The relationship of cognitive question levels to student response patterns in computer mediated instruction
by Kimberly K Obbink

Abstract:
The purpose of this study was to identify the cognitive levels of questions asked by instructors in a sample of online graduate science courses and to determine if there was a relationship between the cognitive level of the question and the corresponding student-instructor and student-student interactions that occurred.

Descriptive quantitative analyses including frequencies, comparison of means, and one-way analysis of variance were used to answer the three questions proposed in the study: ° Research Question #1: What cognitive levels of questions were asked by instructors in the NTEN courses? ° Research Question #2: What student-student and student-instructor response patterns occur as a result of specific cognitive levels of questions? ° Research Question #3: Is there a relationship between cognitive levels of instructor-initiated questions and the resulting student-student and student-instructor response patterns in the NTEN courses? The process of classifying instructor-initiated questions, calculating interaction indices, and constructing discussion diagrams is described in the study. Question levels were compared with the means of the interaction indices in order to determine if there was a statistically significant difference in the interaction patterns that occur as a result of each of the four question levels. Question levels and interaction indices were compared by content discipline and with post-course evaluation results. A supplemental course review was conducted on each of three courses in the sample in order to better identify and understand course design characteristics that might have influenced student interaction patterns and the resulting interaction indices in the courses.

There are four primary conclusions drawn from the findings in this study: 1) The majority of instructor-initiated questions in the sample of courses were found to be higher-level cognitive questions, unlike results found in traditional classroom instruction; 2) Use of higher-level cognitive questions appeared to result in increased student participation and increased probability for student-instructor interaction in the sample of courses; 3) Students were equally or more likely to interact with a fellow student as with the instructor as a result of instructor-initiated questions; 4) Discussion diagrams provide a valuable tool for visualizing and quantifying the interaction patterns that occur in the online instructional process.

THE RELATIONSHIP OF COGNITIVE QUESTION LEVELS TO STUDENT

RESPONSE PATTERNS IN COMPUTER MEDIATED INSTRUCTION

By

Kimberly K. Obbink

A dissertation submitted in partial fulfillment
of the requirements for the degree

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APPROVAL

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Kimberly K. Obbink

This dissertation has been read by each member of the dissertation committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style and consistency, and is ready for submission to the College of Graduate Studies.

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CHAPTER ONE

THE PROBLEM

Introduction

Trends in Higher Education

Distance education is one of the most powerful new forces influencing the direction of higher education today (Connick in Cyrs, 1997). Rapid advances in information and communication technology have had a dramatic effect on the development and delivery of distance learning courses offered by higher education institutions (Dede, 1996). As early as 1989, the US Congress Office of Technology Assessment reported that virtually every state was interested in using telecommunications to serve education, was actively planning for distance education, or was already administering a statewide plan or system with local distance learning projects in place (US Congress, OTA, 1989). Some predict that advances in telecommunications and information technologies, coupled with changes in student demographics, point towards a future in which higher-education success will be determined by the extent to which an educational product or products are provided conveniently for the consumer at a competitive cost (Connick in Cyrs, 1997).

Student demographics in higher education are changing. Cyrs (1997) found that only 52% of college students are eighteen to twenty-one years of age, and only 15% fit the profile of the residential student who is young, attending school full-time, and living

on campus. It is only recently that educational consumers have had choices regarding what, when, where, how, and from whom they can obtain an education. As technical capabilities advance, location will offer little competitive advantage to most institutions, and students will shop for the most efficient, high-quality, affordable, and student-centered services available (Connick in Cyrs, 1997).

Distance Learning Using
Computer-Mediated-Conferencing

Advances in the graphical and multimedia interface capabilities of the World Wide Web (WWW) over the past ten years are fueling the interest in distance education and have made it increasingly easier for higher education to deliver courses over the Internet. Currently, many institutions are systematically converting traditional and other forms of distance delivered courses into Web courses (Jiang, 1998). Numerous researchers (Dede, 1996, Hiltz, 1994, and Papert, 1993) noted that the expanded accessibility and graphical interface of technology such as the WWW may be appealing to students and possess the potential for improved learning. They also cautioned, however, that effective learning requires more than glitzy information technologies and that the education field would benefit from additional research in this complex and rapidly changing environment.

Wagner (1998) noted that with the wealth of new two-way technologies providing real-time, or asynchronous exchange capabilities, between instructor and student, "Distance learning practitioners tend to view interactivity as the single most significant attribute that defines a contemporary distance learning experience" (p. 417). Simply

ensuring, however, that the technical delivery mechanism provides instructor and student with the ability to interact, does not promote or guarantee a successful and quality learning experience. Traditional correspondence courses are a good case in point. Correspondence courses provide students with the ability to interact with the instructor, however, little interaction actually takes place and the course completion rate is often very low (Palloff & Pratt, 1999). Even with the use of new media, many WWW based courses are often focused on content delivery and students remain passive recipients of the information (Palloff & Pratt, 1999).

Although the literature on distance learning and electronic communication is limited, there is evidence that strongly suggests that courses taught via distance learning technologies can be at least as effective and rigorous as traditional face-to-face instruction (Hiltz, 1994). In addition, there is repeated evidence in the literature that instructional settings using computer-mediated-conferencing (CMC) technology, appear to provide additional learning benefits when compared to the more traditional distance learning delivery models such as satellite or television video broadcast (Berge, 1997a). Unlike video broadcast instruction or independent study environments, CMC creates an interactive environment in which students and instructor are able to communicate asynchronously, independent of time and location, through private messages and group discussion resulting in the active-engagement of the students in the learning process. The use of computer mediated conferencing, combined with other new distance learning technologies, enables participants to engage with others as part of a collaborative learning

network and increases the potential for direct student-instructor and student-student interaction resulting in more effective learning environments (Wagner, 1998).

Lauzon and Moore (1989) argued that new developments in communication and information technologies have shifted the emphasis away from the mass production model of distance education (one instructor delivering content to many students), to course design that is more responsive to the personal and individual needs of learners. In contrast to the passive learning and student isolation experienced in distance education delivery models such as correspondence courses, independent study, and one-way video or audio broadcast, new technologies, including CMC, offer instructors a variety of formats for engaging students in active, collaborative learning experiences (Wagner, 1998).

Instructional Techniques to
Promote Interaction in Online Instruction

Although there are numerous studies in the area of computer mediated conferencing (CMC) in online education (Harasim, 1990a; Hiltz, 1994; Eastmond, 1995), many of them analyze CMC used as an element of traditional face-to-face courses. There are few empirical studies that examine courses taught entirely online (Berge, 1997a). These studies (Harasim, 1990a; Hiltz, 1994; Eastmond, 1995) identify the value of CMC interaction in promoting collaborative learning and positive student perceptions of their learning experience, yet few examine specific instructional techniques that might be useful for establishing effective use of CMC in online instruction (Jiang, 1998).

One specific instructional technique that has been the subject of a great deal of research in the traditional classroom is the use of questions and questioning techniques (Wilen, 1991). This research offers an existing framework that may serve as a research base for examining the use of questions in an online environment and for identifying the role that effective questioning might play in establishing a collaborative online environment. Questioning techniques and improved student-student and student-instructor dialogue and discussion appears to be well documented in the traditional classroom instruction literature (Wilen, 1991). Several recent studies in online education have identified instructor use of questions and questioning techniques as an area worthy of further study in online instruction (Jiang, 1998; Anderson & Kanuka, 1997; Palloff and Pratt, 1999). Understanding the use of questions in courses taught entirely online, where instructors and students lack the visual and auditory cues that form a common framework for face-to-face discussion, may be particularly valuable for understanding how instructors might establish active and engaging learning environments for students at a distance.

It appears that distance learning technologies will continue to provide increasingly sophisticated capabilities for student-student and student-instructor interaction, and higher education institutions will continue to expand their efforts to serve non-traditional adult students. In this regard, it is important to increase our understanding of instructional techniques that effectively utilize the technology in order to promote active, constructive, and collaborative learning in an online distance learning environment (Berge, 1997a; Jiang, 1998; USAID Policy Roundtable Series, 1999).

Statement of the Problem

Advances in information and communication technologies are increasing higher education's ability to serve students independent of traditional campus-based instruction. Distance learning courses provide outreach to adult populations seeking both traditional undergraduate and graduate coursework as well as continuing education for professional and personal development. The graphical interface, or ability to provide images, icons, and visual symbols, as well as the broad accessibility of the WWW, has dramatically increased the development of courses delivered entirely online, in which instructors and students never meet face-to-face.

Studies have supported research indicating that students who experience higher levels of interaction tend to have higher levels of achievement and more positive attitudes than those who experience less interaction (Garrison, 1990; Ritchie & Newby, 1989; Hackman & Walker, 1990). Collaborative and active learning instructional strategies have been shown to establish a more effective learning environment, particularly for non-traditional adult learners who are often more motivated, independent, and self-directed about their learning efforts (Merriam & Caffarella, 1999; Cyrs, 1997). In addition, studies have demonstrated the effective use of computer-mediated-conferencing to promote collaborative, constructive learning environments, however, most of this research has been conducted using courses in which CMC supplements traditional classroom instruction, and not in courses delivered entirely online (Berge, 1997a, 1997b). Few studies were found that have examined specific instructional techniques that support

effective CMC dialogue and interaction in online instruction (Berge, 1997a, 1997b; Jiang, 1998; Kanuka & Anderson, 1998; McDonald, 1998).

> Online forums provide potential for new forms of collaborative work, study, and community that reduce barriers of time and distance. Yet the types of interaction and means by which individuals create new knowledge in online environments are not well understood (Kanuka & Anderson, 1998, p. 57).

Research indicates that student-student and student-instructor dialogue and interaction have a positive effect on both students' course achievement and perception of the course effectiveness in both traditional and online instruction (Kindsvatter, 1988; Bossert, 1989; Vygotsky, 1962; Webb 1991; Cyrs, 1997). However, no literature was found regarding ways in which instructors might effectively initiate and foster online dialogue and interaction that support collaborative learning and engage students in interaction that is more than social conversation. Several studies indicate that effective moderation of interaction and discussion is essential to the success of online instruction (Harasim, 1990a; Hiltz, 1994; Cyrs, 1997), yet there appears to be limited research that identifies specific teaching strategies that might better enable an instructor to facilitate dialogue that promotes constructive, collaborative learning and achievement of desired learning outcomes in an online environment.

Purpose of the Study

The purpose of this study was to categorize the levels of questions being used in online instruction according to the Wilen (1991) hybrid question classification model, and to determine if a relationship existed between specific levels of questions used by instructors and the resulting student-student and student-instructor response patterns.

Although there is a wealth of quantitative and qualitative data regarding the use of questions and questioning techniques in the traditional classroom, there appears to be very little documentation collected on the use of effective questioning techniques in an online teaching/learning environment. Several recent studies (Jiang, 1998; Palloff & Pratt, 1999; Anderson & Kanuka, 1997) indicated that the instructor's use of questions in online instruction may play an important role in overall student-student and student-instructor response patterns, as well as contribute to student perception of successful learning in an online course. The authors of these studies recommended further research regarding the use of questions in online instruction. This information may prove valuable to instructors wanting to improve the online learning experience through CMC dialogue that engages students and promotes student-student and student-instructor interaction. In addition, understanding how to promote student-student discussion and collaborative learning will be important to better understand how online courses can scale in size to create effective learning environments for larger numbers of students and still be time and cost effective for instructors.

According to Wilen (1991) the two most common forms of oral discourse in the classroom are recitation and discussion, and teacher questioning is the most often used technique to facilitate student participation within these forms of interaction. In addition, the research literature indicates that recitation, characterized by the familiar teacher-initiation-student response interaction pattern, is the most predominant interaction pattern in the classroom (Wilen, 1991). Discussion, as a form of classroom discourse, is found much less frequently in the classroom and is defined by Wilen as an "educative,

reflective, and structured group conversation with students" (Wilen, 1991, p. 25). Wilen (1991) noted that the concept of conversation is key to the definition of discussion and that the interaction pattern of a discussion is much more varied than that of a recitation, with less teacher talk and much more interaction taking place between students. Several researchers have identified the value of applying the discussion method in the classroom (Wilen, 1991; Bridges, 1990; Kindsvatter, 1990; Klinzing, 1985; White, 1990; Dillon, 1988; Wilen, 1990). Gall and Gall (1990) concluded that the discussion method may be more effective than other instruction methods if achieving higher cognitive level outcomes is the goal. They found discussion to be effective in achieving five types of student learning outcomes: 1) subject-matter mastery, 2) problem solving, 3) moral development, 4) attitude change and development, and 5) communication skills. In spite of the research literature support for using the discussion technique in the classroom, Dillon (1988) conducted an extensive study on discussion and questioning in the classroom and concluded that most teachers excessively controlled classroom interaction, and that teachers defined almost all teacher-student interaction as discussion, when most should be labeled as recitation because of the emphasis on memorization of knowledge. Klinzing and Klinzing-Eurich (1988) concluded that teachers could have encouraged more student involvement by asking a few key questions instead of frequent questions, and by avoiding reaction to every student response. In this way teachers should keep the discussion from moving back to the teacher so as to reduce teacher control.

There are other indications that student-student interaction is valuable to the learning process. Inquiry learning, active learning, collaborative learning, and

constructivist learning theory all emphasize the importance of student-student interaction in the learning process (Caine and Caine, 1991; Harmin, 1994; Lazear, 1991; Marzano, 1992; Renzulli and Reis, 1985; Pratton and Hale, 1986.) Alavi, Yoo, and Vogel (1997) noted that although collaborative learning has been shown to be a highly effective learning strategy, the existing research has been conducted in traditional classrooms with geographical and temporal limits, and that little has been done to understand how to make collaborative learning expandable over time and geographic distance. In an article describing his experience with online learning, Stamps wrote that "learning about a subject is not the same as learning with someone. There's something very different about the spontaneous learning that occurs when a person's mind and thoughts are engaged with those of another person or group of people. And it's that piece that seems to be missing from much Web-based learning today" (Stamps, 1999). This study was an initial attempt to understand how teaching techniques such as questioning might facilitate student-student interaction in an online learning course.

Kindsvatter (1988) described the connection between question types and discussion patterns. Reflective discussion is defined as the highest level of discussion in terms of stimulated student thinking. It is the least structured and has the potential to generate the most student-student interaction. The purpose of this type of discussion is to engage students in high-level critical and creative thinking as they solve problems, clarify values, explore controversial issues, and form and defend positions. Low-, and high-order divergent questions are considered the most appropriate to achieve the objectives of a reflective discussion; however, this can only occur when students are motivated and

mature enough to assume responsibility for their own learning. This study examined the levels of questions used by instructors and the resulting student-student and student-instructor response patterns that occur in online courses made up of a motivated and mature graduate student population. The use of discussion diagrams, a sociogram technique, allowed the researcher to quantify the number of student-student and student-instructor connections that occured as a result of specific levels of questions. Based on the research literature, it was anticipated that the use of higher-level cognitive questions would result in overall increased student participation, as well as increased student-student connections than the interaction that occurs as a result of questions classified in the lower-cognitive levels.

The study consisted of three parts: (a) Course transcripts were analyzed to identify and classify levels of questions posed by instructors in courses offered entirely online utilizing CMC for course communication; (b) Discussion diagrams were constructed in order to visualize and quantify the resulting student-student and student-instructor response patterns to questions in each course; and (c) Data analysis was conducted to determine if a relationship existed between question level and the resulting student-student and student-instructor response patterns.

Significance of the Study

The delivery of distance learning courses taught entirely online, using a combination of CMC and WWW technologies, is still a relatively new instructional environment. No studies were found that have examined the use of specific levels of

questions and the resulting student-student and student-instructor response patterns in CMC courses taught entirely online. This study contributes in the following ways:.

1. Provides insight into the levels of questions that instructors are currently using in CMC online instruction;

2. Demonstrates the use of discussion diagrams to visualize and quantify the student and instructor response patterns to specific levels of questioning;

3. Identifies possible relationships between student and instructor response patterns and specific question levels; and

4. Contributes to educational theories of instruction and learning by identifying ways in which questioning may facilitate discussion and collaborative learning in an online CMC environment.

Research Questions

The following questions were addressed in the study:

1. What levels of questions were used by instructors in the online CMC graduate physical and biological science courses?

2. What student-student and student-instructor response patterns occurred as a result of specific levels of questions? And,

3. Is there a relationship between instructor-initiated question levels and the resulting student-student and student-instructor response patterns in the NTEN courses?

This study focused on these questions in an initial effort to begin to understand the nature of questioning techniques used in the online CMC instruction environment.

To better understand the study, the following background provides information regarding the National Teachers Enhancement Network (NTEN) courses that were used as the basis for data collection in this study.

The National Teachers Enhancement Network (NTEN)

History: The National Teachers Enhancement Network (NTEN) at Montana State University-Bozeman has had continual funding from the National Science Foundation since 1992. NTEN has developed over 25 graduate science courses delivered to high school science teachers nationally and internationally over the past 7 years. The goal of the NTEN program is to improve teachers' understanding of the science content and ultimately improve science instruction in the high school classroom. Each course was developed by a team made up of a scientist or faculty member, inservice science teacher, and technical/design support staff. Courses were offered on a semester basis and graduate course credit could be applied to a masters degree in science education at Montana State University.

Course Design: The NTEN courses were delivered entirely online utilizing a combination of the WWW, print materials such as textbooks, manipulatives for conducting science experiments, and CMC for online course interaction. One primary goal of NTEN course design was to utilize the lowest common denominator approach to the technical requirements for the students, using minimal hardware and software requirements that would keep the courses accessible to as many students as possible. Although courses use a common CMC (FirstClass^{TM}) software platform, the instructors

had flexibility in terms of overall course design and delivery so that each course was somewhat individual in design, based on the particular instructor and content. Common course elements included the CMC software, accessibility via Internet or WWW access, minimal technical platforms, and technical support available for students and instructors. Faculty development was offered on an individual basis, as well as through faculty group seminars in which they shared individual techniques and design, as well as assessment and evaluation results for their online courses.

Evaluation: Evaluation results of the NTEN project repeatedly show positive overall student satisfaction and have contributed to our understanding of online instruction. Horizon Research, Inc., (HRI) of Chapel Hill North Carolina had been the independent contracted evaluator for the NTEN project since its inception. In one annual report, HRI noted that "the most important lesson learned through this project is that electronic courses can be meaningful, collegial experiences for instructors and participants alike," (Smith, 1997, p. 15) and that unlike many online courses, the NTEN courses stress interaction among participants and between participants and instructor. Smith (1997) also noted, however, that not all instructors are equally adept at facilitating an interactive electronic classroom and that only a handful of experienced instructors have developed unusual expertise in this regard. Although the NTEN experience has been overwhelmingly positive, especially in terms of participants' evaluation of the online interaction, the findings are based primarily on participants' and faculty perceptions and qualitative assessment of on-line discussion.

HRI evaluations include pre-, mid-, and post-course student questionnaires, as well as follow-up interviews with individual students and faculty, and evaluation data exist for every NTEN course. Throughout the project, HRI has identified courses with various degrees of student perception of satisfaction and with various levels of student perception of the value of online collaboration with the instructor and classmates. These observations have led to HRI's interest in more in-depth evaluation and understanding of online interaction and the development of the discussion diagram model that will be used in this study.

Observation of questioning techniques that would help instructors facilitate meaningful online interactions is limited. In recent discussions, HRI NTEN evaluator Dr. Sean Smith, suggested that further study of the types of questions and questioning techniques used in the NTEN courses would be valuable (Smith, 1999b). There are several reasons that NTEN courses provide a unique platform for examining questioning in an online environment. NTEN courses are well established in the online delivery format and have been offered continuously since 1993. The NTEN evaluation has collected a wealth of data including course observations, student and faculty interviews, and student satisfaction surveys. In addition, NTEN courses are now taught primarily by experienced online instructors who, according to student evaluations, have established a successful track record for creating and maintaining meaningful online interaction that facilitates learning.

Limitations of the Study

This study involved a multi-method exploratory and descriptive analysis which attempted to provide an initial understanding of the relationship between cognitive question levels used by an instructor and the resulting dialogue that occurred between instructor and students in an online instructional environment. There are several limitations inherent in the study:

1. Limitations of discussion diagrams: The discussion diagrams and interaction indices used to visualize and quantify the online discussion threads are designed to record the direction of interactions only. They do not provide information regarding the total number of interactions, nor do they make any assumptions or inferences regarding the quality of interaction.

2. Comparing question levels across various content disciplines: Different course content and context will understandably lend themselves more readily to various cognitive levels of instructor–initiated questions. In order to minimize the differences that are related to context, the courses used in this study were limited to graduate courses in the physical and biological sciences.

3. No ability to assume cause-effect relationships: Since the study used existing course transcripts to identify instructor-initiated questions and online discussion, there was no ability to manipulate variables. Therefore, the study was unable to identify cause-effect relationships between levels of questions and the resulting online discussion. It did, however, provide descriptive research that made observations and identified patterns regarding the possible relationship between levels of questions asked by

instructors and the resulting online interaction patterns between students and instructors.

4. Other factors related to overall classroom climate and online interaction: Methods used in this study made no attempt to control for the many factors that influence overall classroom climate and interaction among instructor and students. All courses used in the study included requirements for online participation as part of their course grade in an attempt to minimize inconsistency in students' level of motivation for participating in online dialogue. In addition, courses were all graduate level instruction serving self-selecting, non-traditional professional adult students who are motivated to obtain graduate instruction for professional development, and who are more likely to take responsibility for successfully engaging in the learning experience (Cyrs, 1997). Factors that might influence online dialogue, in addition to levels of questions asked by the instructor, are identified in the discussion section of the study.

5. The inability to identify all student and instructor responses that might relate to a specific instructor-initiated question in an electronic course record: It is possible that student responses were posted in separate course folders or conferences in the electronic classroom using a subject header that was different from the subject header of the original discussion thread. In these instances, it was not possible to identify those responses, even though they may have related to a specific question. Although the discussion threads represent the majority of the discussion and responses posted as a result of a specific question, it cannot be assumed that the thread includes all responses that might have been related to the question or that all student-student or

student-instructor interaction is represented as a result of instructor-initiated questions.

Summary

Trends in higher education point towards the increased use of distance and distributed delivery of courses, a focus on student-centered instruction, and an emphasis on attracting a growing market of non-traditional learners who have educational needs—but who also have options (Cyrs, 1997). These non-traditional learners are increasingly able to select educational providers based on ease of course accessibility, quality of instruction, and client-centered services. As educational institutions race to capture this new market, it is important to note that research tells us very little about how to create quality teaching/learning experiences using new distance learning technologies.

One of the more thoroughly researched areas in distance learning is the use of computer-mediated-conferencing in online instruction (Berge, 1997a). The use of this tool holds great promise for creating effective, high-quality collaborative learning. Although the potential value of this delivery mode, especially for engaging students in online interaction, appears to be well documented, a review of the literature revealed very little research regarding instructional techniques that might enable instructors to use this interactive capability effectively.

The purpose of this study was to examine how cognitive levels of questions used by instructors, an instructional technique heavily researched in traditional classroom instruction, might relate to the resulting interaction patterns between students and instructor in graduate science courses delivered entirely online by the NTEN program at

MSU-Bozeman. The study was an initial attempt to determine if a relationship existed between the cognitive levels of instructor-initiated questions and the generation of online responses that encourage interactive discussion and promote student-student and student-instructor interactions in online instruction.

DEFINITION OF TERMS

Asynchronous Communication
>Communication conducted between two or more individuals that is not conducted in real-time, i.e. voice mail, email exchange, computer mediated conferencing, or letter writing.

Bandwidth
>The information carrying-capacity of a communication channel.

Browser
>Software that allows the user to find and see information on the Internet.

Chat Groups
>Online conversations over a network in which participants type text to the rest of the group in real-time and view the postings of others as they occur.

Codec (Coder/DECoder)
>Device used to convert analog signals to digital signals for transmission and reconvert signals upon reception at the remote site while allowing for the signal to be compressed for less expensive transmission.

Compressed Video
>Video signals that are downsized to allow travel along a smaller carrier.

Compression
>The reduction of the amount of data sent in a signal by transmitting only the changes in action.

Computer Assisted Instruction (CAI)
>Teaching process in which a computer is used to enhance the education of a student.

Computer Mediated Conferencing (CMC)
>An exchange of messages among a group of participants by means of networked computers, for the purpose of discussing a topic of mutual interest (Gunawardena, Lowe & Anderson, 1998).

Correspondence Course
>A distance learning course that relies on independent study delivery and more conventional communications methods such as mail and telephone for communication and exchange of instructional materials.

Distance Education
>The organizational framework and process of providing instruction at a distance. Distance education takes place when a teacher and student(s) are physically separated and technology is used to bridge the instructional gap.

Distance Learning
>The desired outcome of distance education.

Distributed Learning
>The use of multiple learning technologies to access resources and conduct instruction.

Electronic Mail (e-mail)
>Messages sent from one computer user to another using computer networks.

Home Page
>A document with an address on the World Wide Web that contains pointers to other pieces of information.

Hypertext Markup Language (HTML)
>The coding or programming used to create and drive Internet Web pages.

Interactive Video
>Video/audio network that allows for two or more sites to see and hear all participants on the network in real-time.

Internet
>A network of networks, global in scope, that allows the connectivity of millions of computers.

Internet Service Provider (ISP)
>An organization that provides access to the Internet and customer service, usually charging a fee.

Listserv
>An e-mail program that allows multiple computer users to connect to a single system and create an online discussion.

Local Area Network (LAN)
> Two or more local computers that are physically connected.

Lurking
> The observation of online interactions without actually contributing to the interaction.

Metacognitive
> A conscious analysis of cognitive activity, thinking about thinking.

Multimedia
> The combination of multiple forms of media to create and enhance a product, utilizing a mix of graphics, sound, video, and text.

Networks
> The ability to connect multiple computers to facilitate the communication and sharing of information between machines.

Online
> Activity conducted while connected to the WWW, Internet, or other computer network.

Personal Computer (PC)
> A generic term used to describe many kinds of personal computer systems found at schools, homes, and offices. A stand-alone computer that does not require connectivity to a local or wide area network for use.

Real-time Communication
> Communication conducted between two or more individuals in conversation at the same time, i.e. face-to-face, by telephone, or by audio or video conference.

Receiving Sites
> All sites, other than the originating site, participating in a real-time telecommunicated course, conference, or meeting.

Satellite
> An orbiting device used for receiving and transmitting signals from one site to multiple receivers around the country.

Server
> Computers that centrally hold and dispense information across a network.

Synchronous Distance Education
> Distance education that takes place in real time but in different locations.

Telecommunication
> The science of information transport using wire, radio, optical, or electromagnetic channels to transmit and receive signals for voice or data communications using electrical means.

Teleconferencing
> Two-way electronic communication between two or more groups in separate locations via audio, video, and/or computer systems.

Threads
> Directed flows of newsgroup or bulletin board software postings. Articles and specific responses to them (and responses to the responses) are described as following a thread, and are bundled together graphically in the software's listing page.

Uniform Resource Locator (URL)
> An Internet address on the World Wide Web.

Video Teleconferencing
> A teleconference using two-way video transmission.

Uplink
> The communication link from the transmitting earth station to the satellite.

Web-Based Learning
> Distance education using extensive hyperlinks and integration of additional learning resources delivered over the World Wide Web. Web-based learning commonly includes student tracking and administrative reporting systems.

Web Page
> An Internet document designated by a specific address (URL) that usually contains various kinds of media and is linked to other web pages or Internet resources.

World Wide Web (WWW)
> The World Wide Web is a cross-platform Internet service allowing interactive access to a global collection of multimedia content "pages" linked by hypertext. (Wagner, 1998)

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

The development of high performance computing and communications is promoting new media and, consequently, new opportunities for online communication and experiences that may reshape both face-to-face and distance education (Dede, 1996). Many distance education experiences that previously relied on the traditional "teaching by telling" method for instruction, are rapidly advancing towards the potential of creating "learning-through-doing environments available anytime and anyplace." (Dede, 1996, p. 4). Because opportunities for using new technologies for instructional delivery are so new, the majority of research available regarding online environments is based primarily on limited case studies and formative evaluations. Enabling students to transform archival information into personal knowledge is critical, and doing so requires educational experiences that empower knowledge construction (Dede, 1996, p.5). This study examined instructor-initiated questions in online courses, and provides an initial attempt to identify possible relationships between questioning techniques and the promotion of online dialogue that, as Dede describes, "creates educational experiences that empower knowledge construction."

There are many types of structures, motivations, and applications of online interaction that make the understanding of this medium both challenging and exciting

(Kanuka and Anderson, 1998). The following literature review outlines some of the literature that is relevant to this complicated instructional environment. The review first provides a brief overview and context of the problem addressed in this study. The review then examines three areas of study that play an important role in addressing our current understanding of ways in which instructors might employ questioning techniques in order to promote dialogue that supports collaborative, constructive learning in online instruction. These three areas include online instruction, constructive learning theory, and questioning techniques in both the traditional and distance learning environment.

Context of the Problem

Understanding how educators can actively facilitate knowledge construction and learning in a distributed learning environment will be necessary if the potential of emerging technologies and the resulting distributed learning are to be realized (Dede, 1996). Much has been learned in the past several decades about facilitating the knowledge construction process in the traditional classroom setting. Educational reform movements abound that promote action learning, collaborative learning, interdisciplinary study, and learning-by-doing initiatives that are slowly changing our fundamental assumptions about teaching and learning in all levels of education (USAID Policy Roundtable Series, 1999).

Meaningful interaction between student-instructor and student-student in the traditional classroom is an important tool for engaging students in the knowledge construction process (Jones, Valdez, Nowakowski & Rasmussen, 1994; Wilen, 1991). This new inquiry-based environment changes the role of the teacher. He or she is a

facilitator who models inquiry and questioning, creates a student-centered learning environment, and provides lessons, learning resources, and guidance that allows students to construct personally meaningful knowledge (Galas, 1999).

> In the inquiry classroom, it is not just the information that is valuable, it is how that information fits within a framework, or explains a concept. Little bits of information...are useless on their own. The way in which the information flows between teacher and student is dynamic, not a static didactic exercise. Students must relate the bits to other bits in a way that helps construct their own understanding... (Galas, 1999, p. 12).

Research is just beginning to emerge regarding meaningful interaction that promotes knowledge construction in a distance or distributed learning environment. Early distance learning researchers classified online interaction according to the agents of interaction (student, instructor, content) and the technical capabilities of the delivery mechanism such as audio or video (Wagner, 1998). For example, one-way satellite broadcast offered limited audio-only interaction capability between student and instructor and did not facilitate any student/student interaction or provide any direct student interaction with content. Two-way interactive-video networks offer both audio and video interaction between instructor-student and student-student.

CMC and emerging technologies related to the WWW offer significant advances in the capabilities and complexity of interaction between student-instructor, students-students and students-instructor-content. Wagner (1998) argued that distance learning research should re-define the notion of interaction in order to distinguish between the technical ability to provide two-way communication between instructor and student, which she defined as "interactivity", and the actual act of communication between online participants, defined as "interaction."

With ever increasing technical abilities for communication between remote individuals, the ability to facilitate communication between students and instructor is now viewed by distance education practitioners as the gold standard and minimum requirement of any distance education program (Wagner, 1998). Unfortunately, the technical ability to provide interactivity does not equate to recognizing or acting upon the potential of classroom discourse to engage students and facilitate the learning process, (Dede, 1996) or to accomplish what Wagner (1998) defined as instructional "interaction."

Real-time video-based technologies, currently used for distance learning by many education and corporate institutions, provide instructors with a format that readily replicates the traditional classroom situation. Students and instructor can see and hear one another at all sites. Observing the types of interaction that are taking place is relatively easy for the instructor or another observer. Research indicates that the majority of instruction that occurs in this environment still models the teaching-by-telling delivery method. Interaction between student-instructor and student-student was minimal, and limited to the traditional concept of communication only during the class meeting (Western Cooperative for Educational Telecommunications, 1994).

Online technologies such as CMC, supported by networked computers, facilitate communication between students and instructor in both real-time or asynchronous environments. Harasim (1990a) defined computer conferencing as "a communication system for dispersed human groups" (Harasim, 1990a, p. 41). CMC software was designed by Murray Turoff in the early 1970s in order to use the computer to structure human communication for information exchange and effective problem solving.

Educational use of computer conferencing appeared in the early 1980s. The asynchronous environment allows students and instructor to interact without requiring them to be together or in any specific place at any specific time. Students are able to post messages, public comment, and read discussions at times and locations that are convenient to them. Communication in this environment is primarily text-based, with additional computer network support (Internet, WWW, etc.) for interaction with course content and other resources. Numerous case studies noted that computer-mediated-conferencing provided the best method of interaction in the online teaching environment (Lauzon and Moore, 1989; Berge, 1997a; Harasim, 1990a) and both students and instructors repeatedly described a significant amount of interaction among all agents (student, instructor, content) in this environment.

Although the volume of interaction appears to increase in this environment, it is also difficult for an instructor to assess the quality, purpose and results of the interaction while the course is in progress. Discussions take place over long periods of time and there are often multiple discussions that occur at any given time. It is very time consuming and sometimes overwhelming for the instructor to track all the details of student interactions. Fortunately, transcripts from online interactions provide written documentation of all course communication and interaction that can be reviewed at any time (Williams, Rice & Rogers, 1988).

The next section of this literature review examines three areas of research that directly relate to our current understanding of the problem and the research questions defined in this study. The first section provides a review of the research in online

learning, including characteristics of online education, computer-mediated-conferencing

(CMC), instructional variables, student interaction and facilitating collaborative learning.

The second section reviews constructivist learning theories, collaborative techniques and

the implications for online education. The final section reviews the research regarding

the use of questioning techniques and question types in both the traditional and the

distance-learning classroom.

Current Understanding of the Problem

Review of Studies on Online Learning

Characteristics of Online Education: Background   Distance   education   is

commonly defined as institution sponsored instruction in which the instructor and the

student(s) are physically separated (Cyrs, 1997; Eisenstadt & Vincent, 1998). Over the

past century, distance learning has evolved from print-based correspondence courses in

the mid 1800s, to electronic technology beginning with mass radio broadcasting

capabilities in the 1930s (Brown, 1994). Electronic technology advancements such as

data compression for simultaneous video/audio broadcast, local area networking for

connecting microcomputers, and graphical interfaces for the Internet, have continued to

expand our ability to serve students who are in need of education opportunities outside of

traditional learning sites and classrooms. The delivery of distance learning has expanded

to include, not only print-based correspondence courses, but audio, video, and local area

computer network and Internet connectivity as well.

Online instruction originally referred to computer-mediated conferencing (CMC), a system using the computer to structure, store, and process written communications among a group of persons (Hiltz & Turoff, 1993). Today, CMC is often utilized as a component of an online course; however, online instruction most commonly refers to a course that is delivered partially or entirely over a local area network or the Internet (Palloff & Pratt, 1999). Online instruction involves two primary techniques, 1) to supplement traditional classroom activity, and 2) as a primary delivery mechanism for distance learning. It is the computer conferencing or computer-mediated-instruction capability and the distance delivery mechanism of online instruction that is the primary focus for the purpose of this study.

Harasim (1989, 1990a) described the computer conferencing capability of online education as a unique expression of both existing and new attributes of the learning environment. Online education combined certain attributes of the distance learning and the face-to-face mode to create a new environment for learning. Online education is time and place independent, however, and is distinguished from many forms of distance learning by the social nature of the learning environment that it offers. Many distance learning delivery models support only a one-to-many communication environment. Similar to face-to-face instruction, the online computer conferencing environment supports interactive group communication that has been available historically only in face-to-face instructional settings.

Harasim (1990a, p.43) identified five key attributes of online education: 1) many-to-many communication, 2) place independence, 3) time independence (asynchronous),

4) text-based, and 5) computer-mediated interaction. These attributes are critical for instructional design of online courses.

Harasim credited the many-to-many communication capability of computer conferencing in online instruction with the ability to support and facilitate active learning collaborations and stated that computer conferencing "deserves serious consideration for theory building, research, and design of online educational activities" (Harasim, 1990b, p. 43). The online environment provides an effective medium for collaborative learning. Collaborative learning includes peer interaction, cooperative group work, and a learner-centered model that treats the learner as an active participant and an important contributor to the learning and cognitive development process at all educational levels (Bouton and Garth, 1983; Brookfield, 1983; Damon and Phelps, 1989; Cohen, 1984).

Eisenstadt and Vincent (1998) described the characteristics of computer-mediated-instruction as it has evolved for use in conjunction with courses offered on the WWW. They described CMC as a Web discussion system that differs in several ways from other types of interaction typically taking place on the Web. Learner dialogues on the Web are described as having the following characteristics:

- Limited number of users;
- Frequent visits;
- Closed environment;
- Focused discussion;
- Use of tutors or instructors;
- Reference to other material;

- ▫ Course management;

- ▫ Review of messages; and

- ▫ Extended interaction and collaboration with other people.

They noted that the most important benefit of locating a conference on the Web is the ability to include links to other Internet sites as part of a message. A message may then support critical thinking by bringing in supporting evidence, bringing in examples elsewhere, or providing starting points for Web exploration.

The most extensive literature review on online education was done by Berge (1997a) who reported that the characteristics, including advantages and disadvantages, have been well described and that the online environment is generally found to be a viable means for teaching and learning (Collins & Berge, 1997; Harasim, 1990a, 1990b; Hiltz, 1994, Lehman, McInerney, and White, 1993; Mason, 1993; Mason and Kaye, 1989; Wells, 1993). Russell (1999) identified and summarized 355 research reports on technology for distance education, all of which found "no significant difference" when comparing learning outcomes for students in traditional and distance education courses.

The majority of this research is based on the use of computer-mediated conferencing, which continues to be the most common definition and component of online education. Since this is a relatively new area of study, Berge noted that there is little research supporting particular theories of learning and teaching in online environments (Berge, 1997a).

Computer-Mediated Conferencing

Computer-mediated conferencing (CMC) is the most researched area in online education (Berge, 1997a). Key advantages summarized by Berge (1997a) include:

- The asynchronous nature of an online course permits 24-hour access to other people and resources, making courses convenient for students with family or work responsibilites;

- The asynchronicity also allows students to reflect on their own responses and fellow students responses;

- Computer conferencing allows for mentoring models of instruction and will change the roles and dimensions of students, teachers, curriculum and instruction;

- Computer conferencing permits interdisciplinary problem solving; and

- Computer conferencing fosters multiple perspective approaches to teaching and learning.

Hiltz's (1987) evaluation of the Virtual Classroom is one of the earliest documented studies in the CMC field. Her research involved five pairs of matched sections of the same courses taught in the virtual classroom (VC) and in a traditional classroom (TC). Courses used the same teacher, text, printed materials, and midterm and final exams. Questionnaires and automatic monitoring were used to collect outcome data in addition to feedback from faculty, student interviews, and content analysis. Pre-, and post-course questionnaires were the primary data source. Major findings from the study indicated that there were no consistent differences in scores measuring mastery of material taught in the virtual and traditional classroom. In addition, correlation analysis

of survey data and qualitative data from individual interviews, revealed that students who experienced high levels of communication with other students and with their professors (who used a "collaborative learning" approach to their coursework) were more likely to judge the outcomes of VC courses to be superior to those of traditionally delivered courses (Hiltz, 1987, p. 167).

Other studies support the finding that computer-mediated conferencing is effective for delivering courses at a distance, although the majority of this research was conducted using single or few online courses, or with courses that were taught in a traditional fashion using CMC as a supplement to instruction. Fabro (1996) examined survey and interview data from twenty-four students in a computer conferencing graduate course and found that computer conferencing can enhance and promote collaboration and critical thinking in a distance education setting. Bourne et al. (1997) also examined the effectiveness of asynchronous learning networks for delivery of online courses. This study examined a three semester-hour course offered by Vanderbilt University entirely online with all materials available in textbooks and on the Web. The study found that the online students learned as much as students in the traditional course, 80% liked the asynchronous delivery, and conferencing was considered important in peer-to-peer learning.

Instructional Variables in Online Education

Although early studies were focused on the viability of online instruction when compared to the traditional classroom, new studies that examine instructional variables in courses taught entirely online are starting to appear. Cairns (1994) used a qualitative

study to examine the facilitation process in post-secondary settings. Interviews were conducted with twelve teachers who had taught a variety of disciplines using computer conferencing as the primary medium. Components of the facilitation process that were identified by the teachers included: the experience of using computer conferencing; creation of a safe community for learning; the teachers' awareness of the learning capabilities of the adult learner; and teacher roles. The study results indicated that computer conferencing enabled the teachers to utilize a style of pedagogy that included individualized instruction, self-directed learning, and student-directed learning. In addition, all of the teachers expressed an interest in continuing use of the medium.

Berge (1997b) and Collins and Berge (1997) conducted similar studies. Berge (1997b) surveyed forty-two post-secondary online teachers in order to identify characteristics that educators might systematically employ to improve their online teaching. Based on the results, Berge identified strategies used by online instructors in their day-to-day teaching. The majority of teachers indicated that these strategies were more student-centered than teacher-centered, and that predominant methods included discussion, collaborative learning activities, and authentic learning activities such as case studies, projects, peer critique, and problem-based activities. Most teachers indicated that guiding learning by asking the "right questions" was more important than being able to give students the "right answer."

Collins and Berge (1997) surveyed electronic discussion group listeners and moderators regarding their perceptions of their roles, responsibilities, and tasks. Results indicated that a moderator would assume different roles at different times for different

lists. Role descriptions ranged from filter, firefighter, facilitator, administrator, editor, promoter, expert, helper, participant, and marketer. Listowners, users, and moderators preferred that discussions be moderated because a moderator can help keep discussions active and focused, hold down "flames," and help digest/edit posts.

Eastmond and Ziegahn (1995) used their own experiences to outline essential considerations and tasks for instructional development with CMC in designing an adult online course. Elements include: design models; a match of content; teaching and learning in an online environment; allocation of resources; preparation of course syllabus; design of various instructional activities that will support students with different backgrounds and learning styles; and evaluation of student learning. Although these suggestions may be useful for online course design, the elements are not based on any empirical evidence obtained from their course implementation.

Jiang (1998) surveyed course participants from 19 post-secondary courses taught entirely online through the SUNY Learning Network. Survey results from course participants were used to quantitatively examine how instructional design, instructional management, and demographic variables were related to students' perceptions of their learning experiences in the online environment. In addition, Jiang conducted an in-depth qualitative analysis of three courses in their entirety in an attempt to define optimal web-based environments for online learning and to reveal instructional factors that might have contributed to students' perceived learning. Jiang found that socio-collaborative course environments are more conducive to perceived learning and that grading instruction and requirements for discussion participation were statistically and positively

related to students' perceived learning. Students showed higher achievement in courses in which instructors placed a strong emphasis on online discussion. Results of the study showed that a certain amount of instructional support in the form of content presentation and response is needed for better perceived learning. Students prefer a balance between behaviorist and constructivist approaches to instruction in the online environment.

Student Interaction in Online Education

Numerous studies have analyzed participant interaction in computer conferencing; however, many of these use data from courses in which computer conferencing supplemented traditional classroom instruction. Simon (1992) described a pilot experiment organized for in-service teacher training courses in Spain. Learners received print-based course content and orientation materials. They worked through the materials, practiced navigation through the software, carried out exercises in the application, sent solutions to a tutor, and answered theoretical questions posed by a tutor. The courses included three face-to-face meetings with the entire class. Simon used both qualitative and quantitative analysis consisting of pre-, and post-questionnaires, as well as hard copies of the messages entered in the computer conference. His findings indicated that only 26.8% of the students logged in frequently and that students relied more on the use of a distribution list for important messages or notifications instead of the conferencing system. Qualitative analysis of the study revealed that the largest percent of messages in each course corresponded to responses to activities and questions posed by learners, but that there were few messages that indicated peer interaction or evidence of collaborative

learning. Students indicated that lack of time and seeming unimportance of participation in conferencing determined their use of the computer conferencing.

Hartman and others (1995) compared the interaction in freshman writing classes at Carnegie-Mellon University that had access to network communication tools to the interaction in similar classes with strictly traditional modes of communication. Both traditional course and courses with network communication tools used collaborative approaches to instruction. The study found that courses with computer conferencing had an effect on the distribution of teachers' attention in the classroom. Less able students communicated more with teachers and classmates electronically than more able students did. More experienced teachers were also found to utilize electronic communication more effectively in terms of encouraging students to communicate with one another electronically.

Other studies indicated a relationship between teachers' experiences, beliefs and practices, and successful student interaction and collaboration in online education. Simon (1992) identified several success factors involving computer conferencing. Study results indicated that planned structures to tasks that give learners a clear objective, minimum requirements to insure student participation, and tutor interventions are all important for creating a collaborative learning environment.

Macabe (1977) studied the level of student interaction in three online courses and found that computer conferencing could support a range of learning environments from a traditional teacher-led symposium to a participatory workshop model. Participants attributed variety to the teachers' beliefs and practices rather than factors related to the

technical medium. Although the data showed that a few students dominated the majority of online discussion, the information also suggested that teachers' frequent participation and explicitness about their expectations are essential factors in a healthy online discussion.

In a review of evaluation methodologies for computer conferencing applications, Mason (1992) found that most computer conferencing research stops with quantitative analyses of messages sent and by whom, number and time of logons, and number of replies. Although there are numerous qualitative studies that attempt to analyze the specific content of conference messages (Levin, Kim, and Riel, 1990; Mason, 1992; Henri, 1992; and Newman et al, 1995), each of them has developed its own complicated framework for message content analysis that does not provide a theoretical model relevant to this study.

Facilitating Interaction in the Online Environment

The rapid development of information and communication technologies has provided educators with a number of new opportunities for facilitating interactive modes of instruction and communication with distributed students. Real-time communication is now supported by a number of technologies. Two-way interactive video, sometimes referred to as compressed video, allows participants to see and hear one another in real-time at multiple distant locations. Streaming video over the Internet or high-speed phone lines also provides two-way video and audio capabilities. Real-time chats allow students to "talk" in real-time by writing to one another online using networked computers.