster knowledge construction and problem solving performances (Bielaczyc et al., 1995).

Finally, reflective activities include 1) monitoring comprehension and learning activities, and 2) clarifying and addressing failures in comprehension.

In asking students to summarize the lecture specifically, I had them identify the main ideas and elaborate their relations to one another. This procedure is related to items 2 (i.e., exploring for new information) and 3 (i.e., identifying the main ideas) of the knowledge building process mentioned earlier. Then, in asking students to explain concepts using concrete examples and to connect these concepts to main ideas, I asked them to interpret the lecture, and to analyze and critically evaluate the ideas in the lecture. This process is related to item 4 (i.e., analyzing and evaluating the relevance) of knowledge building. Finally, reflective activities asked students to plan and monitor their own comprehension of the lecture and learning activities. This procedure is related to items 1(i.e., identifying the purpose and planning) and 5 (i.e., monitoring) of the knowledge building process.

The selected activities are learning strategies that expert learners employ. Slower learners do not adequately summarize texts at their own grade levels, and some students learn to summarize texts at the community college level (Palincsar & Brown, 1984). In terms of organizing information, researchers indicated that, on one hand, "Poor writers frequently ignore to make decisions about the relevance of the information and the importance of organizing the information by grouping, categorizing, and sequencing" (p. 110, Englert & Raphael, 1989). On the other hand, high performance students perform self-explanation, which involves connecting features examples to the concepts of a study (Bielaczyc et al.,1995). Students who do not employ self-explanation activities continue to have difficulties collecting, retrieving, and organizing information to create

information text as was the case with the young writers in Scardamalia and Bereiter's (1985, 1986) research.

In terms of utilizing prior knowledge, on one hand, novice or poor learners rarely activate their prior knowledge when called for or plan and monitor their learning (Bereiter & Scardamalia, 1985; Englert & Raphael, 1989). On the other hand, reflection is a trait of experts (Ertmer & Newby , 1996). However, this trait can be learned because, according to researchers, students who received explicit instruction about monitoring their own learning processes (Bielaczyc et al., 1995) develop a higher understanding than those who did not receive a similar instruction.

For the reasons discovered above, I decided to use the three strategies of summarization, explanation, and reflection as tools to promote convergent knowledge building activities in a virtual university course.

Researches on Interaction and Learning

Many research studies explored the effects of student interactions in small groups (Ball, Yackel et. al.,). Students ask, answer, and clarify questions, and help one other through the interactions. It is often believed that students benefit from giving as well as receiving explanations from their peers. When explaining to others, students are able to clarify and reorganize their thoughts in new ways. In going through this process, students address and resolve otherwise neglected inconsistencies, as well as take on new perspectives and a more complex understanding (Yackel, Cobb, & Wood, 1991). When receiving explanations, students are able to make and strengthen connections between

new information and the ones they already learned (Bielaczyc et al, 1995; Webb et. al, 1995). This often leads to the formation of more efficient problem solving skills and knowledge construction (Sweller, 1989).

Contrary to the above postulate, some experimental studies showed an inconsistencies between receiving explanations and learning, while other studies indicated positive effects between giving explanations and learning (Webb, 1989; 1991). Webb, Tropper, and Fall, (1995) found that the number of occasions nor the amount of time students spent on interacting with classmates did not matter. What showed to be important was that, after receiving help, students would engage in constructive activity. Students who actually verbalized the work or tried to understand the explanation after receiving the help did learn more than those who did not do those things. Students' engagement in highly constructive activities after receiving help was strongly correlated to student achievement. In the study, Webb et al., (1995) had six categories of constructive activities: label 6-- reworks or explains problems, label 5-- applies other's numerical rule, label 4-- finishes other's calculations, label 3-- copies work, label 2-- acknowledges help received, and label 1-- says nothing. Label 6 was categorized as the highest and label 1 as the lowest. Students who worked at the lower levels of constructive activities such as doing nothing or copying other's work were not very successful in solving new problems.

Students' failure to engage in constructive activities like reworking or self-explanation after they received explanation from their peers was identified as the main factor that might have contributed inconsistencies between receiving an explanation and achievement. In the study, it was found that an elaborated explanation rather than a mere

correct answer is the predictor of the level of constructive activity after students received help.

Finally, Webb et al. (1995) concluded that in order for students to actively engage in constructive activities, it was important to encourage individual students to seek explanations that they understand and to continuously work on a task until they could work on their own. Groups also need to learn to give explanations rather than just answers, and to provide individual members with opportunities work on their own. The authors emphasized the importance of designing instructional interventions such as self-explanation prompts, which support constructive activity and suggest that students study the nature of explanations, which encourage constructive activities.

In relation to virtual learning environment, the same problem emerged in recent studies on student interactions. Researchers pointed out that the lack of convergent interaction as a problem in a virtual learning environment (Chung, 1999; Harasim, 1990; Hewitt, 1997, Scardamlia & Bereiter, 1991). Often students merely browse WWW superficially and do not engage in thoughtful and active learning (Richtie & Hoffman, 1997). Students engage readily in divergent processes of knowledge building but needs help in the convergent processes (Chung, 1999; Harasim, 1990; Scardamlia & Bereiter, 1991). The lack of convergent interaction can lead to negative effect on both the student efforts to synthesize ideas and on group collaborative processes (Hewitt, 1997).

To promote the implementation of convergent knowledge building processes in a networked learning environment, researchers suggested the following approaches: developing support tools, such as concept maps (Harasim, 1990; Harasim et al., 1997); using linear message systems while rejecting threaded message systems; and developing

a networked structured message which can provide easy access to other students' displays of ideas and their relationships (Hewitt, 1997). These approaches would be helpful in developing a system which students would find easy to use in building their knowledge. However, those tool development approaches would not be able to help students to be conscious about their learning processes and to monitor their knowledge building processes. In addition, those approaches would not be able to support students to learn to seek for explanations, which they can understand or to learn to continuously work until they can figure out the problems.

Another approach, which would facilitate seeking explanations and monitoring learning processes is using the explanation prompts as suggested by Webb et al. (1995) . I would develop support tools, which would extend the use of prompts not only for explanation but also summarization and planning/monitoring to facilitate active learning in a virtual learning environment.

I will study whether and how support tools, which prompts summarization, self-explanation, and planning/monitoring strategies, facilitate knowledge building in a virtual university course.

CHAPTER 3

INTERACTIONS AND DESIGN IN A VIRTUAL COURSE

Virtual university courses need to be designed carefully in order to promote student interactions and knowledge construction. Previous research reported on the misuse of the Internet, computers, and distance education and pointed out the importance of teachers' integration of the technology into their teaching. Care (1996) reported that careful planning is necessary to ensure that interactions between teacher and student or between student to student occur, and to facilitate the learner-centered learning in distance education..

Design Guidelines

Previous research studies indicate that several factors can promote knowledge building processes in a classroom context:

- Training in the use of self-explanation and self-regulation strategies (Bielazyc et al., 1995);
- Training in comprehension-fostering and comprehension-monitoring strategies such as summarizing, questioning, clarifying, and predicting (Palincsar & Brown, 1984);
- Engaging in inquiry-based projects (Edelson et al., 1995) or scenario-based problem solving activities.

To promote convergent knowledge building in a networked learning environment, previous studies suggested the following strategies:

- Developing concept maps (Harasim, 1990)
- Using artifacts created by students as objects of their study;
- Assigning a leader to each group (Hewitt, 1997)
- Organizing messages as linear: no-threaded messages (Hewitt, 1997)
- Having small group sizes with around three or four members (Chung, 1999)

For the virtual university unit which I developed, I used the following design guidelines:

- Provisions of support to let students use self-explanation with or without reflection strategies.
- Scenario-based problem solving activities.
- Non threaded message system (or messages organized chronologically)
- Assignment of a leader to each group
- Small group size

Based on the above mentioned design principles, I developed a unit about web design for the engineering course, Introduction to the Internet.

Design Framework

Activities, social support, and support tools were used as the design framework in developing the curriculum in a virtual course. The design framework of my study

followed suggestions of prior research (Gomez & Gordin, 1996; Levin, 1995; Collings & Walker, 1996). To facilitate successful interactions in a networked learning environment, Gomez & Gordin, and Levin recommended particular design features: activities (activity structure by Gomez & Gordin, process by Levin), social support (social support by Gomez & Gordin, mediation by Levin), and material support (electronic shared workspace Collings and Walker, 1996, material support by Gomez & Gordin, 1996).

In this study, activities are defined as a sequence of student work which teachers design in order to promote students' active creation or co-production of knowledge in a classroom. Open-inquiry collaborative science projects (Gomez & Gordin, 1996) and group projects requiring WWW searches (Levin, 1995) are examples of activities. Social support is defined as the mediating effort of instructors, teaching assistants, and other technology coordinators to assist or guide the students. Material support is the tool developed to enhance learning, such as a database, communication tools, and electronic shared workspace. Electronic workspace is WWW space in which students, the instructor, and other assistants engage in social interaction by sharing their ideas, discussing, questioning, clarifying, and reflecting on their thoughts.

The design framework developed for the study was as follows:

- Activities: A group project with a scenario was designed, which provided authentic tasks for students.
- Social support: Interaction with peers, the teacher, and teaching assistant (TA) was promoted by providing Internet-based group discussion facilities, and by requiring students to post and share their ideas.

- Support tools: Summarization, self-explanation, and planning/monitoring prompts were selected as support tools to promote students' convergent knowledge building activities.

Development of the Interactive Virtual Course Unit

Here is description of group projects which include: activities with scenario, social support, and support tools with prompts.

Activities: The task for each group was to submit two group reports: discussion of strengths and weakness of the two university homepages (MSU and U of M) and a recommendation on how to redesign the homepage of MSU. I asked each group to support their comparison and recommendation based on the design theory from lecture 3, Design of Web-pages, and other readings of their choice. Students were required to discuss the project with their classmates by using Web-talk.

Scenario: Your group is working as web-page designers for a company which produces web-pages for higher education institutions. Your group is assigned to redesign the homepage of Michigan State University. Your boss asks you to discuss the strengths and weakness of current MSU homepage (http://www.msu.edu) and compare it with the homepage of University of Michigan (http://www.umich.edu) and write a recommendation on how to redesign the homepage of MSU.

Task description: To receive credit for the group assignment, you must post two reports to the Group Web-talk before the due date. Participation in Web-talk will also be part of the individual student's grade. It may be used as an adjustment (up or down) from the group grade. The same group member cannot post both reports. One report must be posted by one group member and the other report must be posted by someone else. The Instructor and TA's will be immediately notified when you make the posting so that it may be graded.

Social support: At the beginning of the semester, brief introductions of the students, the instructor, and the TA, and their picture were posted on the web, so that they could get to know each other better. Facilities, such as the telephone, email, web discussion, and web chat capabilities, supported interactions with the instructor and facilitated interactions with other students and the TA. If students preferred, they could arrange face-to-face meetings, as well.

However, the teacher support was available only when students sought for. The instructor and the TAs were told not to interject themselves during student online discussion.

Support tools: Communication tools are inseparable from their social interaction capabilities in a virtual university group. Email, web group discussion, web chat facilities, and phone support various types of student communication such as one to one, one to many, and many to many. Web group discussion is used as a preliminary support which aids student learning activities through idea sharing and knowledge building.

Messages on Web-Talk (a web group discussion facility which the MSU virtual university developed) are organized chronologically, so that students can avoid the difficulty of accessing other students' messages that are embedded in a different subtopic. This linear organization of messages prevents the tendency toward conversational drift which threaded messages cause. Conversational drift is the tendency to branch off too far from the main issues, leading to gradual fragmentation of the group discussion (Hewitt, 1997).

Prompts, as support tools, serve as scaffolds to help students engage in convergent knowledge building activities. These prompts were developed based on strategies which, according to previous research, were effective in enhancing students' knowledge acquisition and problem solving performance (Bielaczyc et al. ,1995; Bell & Davis, 1996; Palincsar & Brown, 1984). The framework of the knowledge building support tool utilize strategies such as summarization, explanation, and planning/monitoring.

CHAPTER 4

METHODOLOGY

The purpose of this study was to characterize how students built knowledge with the aid of cognitive support tools in a virtual learning environment. This study also investigated the effects of using support tools in the knowledge building process. The cognitive tools in this study were designed to promote learning strategies such as summarization, explanation, and planning/monitoring.

I designed a quasi-experimental study using two different online work environments: 1) without support tools, and 2) with support tools. Regardless of their online work environment, all students in this study were encouraged to discuss and share their ideas within the group. Each student was required to do the same task: first to listen to the lecture, "Design of Web Pages" and then to discuss the strengths and weaknesses of two different university homepages and write recommendations on how to improve one university homepage. Depending on the group, students performed the task online with or without support tools that prompted students to summarize, explain, and monitor their progress.

The data of this study were characteristics of students' knowledge building processes online (in the forms of frequency and pattern of online discussion), the quality of their written recommendations based on comparisons of two college web pages, and self reports on their learning experiences from the two week unit called Design of Web Pages in a virtual university course.

Setting

Since the summer of 1997, MSU has been offering WWW-based online courses through the Internet. The name "Virtual University" refers to the online courses at MSU which offer instruction through WWW without the time and place constraints of traditional university programs. The goal of the Virtual University (http://WWW.vu.msu.edu/) is to meet the learning needs of students when and where it is most convenient to them. The ideal virtual learning environment is a place where students can perform interactive tasks with their classmates; receive guidance or help from their teacher, TA, or technology coordinator; and have an electronic public space where they and their teacher can share their ideas on the WWW. Five virtual courses were offered in summer 1997, 9 in fall 1997, 11 in the spring 1998, 15 in summer 1998, and 20 in fall 1998. Nineteen courses are being offered in spring 1999.

An undergraduate engineering course Introduction to the Internet (EGR124), offered in fall 1998 by the MSU Virtual University, was selected as the research site. At the beginning of fall 1997, the researcher began observing the EGR124 class and collaborating with the instructor to develop activities to enhance interactions among students.

The two-week unit, Design of Web Pages, was developed specifically for this study, based on principles of the three design features of a network-based learning environment discussed above: activities, support, and electronic shared workspace. Group projects were developed to encourage student activities for the lecture "Design of Web Pages." TAs and the instructor provided online support whenever students encountered technical problems. Electronic shared workspace was supported by a program called

Web-talk. Web-talk is an online group discussion tool and was developed by the Virtual University, in order for students to work together by planning, discussing, and otherwise working together online.

Participants

The study participants were college students who were enrolled in the virtual course EGR124 in the College of Engineering in fall 1998. Although the course was developed for first-year engineering students, some lifelong education students and high school students also took the course.

I recruited students from the EGR124 virtual class to participate in the study. The recruitment letter was posted on the course web-site at the beginning of the semester (see Appendix A for a copy of the letter). The letter explained how the activity would differ between the control and treatment groups, and how participants would be assigned to the two groups. To motivate students to participate in the research, three $25 awards were offered.

The 24 students who agreed to participate in the study gave the researcher their consent to access their class projects and communication logs, and to be interviewed if necessary.

Materials

In the study, a pre-survey, an intervention with instruction, and a post-survey were used. I developed the pre-survey, post-survey, and intervention with instructions. The pre-survey was developed to gather demographic information about the subjects such as gender, age, and computer skill levels. This information was helpful in understanding the subjects (see Appendix A).

Intervention with instruction was an interactive virtual unit called Design of Web Pages. The unit ran for a 2-weeks (i.e., the sixth and seventh weeks of the semester) in the form of interactive virtual group activities around the lecture "Design of Web Pages." The lecture was developed by another individual, and I developed the classroom activities, tasks, and cognitive support tools. During the 2-week period, students had access to the lecture '*Design of Web Pages*'. Their task for the unit was to work together to submit a 300 word group report in which they discussed the strengths and weaknesses of two university homepages (MSU and U of M) and to write a recommendation on how to redesign MSU's homepage (see Appendix B).

For the treatment group, I developed cognitive support tools that prompted students to use such learning strategies as planning/monitoring, summarization, and explanation in the virtual class (see Appendix C). For the control group, no cognitive support tools were provided (see Appendix D).

I developed the post-survey to understand the student experience with the Design of Web Pages activities. The post-survey focused on: 1) How much students were

satisfied with group interactions and the support tools, and 2) How students evaluated their own learning in the virtual course (see appendix E, F).

Procedures

The procedures which followed in conducting the study are described in this section. Included are how subjects were assigned to treatment and control groups, how the Design of Web Pages was carried out, and how the data were collected.

Assignment of Subjects to Treatment and Control Groups

At the beginning of the semester, students who volunteered to participate in the study were randomly assigned to one of the two learning environments: the control group (without support tools), and the treatment group (with support tools). After discussion with the classroom instructor, I decided to divide the class into small groups of four students each. Twelve students (three small groups) were in the treatment group and 16 students (four small groups) were in the control group.

Just before the Design of Web Pages unit, one student in the treatment group dropped out of the class. As a result, the number of students in the treatment group dropped to eleven. Then three students in the control group withdraw their consent to participate in the research. Thus, subjects in my study included 11 students in the treatment group and 13 students in the control group.

In assigning students to small groups, the class instructor tried to ensure that all groups had similar skills and activity levels. To do that, the instructor analyzed and ranked the students' frequency of online participation and their class activities in previous

units. Then, student participation and skill levels were divided into four tiers: first, second, third, and fourth level of active participation. Each group had a member from each of the four tiers. The most active students, who belonged to the first tier were assigned as the leaders of their groups.

Design of Web Pages Unit

The unit, Design of Web Pages, was developed as interactive virtual group activities around the lecture "Design of Web Pages" during the sixth and seventh weeks of the semester. During the fourth and fifth weeks, students had time to familiarize themselves with the virtual course by listening to another lecture, posting their ideas on the web, and using the group communication tools. During the Design of Web Pages unit, students listened to the lecture. They also worked together to write a 300 word group report on the strengths and weaknesses of the two university homepages (MSU and U of M) and to write a recommendation on how to redesign MSU's homepages .

During the first week of the unit, students in both the treatment and control groups listened to the lecture. In addition, the treatment group responded to the prompts to summarize the lecture, explain concepts, and monitor their own learning processes. The control group was required only to listen to the lecture.

Regardless of their group type, students were told to discuss their work with their classmates over the Internet. This activity occurred during the second week of the unit. Students discussed the strengths and weaknesses of the homepages of two universities and wrote reports. Discussions about the lecture and/or about the group project in small groups occurred over the Internet, either through email or Web-talk. All communications

among group members were archived through Web-talk, viewed by the group members, and later on viewed by all class members. The group projects were submitted to Web-talk and were accessible to all students in the class.

The instructor, the TA, and the researcher were accessible to students online. All students were encouraged to participate in discussions within the group.

Data Collection

Four main kinds of data were collected in this study: pre-survey online responses, archived online communication data, online group project data, and post-survey online responses. Students' responses to both the pre- and post-surveys were submitted through the web, and I collected the data online. The online pre-survey was administered at the beginning of the semester, and the online post-survey was administered after the Design of Web Pages unit. The online survey data were later coded into the Statistical Package for the Social Sciences (SPSS) for analysis.

Data on the communication among students in the online class and the group project data were automatically archived in Web-talk (which is a group communication tool developed for the virtual university). I used these archives as my data.

Data Analysis

The data studied in this research were comprised of students' interaction patterns, performance, and their perception of learning. Perceptions of learning from group interactions were collected from the self-reports of the post-survey. There was no need to

code that information. Thus, only the data pertaining to interaction patterns and student performance (related to the integration of ideas) were coded.

Coding

Deciding What to Code: Ideas from Previous Studies

Here is a description of the process that I went through in deciding what data to code in order to analyze interaction patterns and student performance.

Interaction patterns refer to the characteristics of online discussions among students. Based on previous studies about knowledge building in online learning environments (Chung, 1996 &1999; Harasim, 1990; Hewitt & Scardamalia, 1996; Scardmalia & Bereiter, 1991), I decided to examine the three distinct features of knowledge building; planning and monitoring, divergent knowledge building, and convergent knowledge building. These knowledge building processes were used as a framework to code online discussions into three types of interactions: planning and monitoring type, divergent type, which includes self-introduction and idea sharing; and convergent type, which consists of agreeing or disagreeing on different ideas and synthesizing ideas in writing (See Table 4.1).

Planning and monitoring interaction refers to discussing the things which need to be done to complete the project, the person who will do specific tasks and the time constraints. In addition, this interaction involves checking if group members are on the right track.

Divergent interaction includes activities such as brainstorming, exchange of opinions, brief self- introduction, and asking questions. Participants who work on a group project exchange and discuss numerous ideas and suggestions. In the end, either a divergent idea becomes a convergent idea or a group of divergent ideas is transformed into a convergent idea for the group paper. It is also possible that during brainstorming, only one idea gets generated. In this case, this idea remains divergent until it is incorporated into the group paper and becomes a convergent idea.

Convergent interaction includes activities, such as explaining, agreeing/disagreeing, critiquing or giving feedback, and bringing different ideas to a report.

Table 4-1 Definitions and examples of types of interaction

	Planning/monitoring	Divergent	Convergent
Definition	1) Discussing what needs to be done to complete the project, who will do what, and checking if they are on the right track. 2) Asking/discussing when and how the group will do the project 3) Reporting their readiness for the project **4)** Checking if their progress is on the right track	1) Idea sharing. 2) Brief self-introductions, brainstorming. 3) exchange of opinions, and questions.	1) Idea linking and idea structuring. 2) Explaining ideas. 3) Agreeing /disagreeing with others' ideas, critiquing or giving feedback. 4) synthesizing ideas, report writing
Examples	" I'm not exactly sure how we are going to coordinate this project,	"Hello everyone, I live on Beaver Island, so I will be	"Emma, good ideas. You took all the ones I was thinking

	but I hope to hear from the rest of you in this group soon." I can do either the comparison or the recommendations. I spent the summer doing similar work for an internet communications company. Hi Group A, We need to figure out who is going to do what for this project. There are 2 parts to it. We should break down the 2 reports we have to do between the 4 of us.	doing all of my work long distance as well." (An example of self-introduction.) In general, I think the U of M page is very slick looking. In using it, I find that it can be somewhat cumbersome to navigate though. I have viewed both web-pages, and i'm not too sure if I favor one more than the other. A good or different thing about U of M's web-page is it posts current information about the what's going on around the campus. I didn't go too far into looking at it to see if it gets confusing as you go more into their web.	about:) Something else I think MSU should think about is using a frame so you will always have the option to skip to different topics without hitting the BACK button several times." (An example of agreeing and adding one more idea.)

Performance was measured by the quality of the students' two reports (i.e., the comparison of the two university web pages and a recommendation to improve MSU's homepage). The reports which were submitted as the product of the group project, were analyzed and scored to measure the extent in which ideas, concepts, and examples were integrated.

The lecture on the Design of Web Pages covered two issues: 1) the characteristics of good web-sites and 2) ways to design a good web page. Five main concepts and 16 attributes were discussed in the section on characteristics of good web-sites. For example, frame, table, hierarchical organization, and image-map were presented as attributes of a well-organized web page. Five main concepts and supporting examples for each concept were covered in the section on "how to design a good web-site" (See Table 4.2).

Both the comparison and recommendation reports were analyzed using the framework of concepts and attributes covered in the lecture. Each of the concepts, attributes, and examples discussed in a report was counted as one point. Based on the lecture, the maximum possible score based on the lecture was 26 points. Any new concept, attribute, or example discussed in a group report but was not covered in the lecture was also counted as one point. Thus, it was possible for a group to earn more than 26 points for one report. The comparison report and recommendation report were rated separately.

Table 4-2 Concepts and attributes discussed in the lecture

	One point for each idea	Points	One point for each attribute	Points
Characteristics of Good Web-Sites				
1	Organization : Ways to organize the web: by audience, subjects, and organization charts		Presentation types • Hierarchical organization: general to specific • Image-maps • Tables • Frames	

2	Navigation: Ways to look for information.		• Screen scrolling size • Links to homepage • Color • Frames	
3	Attractiveness: Aesthetic aspects of the web-sites (pleasant, boring ,etc.)		• Simple colors • Graphics-- size • Animated gifs	
4	Usefulness: (User finds the information on the web useful) Relevance of information to the user		• Content--uniqueness • Content -- comprehensiveness • Uniqueness in approach, audience	
5	Up-to-date		• Dates of the last updates • Currentness	
How to Design a Good Web-Site				
6	Goals : Clearly stated goals, mission statement, or vision			
7	Audience : Identify for whom the web-site is developed			
8	Plan it out: Identify the needs of the target audience and decide the types of information to disseminate.			
9	Support different systems (multi-system)			
10	Maintenance of the system			
11	New ideas not discussed in the lecture			

Coding Procedures to Evaluate Performance: Knowledge Integration

For rating students' knowledge integration, two raters coded the level of integration. I was one of the coders. The other coder was a Ph.D. candidate in Educational Psychology who had had training and experience in coding writings of elementary school

students. I shared with her a summary of the Design of Web Pages lecture, explained the criteria of coding (which consists of concepts, attributes, and examples) as described above (see Table 4-2), and discussed related issues. We started with 13 text units and coded them individually. Then we brought our codlings together and compared whether we had given the same codlings or not. For the parts on which we disagreed, we discussed why we had coded them that way and came to consensus about how to code them. Then we coded another six text units and compared the results. At that time, around 80% of our coding were the same. We discussed our differences again in order to reach a consensus. After that, we coded the group projects without knowing to which group (whether treatment or control group) the report belonged.

Perception of learning was measured using students' self-evaluations of their own learning, such as satisfaction and knowledge building experience as indicated on the post-survey. Data on student satisfaction level came from their responses to the items in the post-survey such as " I enjoyed group discussion" and " Group discussion has been useful to me." The knowledge building experience was measured using studnet responses on a 5 point scale to statements such as " Group discussion helped me to think about web design ideas I would not have thought about alone," "Group discussion helped me to understand the web design concepts more clearly," and " Group discussion helped me to reorganize my thoughts about web design."

Statistical test

Research Question 1: How do students using the tools to support their learning in an

electronic learning environment differ from those who do not use these tools in the knowledge building processes?

a) There will be different participation frequencies in online group discussion between students with the support tools and those without it. Students in the treatment group will interact more often than that of the control group.

b) There will be different participation patterns (divergent vs. convergent) in online group discussion between students with the support tool and those without it. Students in the treatment group will participate more in convergent interaction than students in the control group.

Descriptive statistics were used to compare the two groups based on the frequencies and types of student interactions in group discussions. One tailed t-tests were conducted between the two groups with alpha level at .05 to examine the research question 1.

Table 4-3 Frequency table of student discussion

	Control group: Without tools	Treatment group: With tools
Frequency of discussion		

Table 4-4 Frequency table by interaction type

interaction type	Control group: Without tools	Treatment group: With tools
Planning/monitoring		
Divergent		
Convergent		

Research Question 2: How do students who use the tools differ in the ways they write recommendation and comparison reports from students without the support tools?

a) Students using tools to support their learning in an electronic learning environment build more integrated knowledge (i.e., number of ideas, concepts, examples, and new ideas) than students not using the support tools.

Students' scores on the comparison and recommendation reports were compared to see if there was a difference between the treatment and control groups. One tailed t-tests were conducted between the two groups with alpha level of .05 to examine the research question 2.

Table 4-5 Written report scores by control and treatment group

	Control group: Without tools	Treatment group: With tools
Recommendation		
Comparison report		

Research Question 3: How are the students using tools to support their learning in an electronic learning environment differ in their evaluation of their learning?

a) Students who studied with the tools will report higher satisfaction with their group activities than those without the tools.
b) Students who use the support tools will report more convergent knowledge building experience than those who do not use the tools.

T-tests were conducted to analyze data for perception of learning. In these tests, satisfaction and self-evaluation scores were used. To analyze the level of student satisfaction, responses on a 10 point scale to statements, such as "I enjoyed the group discussion" and "Group discussion has been useful to me" were used. To understand the students' perceptions of their knowledge building experience, their responses to statements, such as "Group discussion helped me to think about web design ideas which I would not have thought about alone," "Group discussion helped me understand the web design concepts more clearly," and "Group discussion helped me reorganize my thoughts about web design" were used. Total 15 point scale was used for knowledge building experience.

Table 4-6 Self-reported scores

	Control group: Without tools	Treatment group: With tools
Satisfaction (1-10 scale)		
Knowledge building experience (1-15 scale)		

Limitations

This research was undertaken to investigate the effect of support tools on student interactions and their learning in a virtual university classroom. I wanted to gain some insights into issues involved in a virtual learning environment.

However, I encountered several difficulties in conducting an experimental study in a regular virtual class. One problem was the fact that the virtual learning environment is very new to education field and only a limited number of virtual courses were offered. Thus, I observed only one virtual course for the study.

Another limitation was that I observed for only a 2-week period. If the students had had an opportunity to work as a group for a longer time, they might have had different patterns of interaction or different perceptions of the virtual learning course. Thus the study findings can be described as learning of students who engage in the virtual university class for short time period only.

The study findings were from only one classroom and thus can not be generalized to describe or explain the phenomena of virtual learning environment in general. The study findings may be generalized only to learning in a virtual learning environment in which students are undergraduate, online discussions among group members are available to the group members, classroom activities encourage group discussion, tasks are group projects, and group discussion tools such as Web-Talk are available.

CHAPTER 5

RESEARCH FINDINGS

The results of the data analyses are presented in this chapter. I discussed the characteristics of the participants in the study first, Interaction patterns and content of the online discussion score, students' performance represented in their project scores third, and their perception of their learning last.

Participants' characteristics

A pre-survey was conducted to collect information about students' age, gender, and level of technical skill in using computer applications, such as Microsoft Word, WWW browser, FTP, graphics software, and Chat. Findings are discussed in the following paragraphs.

Age

The participants were mostly college- age students. Of the 24 students who participated in the study, one was under 17 years old, another was between 23 and 27, and the rest were between 18 and 22 years old. The student under 17 years old was a high school student. Both that student and the other who was over 23 years old belonged to the treatment group. The control group consisted of students between the ages of 18 and 22 (see Table 5-1).

Gender

Of the 24 students, 6 (25%) were female and 18 (75%) were male. The treatment group had four female students and seven male students. The control group included two female students and 11 male students (See Table 5-1).

Table 5-1 Distribution of participants by gender and age

Gender	Age		
	Under 17 years	18 to 22 years	23 to 27 years
Male	1	17	0
Female	0	5	1

Technical Skill Level

Technical skill level was identified as one of the important factors for students' successful (frequent) participation in the networked learning environment ().Information about students' technical skill level was obtained from the pre-survey. All 11 students in the treatment group and twelve out of the 13 the students in the control group responded to the pre-survey.

The self-reported technical skill levels of participants in this study indicated that the control group had slightly higher skill levels in using chat, FTP, Microsoft Word, and graphics software packages than did the treatment group. However, the skill level differences between the treatment and control groups were not statistically significant (See Table 5-2).

Table 5-2 Technical skill levels by control and treatment group

		N	Mean (scale 1-5)	Std. Deviation	t (p value)
Microsoft Word	Treatment Control	11 12	4.36 4.42	.67 .51	.-213 (.833)
WWW	Treatment Control	11 12	4.27 4.17	.65 .72	.371(.714)
FTP	Treatment Control	11 12	2.91 3.58	.83 1.24	-1.516 (.144)
Graphics Software	Treatment Control	11 12	2.73 3.08	1.19 1.00	-.780(.444)
Chat	Treatment Control	11 12	3.45 3.67	.82 .78	-.635(.536)

Interaction Patterns and Content of Interactions

Researchers theorized that interactions are externalized cognitive processes of learners in virtual university courses. In a regular face-to-face classroom, students do not have much opportunity to externalize their thoughts or observe their peers' ideas. Instead, according to Levin (1998), "their learning takes place in isolation from the rest of society, and most of student activities are exercises" (p. 2). In an ideal virtual learning situation, students are forced to externalize their thoughts and ideas by answering and raising questions, to observe others' externalized thoughts and ideas, to evaluate others' ideas by agreeing or disagreeing, and to engage in their knowledge building. Levin described the process of learning in a network-based learning environment as follows:

> As more and more adults use electronic networks in their work, there are increasing opportunities for learners to join these interactions, initially observing the interaction, then being given small tasks to accomplish with guidance, and then taking on more substantial roles during the extended interaction (p. 2).

In the other words, it can be argued that frequency and types of interactions help students learn in a network-based learning environment. If students participate in the group activities more often and have more substantial interactions, they can learn more or build their knowledge more.

To understand how often students interacted and the kinds of interactions they engaged in during the Design Workshop period in EGR124 virtual course, I examined the interaction patterns and content of the interactions during the online discussions in the treatment and control groups.

Interaction Patterns

The students enrolled in the Engineering course, EGR124, exchanged their ideas through email messages, chat, or Web-talk to complete their group projects. In these interactions, there were various types of interactions and different degrees of participation (interaction). Some students read messages instead of contributing their ideas, some answered queries, others asked questions, while some synthesized their group's ideas to write a report.

I analyzed the online discussions during the unit of Design Web Pages to determine the frequencies and types of interactions. The data were analyzed on two levels, one with the group and the other with the individual as a units of analyses. General analysis of interactions was done at the group level, whereas hypothesis testing was done at the individual level. Student discussion postings were categorized as either

planning/monitoring, divergent interactions, or convergent interactions as discussed in Table 4.1.

Planning/monitoring interaction included activities such as 1) asking/discussing when and how the group would do the project, 2) reporting students' progress (readiness) to carry out the project, and 3) suggesting what to do for their group work. Divergent interactions comprised of activities, such as giving brief self introductions, brainstorming, exchanging opinions, and asking questions about the topic. Convergent interactions consisted of activities such as agreeing/disagreeing, critiquing or giving feedback, and bringing different ideas into one's writing.

Group report writing was considered to be an outcome of these group interactions. In addition, the group report writing process itself was also studied to determine whether any group knowledge building process occurred. A report without critical feedback or revisions by other group members during and after the report writing was not considered to be a product of convergent knowledge building. A report, that integrated other students' ideas through giving or receiving feedback, critique, or revision was considered to be a product of convergent knowledge building.

Frequencies of interactions

There were 113 actual postings by 3 treatment groups and 4 control groups. The treatment groups made a total of 52 postings and the control groups made a total of 61 postings. Among the treatment group members, more than 60% of the total postings were posted by one of the groups, group A. Approximately 25% of the total postings were posted by group B, and almost 15% of total postings were posted by group 3. Among the

control groups, group D and G posted roughly 22%and 28%, respectively, group F posted about 11% and group E posted about 36% of the total postings (See Table 5-3).

Table 5-3 Number of Postings by each group

Condition	Treatment				Control				
Total postings	52				61				
Group	A	B	C	Avg.	D	E	F	G	Avg.
Postings (include email comm.)	31	13	8	17.3	15	22	7	17	15.3
% of each group's contribution in each condition	59.6	25.0	15.4		21.6	36.1	11.2	27.9	

There were instances when one posting carried different types of messages. For example, the following posting carried two messages: "I can do either the comparison or the recommendations. I spent the summer doing similar work for an Internet communications company. I take the class on campus and get to take advantage of Ethernet." The first part of message was classified as planning/monitoring, and the latter part was categorized as a self-introduction. In this case, the posting was counted as two messages.

In analyzing the interaction patterns in students' online discussions, I used messages instead of postings because a message gives a more accurate concept of the intention behind the students' postings. Students from both the treatment and control groups exchanged a total of 123 messages. Each of the treatment groups exchanged an average of 18 messages. The average across the control groups was 16.75 messages. On

average, the treatment groups exchanged 1.95 messages more than the control groups (see Table 5-4).

Table 5-4 Messages exchanged by each group

Condition	Treatment				Control				
Total messages	54				67				
Group	A	B	C	Avg.	D	E	F	G	Avg.
Total messages	33	13	8	18	17	26	7	17	16.75
% of each group contribution in each condition	61.11	24.07	14.81		25.37	38.81	10.45	25.37	

When comparing Table 5-3 and Table 5-4, there is not much difference between total postings and messages, except that group A and D had 2 more messages than postings, and group E had four more messages than postings. Although, there was not much difference between the number of postings and messages, I used messages for further analysis.

Types of interactions.

On average, 39% of the messages exchanged students within the treatment groups were categorized as planning and monitoring, 52% as divergent interaction, and 9.5% as convergent interaction (see Table 5-5). In contrast, 24% of the messages exchanged by students within the control groups were classified as planning and monitoring, 69% as divergent interaction, and only 4% as convergent interaction; 3% were unrelated to tasks (see Table 5-6).

Table 5-5 Interaction paterns of studnets within the treatment groups

	Treatment Group				Total	%
Interaction Pattern	A	B	C	Avg.		
Planning/monitoring	18	2	1	7	21	38.89
Divergent	10	11	7	9.33	28	51.85
Brainstorming/ sharing ideas	8	5	3	5.33	16	
Report writing without any reference to or feedback form others	2	6	4	4	12	
Convergent	5	0	0	1.67	5	9.26
Explaining, agreeing/disagreeing, synthesizing	3	0	0	1	3	
Report writing with reference to or feedback from others	2	0	0	0.67	2	
Other postings (unrelated issues)	0	0	0	0	0	0
Total messages	33	13	8	18	54	100

Table 5-6 Interaction patterns of students within the control group

	Control Group						
Interaction Pattern	D	E	F	G	Avg.	Total	%
Planning/monitoring	5	8	1	2	4	16	23.88
Divergent	8	18	6	14	11.5	46	68.66
Brainstorming/ sharing ideas	6	10	4	8	7	28	
Report writing without any reference to or feedback form others	2	8	2	6	4.5	18	
Convergent	2	0	0	1	0.75	3	4.48
Explaining, agreeing/disagreeing, synthesizing	2	0	0	1	0.75	3	

Report writing with reference to or feedback from others	0	0	0	0	0	0	
Other postings (unrelated issues)	2	0	0	0	0.67	2	2.99
Total messages	17	26	7	17	16.75	67	100

Students within the treatment groups exchanged an average of 7 planning/monitoring messages, whereas the students within the control groups exchanged 4 such messages. With divergent interaction messages, students in the treatment and the control group exchanged 9.33 and 11.5 messages, respectively. In addition, the treatment groups exchanged 4 messages concerning individual report writing, whereas the control groups exchanged 4.5 messages on average. Furthermore, the treatment groups exchanged an average of 1.6 convergent interaction messages whereas the control groups exchanged 0.75 such messages. Finally, the treatment groups exchanged an average of 0.67 messages concerning report writing with others, while the control groups did not exchange such messages (see Table 5-7).

Table 5-7 Interaction patterns by treatment and control group

Group	Planning/ Monitoring	Divergent	Convergent	Other	Total
Treatment	7	9.33	1.65	0	18
Control	4	11.5	0.75	0.67	16.75

In the categories of idea sharing and individual writing, the control group exchanged more messages than the treatment group. However, in the categories of planning/monitoring and convergent interaction, students within the treatment groups exchanged almost twice as many messages as students in the control groups.

As shown in Figure 5-1, groups in the treatment group involved in fewer divergent interactions, whereas they engaged in more convergent interactions and planning/monitoring activities than the groups in the control group. In other words, the groups in the treatment group seemed to be more focused on their knowledge building than those in the control group.

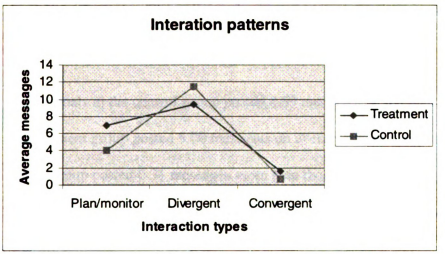

Figure 5-2 Interaction patterns by treatment and control groups

Results of Testing Hypothesis on interaction patterns

Research Question 1: How do students using support tools to support their learning in an electronic learning environment differ in participating frequencies from those who do not use these tools in the knowledge building processes?

Frequency of interactions

I anticipated that students using the support tools would differ from those not using such tools in terms of frequencies of participation in online group discussions. Specifically, I thought that students in the treatment group would participate more often than those in the control group. To test this assumption, null hypothesis 1a was formulated:

Null Hypothesis 1.a: The individual student participation frequencies of the treatment group will not be higher than that of the control group.

Individuals in the control group posted 4.69 messages on average, whereas students in the treatment group posted 5.00 messages on average; that is, individuals in the treatment group posted 0.31 messages more than those in the control group. The difference was not statistically significant ($p<.05$) (see Table 5-8). Thus Null Hypothesis 1.a was not rejected.

Table 5-8 Average number of messages by each individual in treatment and control group

	Control group: Without tools (n=13)		Treatment group: With tools (n=11)		t (p value)
	Mean	Standard Deviation	Mean	Standard Deviation	
Total messages	4.69	3.38	5.00	3.19	.228 (.411)

Types of interactions.

I anticipated that students using the support tools would differ from those not using such tools in terms of their types of interactions (divergent versus convergent) in online group discussions. Specifically, I thought that students in the treatment group would participate in more convergent interactions than those in the control group. To test this assumption, Null Hypothesis 1.b was formulated:

Null Hypothesis 1b: Individual students in the treatment group will not engage more in convergent interaction than that of the control group.

In the convergent interaction category, students in the treatment groups posted 2.55 messages on average, whereas those in the control groups posted 0.85 messages on average. Even though the treatment groups posted more than twice as many messages as the control groups, the difference was not statistically significant at $p<0.05$ (See Table 5-9). Thus, Null Hypothesis 1.b was not rejected.

Table 5-9 Number of Convergent interactions

	Control Group: Without tools (n=13)		Treatment Group: With tools (n=11)		t (p value)
	Mean	Standard Deviation	Mean	Standard Deviation	
Convergent interaction	.85	.90	1.82	2.52	1.82 (.103)

Content of online Discussion

I examined the convergence of ideas by analyzing the content of students' online group discussion. Messages that dealt with planning/monitoring were excluded from this analysis, because planning/monitoring activity was related to the progress of their task completion, rather than to convergence of ideas. In other words, only messages that dealt with discussions of concepts were studied.

The concepts used in each individual posting were identified and then compared to determine whether those concepts were used by other group member. The total number of concepts identified was considered as the total number of generated ideas (A shared idea was only counted once). If a concept expressed by one student was used in other group members' postings again, the idea became a shared concept. The frequency of shared concepts used during the discussions indicated that convergent knowledge building process was implemented.

Table 5-10 Total number of shared ideas used by treatment and control groups

Treatment	Use of shared ideas during discussions
Group A	19
Group B	11
Group C	0
Control	
Group D	4
Group E	13
Group F	0
Group G	5

The number of shared concepts used during group discussions was used as a measure in a t-test. From the test, it was found that students in the treatment group used more shared concepts during their discussions, but not significantly more than students in those control group at $p<0.05$. This finding was interpreted to mean that convergent interactions in group consensus building within the treatment group did not occur significantly more than within the control group (see Table 5-11).

Table 5-11 T-test results based on the use of shared ideas by control and treatment groups

	Control Group: Without tools (n=13)		Treatment Group: With tools (n=11)		t (p value)
	Mean	Standard Deviation	Mean	Standard Deviation	
Use of shared ideas during the online discussion	1.69	2.14	2.73	3.69	.858 (.200)

I wanted to further examine the ways in which interactions occurred. In examining the interaction styles in detail, I discovered that there were differences in group participation. Group C in the treatment group and group F in the control group were very inactive. Both groups posted only one or two observations, and their group reports were posted without any feedback or other discussion. In addition, Group F even failed to post two group reports; they posted only 1 report. The student interactions in groups C and F were not functional enough to help students become successful in their group works. The small group interactions are summarized in Table 5-12.

Table 5-12 Descriptions of group interactions during online discussion and report writing

Treatment	Description of Interactions
Group A	All members exchanged their ideas in a structured way, synthesized ideas, and reached agreements about strengths and weaknesses of the web-sites. All group members were involved in group report writing by either drafting the reports, giving feedback, or revising the reports.
Group B	All members wrote their individual observations about the strengths and weaknesses in a report like manner. Each student who volunteered, or was assigned to write, wrote a report by synthesizing ideas from the individual written observations. There was no feedback or revision after the reports were written.
Group C	Students posted their ideas about the strengths and weakness of the web-sites on two occasions. Each of the two reports was written by students who either were assigned by the group leader or volunteered. There was no feedback or revision after the reports were written.
Control	
Group D	All members contributed their thoughts and ideas about the two web-sites. Then two of the four members wrote the group reports. Once the reports were generated, authors clarified that the reports were draft and not the final copies. The authors asked the rest of the groups to give them feedback. Two members responded that the reports were sufficient and no modification was necessary. After the feedback, the reports were posted as final copies.
Group E	All members contributed their ideas by sending brief comments or detailed observations. The assigned writers wrote the group reports. There was no feedback or revision after the reports were written.
Group F	Only one observation about the web-sites was posted. One group report was posted. There was no feedback or revision after the report was written.

Group G	Most members contributed their ideas through posting, email, and ICQ (interactive-- similar to chat). Once the group reports were posted, there was no feedback or revision after the reports were written.

Based on these results, I decided to exclude groups C and F from the analysis and reran the t-test. Because a group was excluded from each treatment and control condition, testing Null Hypothesis 1.b only included two groups in the treatment group and three groups in the control group. Without groups C and F, the test result was substantially significant (p=0.063), but still not statistically significant (p<0.05) (See Table 5-13).

Table 5-13 T-test resuslts based on the use of shared ideas by treatment and control groups without group C and group F

	Control group: Without tools (n=11)		Treatment group: With tools (n=7)		t (p value)
	Mean	Standard Deviation	Mean	Standard Deviation	
Use of shared idea during the online discussion	2.00	2.19	4.29	3.86	1.613 (.063)

The difference in numbers of shared concepts which the treatment and control groups used during their online discussions was found to be substantially significant. This difference indicates that the treatment groups used a significantly higher number of shared concepts than the control groups at p=0.063. However, it was also interpreted that students in the treatment group did not engage in convergent knowledge building on a significantly higher level than students in the control group (p< .05).

Student Performance

Student performance was measured by students' scores on the group project. The group project had two parts: 1) a comparison essay discussing the strengths and weaknesses of two university web-pages, and 2) a letter of recommendation on how to improve a university web-site.

The group project score, which intended to measure the integration level of concepts, was based on the number of concepts and their linked examples written in the group projects. The number of citations and anecdotes (such as principles, classroom examples, everyday experience, and so on.) is an indicator of knowledge integration (Davis, 1998). It is believed that the more citations students mention, the more knowledge they integrate. For the group project, each group wrote two reports: the first one was a comparison of two university homepages, discussing their strengths and weaknesses; the second report was a recommendation on how to improve one university's homepage.

The Project Scores

For each of the comparison and recommendation reports, the number of concepts, ideas, examples, and evidence discussed in the reports was counted and total points were considered as the project scores. On both reports, the treatment group's scores were higher than the control group's scores. The treatment group score on the comparison report was 13.73, whereas the control group score was 8.92. Moreover, the treatment

group score on the recommendation report was 17, whereas the control group score was 8.15 (see Table 5-14).

Table 5-14 Project scores of the treatment and control groups

Treatment/Control	Group	Comparison Report Score	Recommendation Report Score
Treatment	A	16	21
	B	13	13
	C	12	16
	average	13.73	17
Control	D	7	8
	E	11	11
	F	7	0
	G	10	10
	average	8.92	8.15
Total average		11.13	12.21

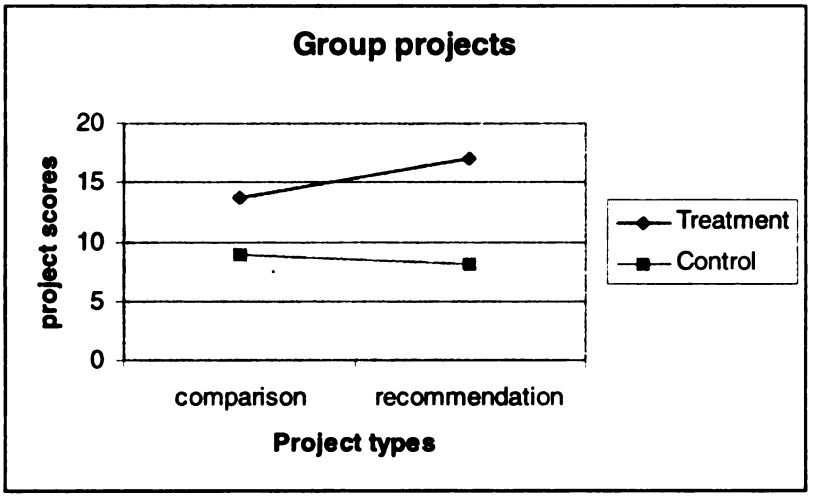

Figure 5-2 Project scores of the treatment and control condition

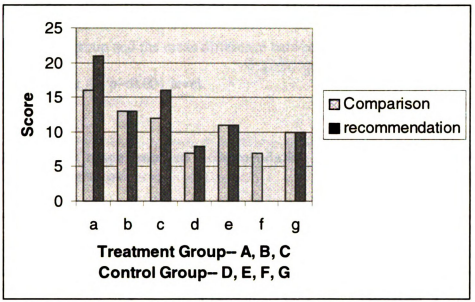

Figure 5-3 Project scores of the treatment and control groups

Results of Testing Hypothesis 2.a:

Research Question 2: How do students who use the tools differ in the ways they write recommendation and comparison report from students without the support tools?

I anticipated that students using tools to support their learning in an electronic learning environment would build more integrated knowledge (i.e., the number of cited ideas and concepts, examples, and new ideas) than students not using such tools.

Null Hypothesis 2.a : Students in the treatment group will not build more integrated knowledge than students in the control group.

The mean recommendation score of the treatment group, who used tools designed to support their learning in an electronic environment, was 17, whereas the

mean of the control group was 7.25. The treatment group scored 9.75 points higher than the control group and the mean difference between the two groups was statistically significant at the $p < 0.001$ level.

Table 5-15 Comparison and recommendation scores of the control and treatment groups

	Control Group: Without tools (n=13)		Treatment Group: With tools (n=11)		t
	Mean	Standard Deviation	Mean	Standard Deviation	
Recommendation (max 30)	8.15	3.83	17.00	3.41	5.93***
Comparison report (max 30)	8.92	1.89	13.74	1.85	6.264***

(*** = significant at $p < 0.001$)

The mean comparison score of the treatment group was 13.74 and the mean of the control group was 8.75. The treatment group's mean score was 4.99 points higher than that of the control group. The mean difference between the two conditions was statistically significant at $p < 0.001$ level. Thus, Null Hypothesis 2.a was rejected.

The probability that the treatment group would build more integrated knowledge than the control group by chance was less than .001. In other words, the t value for the difference in mean scores between the two conditions on the recommendation and comparison reports was significant at $p < .001$. Thus, students using tools to support their learning in an electronic learning environment integrated knowledge (i.e., the number of cited ideas and concepts, examples, and new ideas) more into their group reports than those not using such tools.

Satisfaction

To understand the level of student satisfaction and their knowledge building experiences in the virtual university course, a post-survey was administered. Students' responses to the questions indicated their level of satisfaction and learning experience.

The indicators of student general satisfaction, were responses to survey items, such as " I enjoyed group discussion," and "Group discussion has been useful to me". Their responses to items such as " My group discussion included some discussion of personal issues," "My group discussion experience was boring," "My group discussion via the web made me feel isolated," and "My group discussion experience gave me the feeling that I was really part of a group" became the basis for assessing their satisfaction with the virtual learning environment from a social perspective.

As indicators of learning experience, survey items concerning students' knowledge building experience and general learning experience were asked. The items for knowledge building experience were: " Group discussion helped me to think about web design ideas I would not have thought about alone," "Group discussion helped me to understand the web design concepts more clearly," and " Group discussion helped me to reorganize my thoughts about web design." Items about general learning experience were: "I learned from group discussion" and "Group discussion helped me to plan ways of doing the project."

Levels of Satisfaction and Learning Experience

The means of students' responses to the items regarding their satisfaction and learning experiences are shown in Table 5-16.

Table 5-16 Means of student responses on their satisfaction and learning experience

	Control group: Without tools (n=13)		Treatment group: With tools (n=11)		t (p val)
	Mean	Standard Deviation	Mean	Standard Deviation	
I **enjoyed** group discussion	3.62	.96	3.18	1.17	-.999 (.165)
Group discussion has been **useful** to me	3.62	.96	3.45	.93	-.414 (.342)
My group discussion experience was **boring**	2.00	.58	2.64	1.43	1.471 (.078)
My group discussion via the web made me feel **isolated**	2.08	1.61	2.18	1.40	.169 (.434)

Scale for items: Strongly agree = 5, agree =4, neutral = 3, disagree = 2, strongly disagree = 1.

Results of Testing Hypothesis 3

Research Question 3: How do students using tools to support their learning in an electronic learning environment differ in their evaluation of their learning from students not using such tools?

I anticipated that students who studied with the support tools would report higher satisfaction with their group activities than those who did not use such tools. Null Hypothesis 3.a was formulated to test this assumption.

Null Hypothesis 3.a : Students' satisfaction level of the treatment group will not differ from that of the control group.

Students' satisfaction level was measured by combining their mean scores on items regarding level of enjoyment and usefulness of the group discussions. The mean score for the satisfaction of the control group was 7.23 and that of the treatment group was 6.64. The control group's satisfaction score was .59 higher than that of the treatment group (see Table 5-17). The difference, however, was negligible and statistically insignificant. Thus, Null Hypothesis 3.a was not rejected.

Table 5-17 Combined mean scores of the satisfaction and social aspects of the control and treatment groups

	Control group: Without tools (n=13)		Treatment group: With tools (n=11)		T (p Val)
	mean	Standard Deviation	mean	Standard Deviation	
Satisfaction (1-10 scale) (enjoy + useful)	7.23	1.78	6.64	1.80	-.808 (.214)
Social (1-10 scale) (boring + isolate)	4.08	2.01	4.82	2.44	.815 (.212)

Scale for items: strongly agree = 5, agree =4, neutral = 3, disagree = 2, strongly disagree = 1.

Table 5-18 Self-reported scores of satisfaction and social aspects by control and treatment group

	Control group: Without tools (n=13)		Treatment group: With tools (n=11)		T (p val)
	mean	Standard Deviation	mean	Standard Deviation	

My group discussion experience gave me the feeling that I was really part of a group	3.38	1.04	3.09	1.38	-.595 (.279)
My group discussion included some discussion of personal issues	2.08	.86	2.18	1.17	.253 (.402)

Scale for items: Strongly agree = 5, agree =4, neutral = 3, disagree = 2, strongly disagree = 1.

I anticipated that students who used the support tools would report more convergent knowledge building experience than those who did not use such tools. Null Hypothesis 3.b was formulated to test this assumption.

Null Hypothesis 3.b: The convergent knowledge building experience of the treatment group will not be greater than that of the control group.

The convergent knowledge building experience was measured by combining students' responses to items concerning knowledge building, such as broadening the scope of understanding, reorganizing concepts, and clarifying them (see Table 5-20).

Table 5-19 Combined mean scores of convergent knowledge building experience by control and treatment groups

	Control group: Without tools (n=13)		Treatment group: With tools (n=11)		t (p value)
	Mean	Standard Deviation	Mean	Standard Deviation	
Learning experience (1-15 scale) (broad + concept + reorg)	9.84	2.64	9.55	3.45	-.242 (.406)

Scale for items: Strongly agree = 5, agree =4, neutral = 3, disagree = 2,
strongly disagree = 1.

Table 5-20 Self-reported learning experience by the control and treatment groups

	Control group: Without tools (n=13)		Treatment group: With tools (n=11)		t (p val)
(1-5 scale)	Mean	Standard Deviation	Mean	Standard Deviation	
Group discussion helped me to think about web design ideas which I would not have thought about alone.	3.38	.96	3.36	1.50	-.041 (.484)
Group discussion helped me to understand the web design concepts more clearly	3.31	1.03	3.18	1.17	-.280 (.391)
Group discussion helped me to reorganize my thoughts about web design	3.15	1.07	3.00	1.18	-.335 (.372)
Group discussion helped me to plan ways of doing the project	3.69	1.03	3.64	1.29	-.118 (.454)
I learned from group discussion	3.69	1.18	3.36	1.21	-.672 (.254)

Scale for items: Strongly agree = 5, agree =4, neutral = 3, disagree = 2,
Strongly disagree = 1.

The mean score of the control group on convergent knowledge building experience was 9.84 and that of the treatment group was 9.55. The difference in mean convergent knowledge building scores between the treatment and control groups was very small and statistically insignificant (see Table 5-21). Therefore, Null Hypothesis 3.b was retained (not rejected).

Summary of the research findings

There was no significant difference between the control and the treatment groups with regard to frequencies of participation in online group discussions. However, based on a content analysis of students' interactions during their online discussions, I found that students who received the treatment group used shared concepts more than students in the control group ($p=0.063$). From this I concluded that students in treatment group were more likely to engage in convergent interactions than those in control group.

A significant difference was found between the treatment and control groups in terms of integration of concepts as represented in the group reports. The students in the treatment group integrated more concepts, examples, and evidence in their project writing than the students in the control group.

No significant difference was found between the treatment and the control groups with regard to their satisfaction with group discussions in the virtual university course. Students in both groups had comparable satisfaction levels.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

This chapter contains a summary of the study and a discussion of the findings related to the research hypotheses. This chapter also includes conclusions drawn from the study findings, implications of the study, and recommendations for future research.

Summary

In a WWW-based virtual learning environment where students and teacher are physically separated, the frequency of online interactions among students or with instructors may have an effect on learning. One positive effect is that these interactions may facilitate knowledge building activities in virtual courses. However, negative effects, like lack of interactions, may surface. The lack of such an interaction may be one of the major causes of unsatisfactory learning experiences.

However, problems may arise even when interactions between students in distance learning occur. The types and the quality of interactions matter. Many students in a virtual university simply tend to post their ideas or read others' ideas without engaging in deep thinking processes such as analyzing, evaluating, and synthesizing ideas. Furthermore, students often merely browse the WWW superficially and do not engage in thoughtful and active learning (Ritchie & Hoffman, 1997). If students rarely engage in convergent knowledge building in a virtual university environment, the

knowledge building process is not complete, and students are not able to construct new understanding or build new concepts.

This lack of knowledge linking and structuring activities in the online learning environment was identified as a problem in the networked learning environment by previous studies (Chung, 1999; Harasim, 1990; Harasim, Calvert, & Groeneboer, 1997; Hewitt, 1997) and can have a negative effect on both the students' efforts to synthesize ideas and group collaborative processes (Hewitt, 1997). This study proposed to develop support tools to foster learning in such an environment and investigated the characteristics of interactions with the aid of the support tools in a WWW-based virtual learning environment.

The purpose of this research was to study how support tools facilitate knowledge building processes in a WWW-based virtual university engineering course. Specifically, the first objective was to identify the types of knowledge building activities students engage in when they use support tools. The second objective was to assess the effect of support tool use on student performance. The third objective was to explore how satisfied students were with use of support tools and with the group activities.

The idea of developing support tools for learning strategies came from the theoretical arguments (Palincsar & Brown, 1984; Bielaczyc et al., 1995; Ertmer & Newby, 1996) that using learning strategies such as explanation, summarization and planning/monitoring may help students build their knowledge in place of face-to-face learning. The online support tools developed in this study were three types of online prompts which encouraged students in virtual learning environments to reflect on their

knowledge building by using summarization, self-explanation and planning/monitoring strategies to facilitate knowledge building activities.

For the study, a quasi-experimental study was designed. An undergraduate engineering class of a virtual university was selected as the research site and students were randomly assigned two different environments: 1) without support tools, and 2) with support tools. The virtual engineering course was "Introduction to the Internet" in which students learned about broad aspects of the Internet such as the History of the Internet, Internet tools, Design of Web pages, and other technical topics. I created a group activity and the instruction for the two week period of the "Design of Web pages" unit. In the unit, the students' tasks were as a group to discuss and write the strengths and weaknesses of two different university homepages and to write recommendations on how to improve one university homepage. A group leader was assigned as a moderator to coordinate and facilitate the group work.

The study analyzed the frequency and types of online discussion in order to understand student knowledge building processes, evaluated group reports in order to see the extent of students' knowledge integration, and analyzed the self-reports to find out about students' satisfaction and convergent knowledge building experiences in taking the virtual university course.

Discussion and the findings

The discussion is organized around the three research questions, as follows.

Research question 1:

How do students using the tools to support their learning in an electronic learning environment differ from those who do not use these tools in the knowledge building processes?

Research Hypothesis 1.a

(Frequency of interaction)

There will be different interaction frequencies in online group discussion between students with the support tool and those without it. Students in the treatment group will participate more often than those in the control group.

There was no significant difference between the control and the treatment groups in interaction frequencies. Students in the treatment group did not interact more frequently than those in the control group.

This finding is different than what I expected. I expected that answering the summary and reflection prompts would enhance students' ability to clarify concepts, organize thoughts, and do more planning of other group tasks. Therefore I thought that the students would exchange their ideas more frequently. The treatment group posted an average of 18 messages while the control group posted 16.75 messages. The treatment group exchanged 1.25 messages more. However, the difference was not statistically significant at $p<0.1$ level. This finding is also different from the research finding of Bures

(1997), which reported that the use of group reflection forms and an assigned moderator role in online small group activities increased student interactions at $p<0.05$.

I wanted to examine factors, which might have contributed to the conflicting results of the two studies. The factors I examined were 1) frequency is not a good indicator, 2) role of moderators, and 3) teacher was not proactive.

1. Frequency of interaction was not a good indicator.

I think one of the factors which might have influenced this result--- that is, no significant difference in the participation frequency between the treatment and control groups--- was that the frequency of interaction was not a good indicator of student interactions in my study. It could be that the message frequency could not represent or capture the magnitude of student interaction in this study. Close observation of student interactions by examining their messages captured some differences between the two groups. Students in the treatment group posted their ideas in a very organized way. They wrote long individual reports rather than a short comments about a web design issue. Each student from two of the three treatment groups posted their individual reports about the strengths and weaknesses of two web sites. Then they discussed differences, agreed or disagreed on several matters, revised, and synthesized their reports into group works. On the other hand, in the control group, some students posted their individual thoughts about the web sites' strengths and weaknesses, but these reports were rather short. In some cases, students posted their thoughts in several postings rather than in one organized posting. If students in the treatment group had written several short essays

instead of the long individual reports, the participation frequency of the treatment group would have increased.

2. Role of moderators

There was, however, an important aspect of student interaction which was uncovered through frequency analysis. I observed that two groups, one from the treatment and the other from the control group, had sparse interactions and did not engage in any kind of meaningful interaction within their groups. The lack of interaction of these two groups was surprising, because I thought that I had designed a virtual unit which would facilitate student interaction. For the "Design of Web Pages" unit in EGR124, I had the students perform a project-based group activity, provided an online group communication facility for them, and made available the online support of the instructor and TAs. The three necessary conditions for successful interaction in online learning environments, group activity, material support and social support (Gomez& Gordin, 1996; Levin, 1995) were present in this virtual course. Also, a group moderator facilitated student interaction within the group.

The design effort did not work for group C in the treatment and group F in the control group. In this case, the lack of interaction among student members could indicate that the role of the moderator or teacher is important. The moderator or teacher motivates and encourages member participation. In the case of treatment group C, the moderator tried to encourage students to share their thoughts and ideas and sent email messages to the members. However, in one instance, a student member reported a technical difficulty in posting her message, the moderator failed to encourage her future participation by

saying that he would write the group report without her input. Instead of volunteering to do the work by himself, the moderator should have given the student suggestions on how to solve her technical problems. Even though the moderator had intended to enhance group interaction, he did not encourage member participation in this situation. It seems that he imposed his decision on the members. Below is the example when a group member, Sally explained why she could not post her comments yet and when she could work, how the moderator volunteered the work.

From Sally to the group members:

> Hi there,
> sorry i haven't gotten a hold of any of you guys yet. i haven't figured out how to post on that page yet, but i'm sure i could figure out how to by Friday if you need me to. if you want me to type up the report i can do that, but i'd appreciate if all the group can email me on their suggestions for what msu can do better so i can compile them. i don't have time to do all the research for it since i have 3 midterms this week. I'll be done with everything else by Thursday, so just let me know what you want me to do. If someone else is going to do it, then i can email them some of my comments.
> Sally

From the moderator to Sally:

"Sally, I will write the comparison, don't worry ."

In the case of group F in the control group, the moderator did not take much initiative to enhance interaction. In addition, very little interaction and group effort occurred. When moderators were not successful in facilitating student interaction, the teacher should have intervened and encouraged or facilitated group interactions. During the unit, by design, the instructor did not initiate any contacts with students during online discussions about their group tasks in either the control or treatment groups. The

instructor's involvement in the group discussion was different from Maccabe's recommendation (1997), which suggests teachers' frequent participation and clarification of their expectation in online learning environments in order to increase student interaction.

3. Teacher was not proactive.

In observing the teacher's role in this study, I realized that the instructor merely being available online is not sufficient for students whose group does not interact. The availability of the instructor and the TAs on the network did not equate with the meaningful interactions with students, facilitation of student interaction, or clarification of teacher's expectations in the absence of student interaction.

My expectations on a teacher's role are different if students who take initiative in communicating. If students take initiative in group communications and ask questions or requeste for assistance, teachers would be able to obtain clues, give advice and other kinds of support for student learning.

However, because the students in the Group C and F did not take much initiative to communicate, it would have been helpful if the teacher initiated an active role when dealing with those students. When there is no interaction among group members, the instructor should clarify what is expected from them, that is, students should take initiative for their own learning by asking questions, communicating with the instructor and group members, and so on. In a group of students with very low interaction, teacher intervention is necessary to help them interact with each other and to coordinate their work.

Research Hypothesis 1.b

There will be different participation patterns (divergent vs. convergent) in online group discussion between students with the support tool and those without it. Students using the support tool will engage more in convergent interaction than students not using the support tool.

My hypothesis test, the difference between participation level in convergent interaction between the treatment and control group, was not statistically significant ($p<0.05$).

I predicted that students who used the self-explanation and reflection prompts in a virtual course would participate in convergent knowledge building activities more because answering the summary and reflection prompts would enhance the ability of students to organize concepts, clarify them, and plan/monitor group work more.

Individual expertise or knowledge tends to affect the quality of group discussion in a learning environment and the quality of a group discussion, in turn, helps students solve problems and increase their learning achievement (Webb et al. 1998; Cohen 1994 ; Salomon 1993). Webb et al. found out that students of higher abilities contributed more detailed explanations in group discussions than lower ability students. Elaborate explanations encouraged other group members to engage in more meaningful exchanges,

to agree or disagree with others' ideas, and to link, discriminate, and synthesize different ideas (Webb et al, 1998).

The hypothesis test result, which was concerned with the difference in participation levels of the treatment group in convergent interactions was not statistically significant ($p < 0.05$). During online discussion, students who received the support tool did not engage more in convergent interaction than those in the control group.

The finding was different from what I expected. The test result, however, seems to be consistent with Webb et al. (1998), which found that the frequency of high-level (or constructive) interaction remained similar across different ability groups. In their study, students who belonged to below-average ability group engaged in asking questions, paraphrasing other students' suggestions, and defending their own suggestions as much as the group of above-average ability. The students in different ability groups had similar interaction frequency levels, whereas different ability group students showed different quality of interaction. Higher ability students provided more detailed explanation, while the lower ability group students exchanged a quick answer only.

I further examined the content of the student interactions, excluding the two groups who did not engage in group interactions. By examining the content of student interaction, I found that the treatment groups used a higher number of shared concepts during their group interactions at $p=0.063$. I interpreted this result to mean that, in the treatment group, certain themes emerged from online group discussion. The students who used support tools in the treatment group engaged more in elaborating of, connecting, and discriminating between ideas. These students used their shared concepts more during knowledge building than students in the control group.

Although there was no statistical significance found in the difference between the treatment and control groups in the frequency of engaging in convergent interaction, students in the treatment group seemed to engage in more convergent interaction than students in the control group.

Research Question 2:

How do students who use the tools differ in the ways they write recommendation and comparison reports from students without the support tools?

Research Hypothesis 2.a

(Integration of knowledge)

Students using tools to support their learning in an electronic learning environment will build more integrated knowledge (i.e., the number of ideas, concepts, examples, and new ideas) than students not using the support tools.

There was a significant difference between the treatment and control groups in the levels of integration and elaboration of concepts in the group reports ($p<0.05$). The treatment group used more concepts, examples, and new ideas in their project writing than the control group.

This result supports my hypothesis that students who use the support tools which prompt them to summarize the lecture, explain the concepts, and reflect on what they need to know and what they need to plan to do the group tasks, would build more

integrated knowledge than students in the control group, who did not receive any prompts.

I expected this result, because the learning strategies prompted by the tools such as self-explanation and self-monitoring are key activities for knowledge building. This could seem to support the idea that self-explanation helps students internalize principles and construct specific inference rules for solving problems (Chi & Bassock, 1989 cited in Webb, et al, 1995). It may also that self-monitoring increase students' consciousness about what they know, and builds awareness of their own knowledge gap (Chi & Bassock, 1989 cited in Webb, et al, 1995).

My research found that this hypothesis was consistent with other recent findings. The researches support the positive effects of the use of learning strategies such as self-explanation and self-monitoring on student knowledge building, especially on convergent knowledge building such as elaborating or organizing their ideas( ). A study by Davis (1998) about the effect of using reflection prompts in knowledge integration confirms that focusing students on reflection significantly increased knowledge integration. She also suggests that students identify weaknesses in their knowledge by engaging in reflective activity. Then they will be more ready and able to connect and reorganize their ideas. A study about the role of reflection in a CMC suggests that the reflection is helpful for students to construct meaningful understanding (Andrusyszyn, 1996).

Here is students' self report about the positive impact of the support tools on their knowledge integration. Treatment group students reported that using the support tools helped them engage in knowledge integration. From 11 treatment students, one student response was negative, two responses were neutral, and eight responses were

constructive. Students in the control group did not use the support tools, so their information about the support tools is not available.

Through their use of the summarization, self-explanation, and planning/monitoring prompts, students in the treatment group experienced vigorous knowledge building and re-conceptualization. One student mentioned that the self-explanation prompts forced him to engage in constructing his knowledge more deeply: " I like them because it allows me to process the information more thoroughly." Another student reported that it helped him to reconstruct his ideas about the lecture: "I found the prompts make me rethink the lecture and get an overall picture of the concept. It was useful in that regard." Two students felt that the prompts helped them focus on identifying main ideas of the lecture: "Sometimes I feel that the prompts are helpful because they help you to recall and concentrate on the things you learned in the lecture." and "They reinforced the important points of web design, which helped us focus on what to look at when reviewing the web pages." Some students said that it helped them expand their knowledge: "They expand my knowledge a little bit.", "Yes, I think they helped me a lot."

Also, students noted that the self-explanation prompts helped them check whether they understood the concepts, so they would become aware of their knowledge gap. One student described her experience, saying " It makes me question myself did I learn something instead of just brushing it aside." A student found that the self-explanation prompt led to more self-monitoring as well as more self-explanation: "I have to explain the information beyond just watching the video, and then know what I learned and what I did not yet understand."

Both the statistical analysis and the student self report endorse the hypothesis that support tool use encourages students' integration of knowledge.

Research question 3:

How do students using tools to support their learning in an electronic learning environment differ in their evaluation of their learning from students not using students such tools?

Research Hypothesis 3.a
(Satisfaction)

Students who studied with the tools will report higher satisfaction with their group activities than those without the tools.

Students in both groups had a comparable satisfaction level. I expected students using the tools would more clearly grasp ideas and have a better understanding of the concepts covered in the lecture and would be better prepared to do their group projects. I hypothesized that if students were better prepared and were ready to do the group work, then students would feel more satisfied with themselves. If students were well prepared, they would contribute more elaborate or more intelligent explanations or engage in more interesting and relevant types of discussion with group members than those who were

less prepared. I thought students would experience more satisfaction with their own contribution to the group.

The study result did not support my hypothesis. Students as a whole were satisfied (mean=3.4) with their own learning in the virtual learning environment and the satisfaction levels of the treatment and control groups were not statistically significant. Moreover, the control group (mean = 3.62) enjoyed more than the treatment group (mean = 3.18), and satisfied (mean = 7.23) than the treatment group (6.64) in general. With support tools, treatment group might felt pressured to think about web design issues more deeply and became less satisfied. Without support tools, control group might not felt any pressure to think more deeply and did not experience any problem.

The result of my study corresponds to other previous studies about student learning experience in online learning environments. Those studies report that there is not much difference in student satisfaction across different learning environments. It could be that satisfaction is strongly related to individual expectations, so differences in individual expectations on the course might have influenced the no difference result.

Thus, the satisfaction level in this study did not give any clue to the cause of the difference in the level of engagement in knowledge building processes or knowledge integration between the treatment and control group, as evidenced in their reports. The satisfaction level represents subjective and affective state of students, but not knowledge building in cognitive aspects.

Research Hypothesis 3.b

Students who use the tools will report more convergent knowledge building experience than those who do not use the tools.

There was no significant difference between the students in the treatment group and the students in the control group in terms of their self-reported amount of convergent knowledge building experience ($p < 0.05$). However, there was a difference in the student self-reports about their experience with the group activities. Students in the treatment group reported their engagement in convergent knowledge building while students in the control group did not. The analysis of their self-reports are as follow.

The prominent difference between the two groups is that some of students in the treatment group stated that the most valuable part of their learning experience was their convergent knowledge building caused by their group activities. None of students in the control group reported a convergent type of learning from the group activities.

Students in the treatment group valued the process of synthesizing different ideas into one report, structuring and restructuring their ideas, applying the concepts learned from the lecture into the project, and learned multiple perspectives from their group members. For example, two treatment group students stated their most valuable experience as synthesizing theirs' and other group members' ideas into their group report writing. One student said that " Drafting the essay for the comparison of the MSU and U of M web sites was most valuable to me. I used ideas and opinions from group members

and from my own observations to create in my opinion a very objective and interesting comparison of the MSU and U of M web sites." Another student said, " The compilation of our ideas into a single paper was the most valuable part of the whole experience for me." These two students describe the convergent knowledge building processes between group members. They formed their own ideas, exchanged and discussed ideas with group members, and then synthesized different ideas into one report.

Two other treatment group students described their convergent knowledge building processes in structuring and restructuring ideas: " Thinking about how the different web sites were designed and putting it on paper." " The most valuable part was trying to be concise in my writing of the first report. I felt I had to keep it to 300 words as directed, and it was hard to do so much editing (my original report was about 600 words). I wanted to be as direct and concise as possible, and having that goal in mind allowed me to do so." These two students were describing their experience of idea linking and idea reorganization.

Another treatment student talked about his effort to apply the concept learned in the group project: " Honestly, it was an attempt at applying what was learned in the lecture. It was simple. I guess what it gained was remembering concepts more by thinking about them in the project."

The rest of the treatment group saw the benefits of recruiting multiple perspectives from the group interactions: "Seeing what other people felt between the two web pages was the most valuable. Some people in my group brought up ideas that I would have never thought of. I thought that was very interesting and a valuable learning experience." " Discussing what we liked and disliked about each of the sites." " You

worked as a group, but on your own time and still had good communication." and " I liked the idea that we divided the work but still shared ideas with each other. I also enjoyed meeting other people in the class that way."

Students in the control group valued the opportunities they had to see different perspectives or ideas from their group members. About the benefits from the group interaction, four out of 13 control group students either did not respond or gave negative responses. Two students said that " Nothing really stood out", and " None of it was valuable". The rest of control groups mentioned that they valued the opportunities of getting different ideas from their group members: " Getting the input from fellow students. This helped me realize what different people were looking at in the two pages. It will be useful when I finally am able to start working on my web-page and is just interesting to know." " I enjoyed the collaboration of ideas. There were a lot of ideas that my group members contributed that I didn't think of. It really helped open my eyes to new ideas." and " I think getting other peoples opinions on things and being able to see other peoples perspectives, because other people look at things differently and see different details."

Almost half of students in the treatment group reported convergent knowledge building experience and another half of the treatment group reported divergent knowledge building as the most valuable part of their group activities. Whereas most of the control group students reported divergent knowledge building as the most valuable experience of their group activities. Looking at what the students said about their most valuable experience from the virtual learning experience, comments about their convergent knowledge building showed up only in the treatment group.

Conclusions

The overall question of this study was whether the students who received the support tools engaged in knowledge building, especially in convergent knowledge building. Following are the major findings of this study:

1. With the support tools, students in the treatment group did not interact more frequently than those in the control group. The difference between the control and the treatment groups in participation frequencies was not statistically significant ($p < 0.05$).
2. With the support tools, certain themes and group consensus emerged from the online group discussion among members of the treatment group. However, the difference in shared concept use between the treatment and control groups was not statistically significant ($p < 0.05$).
3. With the support tools, students in the treatment group integrated more concepts, examples, and new ideas into their report writing. Statistically significant difference ($p<0.001$) was found between the treatment and control groups.
4. Overall, students in both the treatment and control groups were satisfied with their learning experiences with the virtual university course.
5. The students in the treatment group reported their group learning experience as convergent knowledge building experience.

In addition to the above findings, I found out that the measures of frequencies of the overall interaction and convergent interaction were not the best indicators of student

knowledge building activity. It seems that the length or content of a student's message would better represent or capture the magnitude and types of student knowledge building activities. I also found that the roles of moderators and teachers are important for groups of students who are inactive. Moderators and teachers need to know who to facilitate and how to sustain interaction in a group.

In summary, the use of support tools enhanced student performance in integrating concepts in group report writing. Students in the treatment group, who used the support tools and actively participated in social interactions in the online virtual university course, integrated significantly higher numbers of different concepts and ideas in their group report than students in the control group who just engaged in social interaction. In an analysis of smaller groups, with the exception of the two inactive groups, the treatment group used substantially higher numbers of shared concepts. In addition, students who used the support tools in social interactions reported that these tools helped them rethink the concepts in the lecture and get an overall picture of the concepts. These students also reported that the experience of integrating ideas into a report was valuable: "The compilations of our ideas into a single paper was the most valuable part of the whole experience for me." These results appear to support the idea that the use of summarization, self-explanation and planning/monitoring strategies with group interaction facilitates convergent knowledge building in a networked virtual university learning environment, thereby increasing students' knowledge integration.

Implications for Theory

This study has an implication for theory that the opportunity to engage in interaction itself is not enough for students to integrate knowledge or develop/ improve the coordination of group work in an online learning environment. Students' frequent interaction with their peers is not enough either for students to integrate knowledge or develop/ improve coordination of group work in an online learning environment. The type of interaction matters, especially because convergent type of interaction facilitates students' knowledge integration.

My study finding suggests that the high frequency of group interaction itself is not enough to promote student knowledge building, such as coordinating their group work and bringing different ideas together. While the interaction frequencies of students in both treatment and control groups were almost same, students in the control group, who engaged in group interaction, only reported their divergent knowledge building experience. Moreover, compared to the treatment group, less integration of knowledge occurred in the control group. In other words, students in the treatment group, who had the opportunity to engage in group interaction, as well as using summarization, self-explanation, and planning/monitoring prompts, engaged in more convergent knowledge building experiences and integrated more concepts and examples than student in the control group.

These results appear to support the theory that convergent types of interaction facilitate students' knowledge integration. Students in the treatment group who experienced more convergent knowledge building were able to integrate more concepts and examples than students in the control group who did not experience convergent knowledge building.

These results seem to support the theory that the use of self-explanation, summarization, and planning/monitoring prompts facilitates convergent knowledge building interaction in online college courses, thereby increasing students' knowledge integration. Webb et al. (1995) suggested that in a small group discussion the quality of interaction (i.e., whether or not students provide elaborate explanation) facilitates students' constructive activities, which in turn lead to student knowledge integration. In support of this theory, my study suggests that students who used support tools, prompts of summarization, self-explanation, and planning/monitoring experience convergent knowledge building in their group interaction which in turn leads to knowledge integration.

Implications for Design

This study's implication for the design of a virtual learning environment is that one can design support tools to promote student convergent knowledge building and higher knowledge integration. My study findings indicated that the group of students who used the support tools of summarization, self-explanation, and planning/monitoring experienced convergent knowledge building and integrated knowledge more than the group of students who did not use the support tools.

Recent research recognized the lack of support for the quality of student interaction (i.e., whether convergent knowledge building is present or not) in networked learning environments. Hewitt (1997) found out that it is more difficult for students to focus on the topic of a discussion than to branch off to a fragment of the topic or access

and respond to the bigger picture or essential issue of the discussion. The necessity of self-regulation ability of students to help them implement a successful online group learning is well described by Hewitt: "learners need to have awareness of group practices, and how learner can productively engage in those practices." (p.4). Hewitt et al. (1998) identified that "coordination" of student group work and the achievement of "group coherence" are crucial issues in online learning environment and suggested the development of new tools;

> New tools are needed that help learners analyze the activity of the collective and to contrast that activity with their own involvement. In the same sense that meta-cognitive computer tools permit reflection about cognitive processes, so should " group cognition tools" be developed to permit reflection about social processes and one's own role in them (p. 4).

Support tools in my study were not developed to analyze the activity of the group and to compare and contrast that activity with an individual student's own involvement, as Hewitt described above. Instead, the support tools were developed to prompt students to summarize the lecture, explain the concepts, and plan and monitor their own learning processes at the individual level. Students' use of support tools at individual level might have helped them to develop their ability to coordinate their own learning processes. In turn this ability could have been used to use to monitor the group processes and students' own learning. This suggests a possibility that one can design support tools in a virtual group learning environment to encourage reflection about group processes and student's own role in them.

In designing a virtual learning environment with the support tools, we should also consider that some groups of students may be inactive. Thus, teachers and moderators should take active roles in a virtual learning environment, especially for the student

groups who are inactive. The role of teachers as facilitators is not to do less than lecturing but to do more by paying attention to student interaction and progress, and giving timely guidance. Teachers should make it clear about what they expect from students and encourage them to take initiatives for their learning by asking questions, clarifying, and communicating with their peers and instructors in a virtual learning environment.

In order to facilitate group interaction successfully in a virtual learning environment, teachers need to know what types of questions to ask and how to sustain the interaction. Sometimes, it would be beneficial for students to learn how to ask questions and communicate constructively with their peers. This would be consistent with Webb et al.'s (1995) finding which recommended the need to encourage students to give explanations rather than a quick answers in order to enhance students' constructive activities in group learning settings.

Recommendations for future research

The results of this study suggest that students who used the support tools, prompts of summarization, self-explanation, and planning/monitoring experience convergent knowledge building in from their group interaction which in turn leads to student knowledge integration. However, the study did not investigate how support tools promoted student knowledge building experience and knowledge integration. For example, the results did not indicate whether use of support tools helped students to explain more elaborately to their group members, enabled students to understand their peers' ideas better, or enhanced their ability to coordinate their group work. Future

research should analyze how support tools promote student knowledge building and knowledge integration.

My study identified the situation when more facilitative role of teachers and moderator would be helpful and suggested that teachers and moderators need to be proactive and knowledgeable how to facilitate students' interaction, especially with students who are inactive. Future research should study the roles of teachers and moderators and the effective ways of facilitating student interactions in a virtual learning environment.

Epilogue

As discussed in the previous chapters, the research results support my hypothesis that use of reflective prompts enhances student performance in integrating diverse concepts and experience in more convergent knowledge building. While this study did not directly capture or provide descriptions of how this convergent knowledge building occurs among the students because it was beyond the scope of the study, the course instructor had some thoughts about the processes involved.

Addressing this issue now, I would like to share what the course instructor (Virtual course, Eng 124) and I discussed. He brought up processes (mechanisms) of student convergent knowledge building when I discussed the research result with him. He speculated that the reflective prompts "let students engage in divergent and convergent process by using their imagination and reviewing materials. They also allow them to drive their learning questions. If the teacher asks a question, students answer the question and that is it. They do not push themselves any further. By responding to the prompts and exchanging their ideas, students better judge, explore more, and pay more attention. The prompts force them to view all materials, and make them think about the issues and integrate those different issues into their own thinking."

He pointed out the positive effect of reflective prompts by saying, "I felt that the students learned far more about web design with the addition of the reflective prompts. By allowing them to express to others what they learned, it solidified their knowledge and allowed them to hear other students restating the concepts using their own words."

The instructor plans to use reflective prompts as instructional strategies in his other classes. He values the time when students are asked to provide their own interpretation of the material and when they read other's interpretation of the material. He speculated that "Each time a student asks another student a question, there is learning that happens at both ends of the question. If the Teaching Assistants answer all of the questions, 50% of the learning opportunities are lost."

The instructor's speculation about how students engage in convergent knowledge building and his plan to use the reflective prompts as instructional strategies provide additional support for the effect of reflective prompts in student knowledge integration.

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APPENDICES

APPENDIX A

CONSENT FORM AND PRE-SURVEY

Letter and consent form for virtual university class students

I am a Ph. D. candidate in Cognition and Technology program, College of Education, Michigan State University. As my dissertation research, I designed the study to examine how different instructional prompts influence students' learning in a virtual university course.

The Design Workshop is one of your class projects, so all students are required to carry out the project as a small group whether they participate in my study or not. The project assignment is writing your recommendation to improve the existing online instruction material including your analysis and evaluation of the existing instructions.

The students who volunteer for the research will be randomly assigned to a control group or the two experimental groups: A control group will be assigned to a learning environment where no prompts are available to complete the tasks. The experimental groups will be assigned to an environment either with an activity prompts or with reflective prompts. The activity prompts will provide procedural guides to complete the project. The reflective prompts will give additional cue to think about their learning processes.

Your participation is voluntary and you can withdraw from the study at any time without penalty. There will be no penalty for not participating in this study. All of the data that I collect will be shared with your instructor and treated with strict confidence; your name will not be used in any reports about this project, and any identifying characteristic will be disguised.

If you participate in this research, you will have a chance to win one of the two twenty-five-dollar gift certificates. After the Design Workshop period, the lottery will be generated to give away the awards to two students among those who completed the workshop. I also believe that the knowledge you will gain by participating in the research will be valuable in understanding of your own learning processes and you will develop deeper understanding.

I would like to ask you to participate in the study, fill out the surveys, and give me permission to observe your online virtual class, access your written work, test scores, and other learning activity products.

If you need any further information, please contact SeJin Chung at 349-8653 or chungsej@pilot.msu.ed

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Consent for participation

I have read the above description and understand the nature of my involvement in it. I have been assured that in any case, my identity will not be revealed.

I agree to participate in the survey, interview, and give you permission to have access to samples of my work AS DESCRIBED ABOVE.

Date _____

date _____

Name _____

E-Mail _____

Course _____ Semester (U98,F98,S99, etc.)
_____

If you have any questions regarding this form, please contact SeJin Chung at 571-349-8653 (MSU College of Education) or Dr. Charles Severance at 517-353-2268 (MSU College of Engineering).

Again, thank you for your participation.

Gender (M/F) _____

Age (1=Less than 17, 2=18-22, 3=23-32, 4=33-40, 5=41 and over)
_____

Interest in Course
(1=no interest 2=mild interest 3=don't know 4=quite interested 5=very interested)
_____

At this time, how would you rate your skill in this topic area from 0 to 100 where 100=expert [ ]

Years of: Computer use [ ] Network use [ ]

Check here if you can access the Internet: From home ◉ From school ○ From work ○

Which location do you use to access the Internet most often? [ ]

What is your most commonly used speed and connection (modem, etc)? [ ]

How long have you been studied in online learning environment before this class?

None ○ One course ○ Two courses ○ Three courses ○ More than four courses ○

For the following, describe your skill level
(1=no knowledge 2=not competent 3=neutral 4=competent 5=very competent)

Word Processing: [ ] SpreadSheet: [ ] Web Browser: [ ]

Chat Rooms, Bulletin Boards, Network News [ ]

File download or transfer (FTP, Fetch, etc) [ ]

Graphics Programs such as Photoshop [ ]

Use of the Internet to do research [ ]

Indication of general study habits:
strongly agree=5, agree=4, neutral=3,disagree=2, strongly disagree=1, Not applicable=0

I usually plan how to study or how to solve the problem

I usually take notes of the main ideas of the lecture or assigned readings.

I quiz myself to make sure that I understand the material I have been studying

I usually ask/discuss questions to clarify to my classmates, TAs, and the instructor

---

Ideally what percentage of your learning should come from (total should be 100%):

Interaction with classmates

Interaction with your instructor or TAs

Your independent work with content

Other Describe

Thank you for taking the time to fill out this survey. Submit Query

APPENDIX B

ACTIVITES AND INSTRUCTION FOR THE TREATMENT GROUP

Topic: Design of Web Pages

Lecture Material (October 2 - October 9):

Our guest lecturer this week is a great friend - Sue Davidsen of the Michigan Electronic Library.

Part 1: Video (11:07)
Part 2: Video (43:40)
Part 3: Video (15:36)

Activities:

Note: You are currently a member of group A

You can check the group membership here.

1. You will do two group reports comparing two web sites. Here are the instructions.
2. After you have viewed the lecture, you must fill out the Lecture Summary Form.
3. You will have to take the Quiz before Midnight October 9, 1998
4. You will have two full weeks to discuss the group reports in Web-Talk using the topic Group Discussions for this web design workshop. You have to submit your group reports in Web-Talk before midnight October 16, 1998.
5. You must answer a survey about the group project before October 21. This survey will be available sometime after October 16.

Optional Handouts:

Lecture notes in PowerPoint and PDF

To view PDF files, you will need the free Adobe Acrobat Reader from www.adobe.com. To view and print the PowerPoint files you will need either (1) PowerPoint, (2) the PowerPoint Viewer (from www.microsoft.com), or (3) Internet Explorer 4.0 (comes with Windows-98).

Welcome members of Group A

By now you should have received E-mail assigning you to a group for this activity. You will also find a separate web-talk activity for each group which has been set up. If you have not yet been assigned to a group, contact the instructor immediately.

Description of Group Project

Activity: The task of each group is to submit two group reports: discussion of strengths and weakness of the two university homepages (MSU and U of M) and a recommendation on how to redesign the homepage of MSU. You and the rest of your group will support your comparison and recommendation based on the design theory from lecture 3, Design of Web-pages, and other readings of your choice. You are required to discuss the project with your classmates by using Web-Talk.

Here is a scenario which you are to use the design concepts learned from the lecture to solve the problem.

Scenario: Your group is working as web-page designers for a company which Produces web-pages for higher education institutions. Your group is assigned to redesign the homepage of Michigan State University. Your boss asks you to discuss the strengths and weakness of current MSU homepage (http://www.msu.edu) and compare it with the homepage of University of Michigan (http://www.umich.edu) and write a recommendation on how to redesign the homepage of MSU.

Learning Strategies

We suggest that you use two strategies called "self-explanation" and "self-monitoring" to help you understand new concepts in the lecture so as to produce better performance in problem solving situations.

Self-explanation strategies are
a) summarizing a lecture by identifying main ideas,
b) working with concepts using concrete examples, and
c) connecting the main ideas with concepts and examples.

Self-monitoring strategies are
a) Planning your learning activities by asking questions such as "Is there anything I need to think about as I progress", and
b) Clarifying and addressing problems by asking yourself questions such as "What do I need to know" or "What needs to be clarified?"

Your **lecture summary form** will help you use these techniques for this project.

Activities

To receive credit for the group assignment, you must post two reports to the Group Web-Talk before the due date. Participation in Web-Talk will also be part of the individual student's grade. It may be used as an adjustment (up or down) from the group grade.

A 300 word discussion of the strengths and weaknesses of the MSU and UM home pages
A 300 word report on how the MSU home page might be improved

The same group member cannot post both reports. One report must be posted by one group member and the other report must be posted by someone else. The Instructor and TA's will be immediately notified when you make the posting so that it may be graded.

APPENDIX C

PROMPTS

1) Summarize the lecture: identify the main ideas and write a brief statement for each idea.

1.1) After the summary, please think about the following questions and write your yes/no responses to the questions with brief explanations.

a. Do I understand the lecture well?
b. Are there things to clarify or improve? If yes, what are they? What will I do now to remedy the situation?

2) Identify two particular important concepts, explain them, and give examples.

2.1) After explaining the concepts with examples, please think about the following questions and write your yes/no responses to the questions with brief explanations.

a. Do I understand the concepts ? If not, what don't I understand?
b. Do I understand how they work? If not, what can I do to remedy the situation?
c. Is there anything more I need to know about the concepts? If yes, what is it?

3) Discuss how one of the two concepts you wrote about can be used in designing a web page.

3.1) Please think about the following questions and write your responses.

a. What concepts or main ideas I really don't understand and what I can do now to remedy the problem?
b. What specific things do I need to think about for my two tasks: 1) to discuss strengths and weakness of the two university home pages and 2) to write a recommendation? List them.
c. What concepts will I use for my two tasks: 1) to discuss strengths and weakness of the two university home pages and 2) to write a recommendation? List them.

APPENDIX D

ACTIVITES AND INSTRUCTION FOR THE CONTROL GROUP

Topic: Design of Web Pages

Lecture Material (October 2 - October 9):

Our guest lecturer this week is a great friend - Sue Davidsen of the Michigan Electronic Library.

Part 1: Video (11:07)
Part 2: Video (43:40)
Part 3: Video (15:36)

Activities:

Note: You are currently a member of group d

You can check the group membership here.

1. You will do two group reports comparing two web sites. Here are the instructions.
2. After you have viewed the lecture, you must fill out the Lecture Summary Form.
3. You will have to take the Quiz before Midnight October 9, 1998
4. You will have two full weeks to discuss the group reports in Web-Talk using the topic Group Discussions for this web design workshop. You have to submit your group reports in Web-Talk before midnight October 16, 1998.
5. You must answer a survey about the group project before October 21. This survey will be available sometime after October 16.

Optional Handouts:

Lecture notes in PowerPoint and PDF

To view PDF files, you will need the free Adobe Acrobat Reader from www.adobe.com. To view and print the PowerPoint files you will need either (1) PowerPoint, (2) the PowerPoint Viewer (from www.microsoft.com), or (3) Internet Explorer 4.0 (comes with Windows-98).

Welcome members of Group A

By now you should have received E-mail assigning you to a group for this activity. You will also find a separate web-talk activity for each group which has been set up. If you have not yet been assigned to a group, contact the instructor immediately.

Description of Group Project

Activity: The task of each group is to submit two group reports: discussion of strengths and weakness of the two university homepages (MSU and U of M) and a recommendation on how to redesign the homepage of MSU. You and the rest of your group will support your comparison and recommendation based on the design theory from lecture 3, Design of Web-pages, and other readings of your choice. You are required to discuss the project with your classmates by using Web-Talk.

Here is a scenario which you are to use the design concepts learned from the lecture to solve the problem.

Scenario: Your group is working as web-page designers for a company which Produces web-pages for higher education institutions. Your group is assigned to redesign the homepage of Michigan State University. Your boss asks you to discuss the strengths and weakness of current MSU homepage (http://www.msu.edu) and compare it with the homepage of University of Michigan (http://www.umich.edu) and write a recommendation on how to redesign the homepage of MSU.

Activities

To receive credit for the group assignment, you must post two reports to the Group Web-Talk before the due date. Participation in Web-Talk will also be part of the individual student's grade. It may be used as an adjustment (up or down) from the group grade.

A 300 word discussion of the strengths and weaknesses of the MSU and UM home pages
A 300 word report on how the MSU home page might be improved

The same group member cannot post both reports. One report must be posted by one group member and the other report must be posted by someone else. The Instructor and TA's will be immediately notified when you make the posting so that it may be graded.

APPENDIX E

POST-SURVEY FOR THE TREATMENT GROUP

Please indicate your reaction to your experience participating in **group discussion** during the Design Workshop Project.

Strongly agree = 5, agree =4, neutral = 3, disagree = 2, strongly disagree = 1.

So far, group discussion has been useful to me. 1

Group discussion helped me to think about web design ideas I would not have thought about alone. 1

Group discussion helped me to reorganize my thoughts about web design. 1

Group discussion helped me to plan ways of doing the project. 1

Group discussion helped me to understand the web design concepts more clearly. 1

I enjoyed group discussion 1

I learned from group discussion. 1

Please indicate your reaction the **learning strategies** such as self-monitoring and self-explanation on the Lecture Summary Form.

Strongly agree = 5, agree =4, neutral = 3, disagree = 2, strongly disagree = 1.

The learning strategies have been useful to me. 1

Learning strategies have helped me to think about web design ideas I would not have thought about alone. 1

Learning strategies have helped me to reorganize my thoughts about web design. 1

Learning strategies have helped me to plan ways of doing the project. 1

Learning strategies have helped me to understand the web design concepts more clearly. [1]

I enjoyed using learning strategies. [1]

Using learning strategies helped me to learn. [1]

Please indicate your reaction to your experience of group discussion during the Design Workshop.

Strongly agree =5, agree =4, neutral =3, disagree =2, strongly disagree =1

My group discussion experience gave me the feeling that I was really part of a group [1]

My group discussion included some discussion of personal issues [1]

My group discussion experience was boring [1]

My group discussion via the web made me feel isolated [1]

Please indicate your reaction to your experience of group discussion during the Design Workshop.

Strongly agree =5, agree=4, neutral =3, disagree =2, strongly disagree =1

It was easy to learn about other members' ideas [1]

It was easy to participate in the Design Workshop discussion [1]

It was easy to synthesize different members' ideas into the group recommendation [1]

What percentage of your learning about web design came from (total should be 100%)?:

Interaction with classmates [ ]%

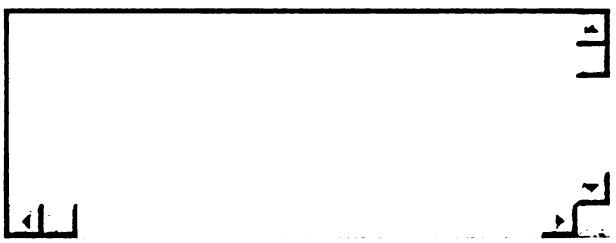
Interaction with your instructor or TAs [ ]%

Your independent work with content [ ]%

Other [ ] % Describe [ ]

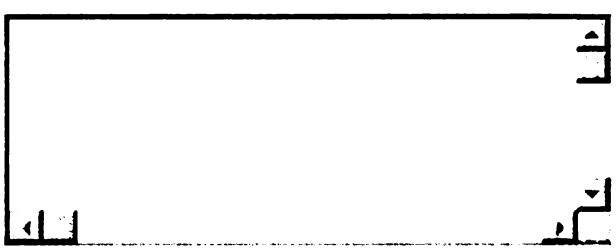
---

1. Please tell us what kinds of communication tools (email, Web-Talk, face-to-face, and others) you used to interact with your group members in doing the group project and why. How much time did you communicate with your group members? How long were the commenications, and what was the total time spent communicating with the members of your group?

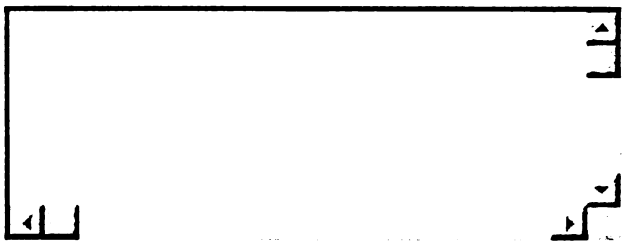


2. Please tell us about your role in group report writing. Did you like the way you interact with your group memebers for your project? Were there any difficulties for you to work as a group? If yes, please describe the difficulties you encountered during the groupwork.

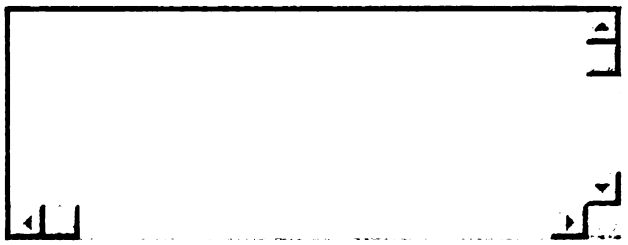
3. Did you learn something beyond the lecture from your group discussion with other members? Do you think that you would have learned as much about Web Design from the lecture without the group activity?



4. Do you prefer working as an individual rather than group work? Please discuss the advantages or disadvantages of the group work during the Design Workshop.

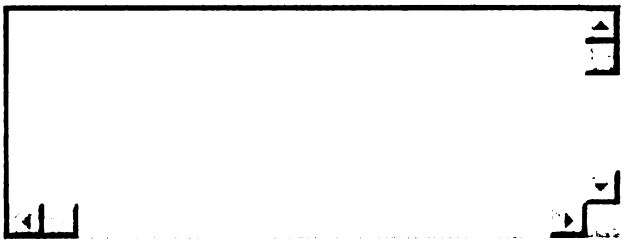


5. Did you find lecture summary forms, which enable you to use the learning strategies, self-explanation and self-monitoring strategies, useful for you to understand the lecture or to work with your group members? Please explain why and why not.



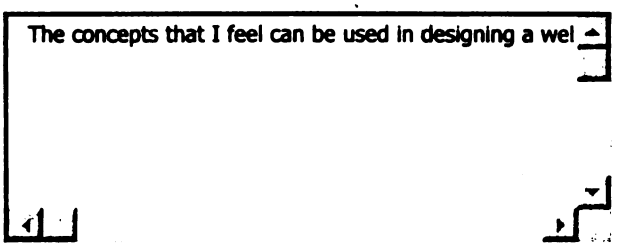
6. What part of the Design Workshop group activity was the most valuable for you?

7. We would like to improve the Design Workshop activity more useful or more enjoyable for your learning. Did you have enough feedback from your instructor or TAs? Please give us your evaluation of the Design Workshop activites and suggestions on how to make it better.

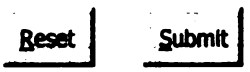


We lost your answers to the question 3 in the lecture summary. Please try to remember your answer to the question

Discuss how the concepts you wrote about can be used in designing a web page.



Thank you for your time and cooperation!!!



APPENDIX F

POST-SURVEY FOR THE CONTROL GROUP

Please indicate your reaction to your experience participating in **group discussion** during the Design Workshop Project.

Name: _____

Strongly agree = 5, agree =4, neutral = 3, disagree = 2, strongly disagree = 1.

So far, group discussion has been useful to me. 1

Group discussion helped me to think about web design ideas I would not have thought about alone. 1

Group discussion helped me to reorganize my thoughts about web design. 1

Group discussion helped me to plan ways of doing the project. 1

Group discussion helped me to understand the web design concepts more clearly. 1

I enjoyed group discussion 1

I learned from group discussion. 1

Please indicate your reaction to your experience of group discussion during the Design Workshop.

Strongly agree =5, agree =4, neutral =3, disagree =2, strongly disagree =1

My group discussion experience gave me the feeling that I was really part of a group 1

My group discussion included some discussion of personal issues 1

My group discussion experience was boring 1

My group discussion via the web made me feel isolated 1

Please indicate your reaction to your experience of group discussion during the Design Workshop.

Strongly agree =5, agree=4, neutral =3, disagree =2, strongly disagree =1

It was easy to learn about other members' ideas 1

It was easy to participate in the Design Workshop discussion 1

It was easy to synthesize different members' ideas into the group recommendation 1

What percentage of your learning about web design came from (total should be 100%)?:

Interaction with classmates _____ %

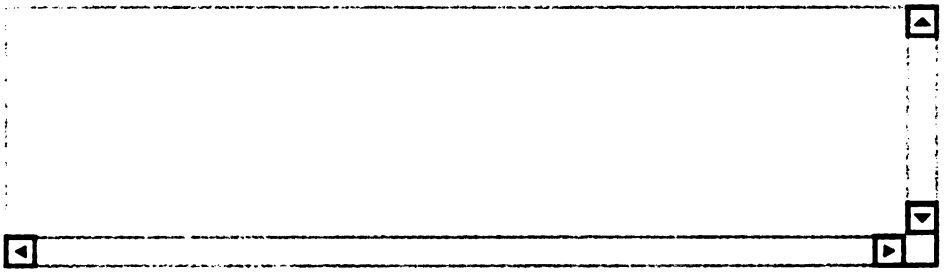
Interaction with your instructor or TAs _____ %

Your independent work with content _____ %

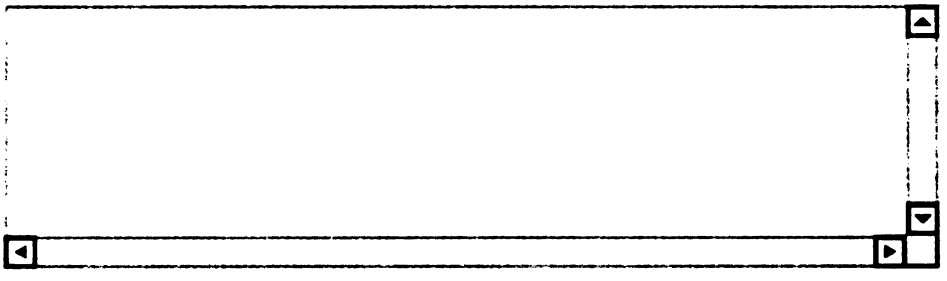
Other _____ % Describe _____

---

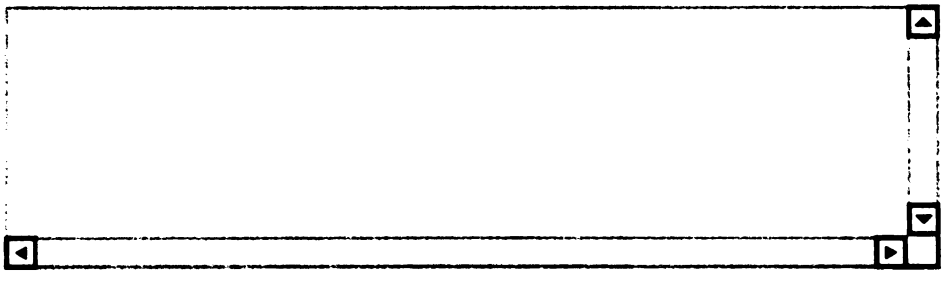
1. Please tell us what kinds of communication tools (email, WebTalk, face-to-face, and others) you used to interact with your group members in doing the group project and why. How much time did you communicate with your group members? How long were the commenications, and what was the total time spent communicating with the members of your group?



2. Please tell us about your role in group report writing. Did you like the way you interact with your group memebers for your project? Were there any difficulties for you to work as a group? If yes, please describe the difficulties you encountered during the groupwork.



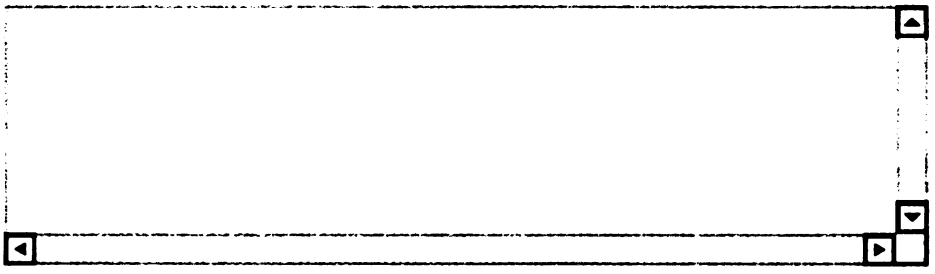
3. Did you learn something beyond the lecture from your group discussion with other members? Do you think that you would have learned as much about Web Design from the lecture without the group activity?



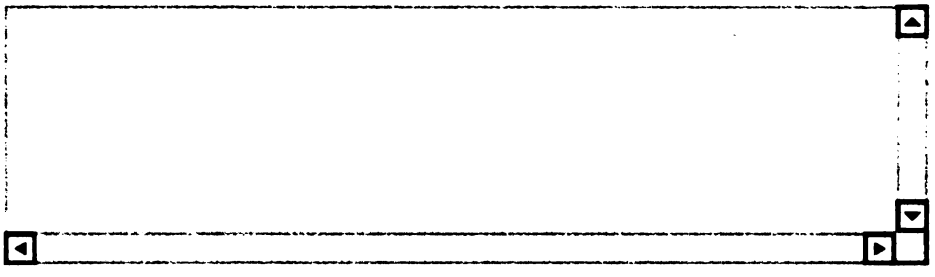
4. Do you prefer working as an individual rather than group work? Please discuss the advantages or disadvantages of the group work during the Design

Workshop.

5. What part of the the Design Workshop group activity was the most valuable for you?



6. We would like to improve the Design Workshop activity more useful or more enjoyable for your learning. Did you have enough feedback from your instructor or TAs? Please give us your evaluation of the Design Workshop activites and suggestions on how to make it better.



Thank you for your time and cooperation!!!

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