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Cooperative Learning Incorporating Computer-Mediated Communication: Participation, Perceptions, and Learning Outcomes in a Deaf Education Classroom

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**Cooperative Learning Incorporating
Computer-Mediated Communication:**
*Participation, Perceptions, and Learning Outcomes
in a Deaf Education Classroom*

MSSE Master's Project

**Submitted to the Faculty
Of the Master of Science Program in Secondary Education
Of Students who are Deaf or Hard-of-Hearing**

**National Technical Institute for the Deaf
ROCHESTER INSTITUTE OF TECHNOLOGY**

By:

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**In Partial Fulfillment of the Requirements
For the Degree of Master of Science**

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Capstone Research Project Report

Cooperative Learning Incorporating Computer-Mediated Communication:

*Participation, Perceptions, and Learning Outcomes
in a Deaf Education Classroom*

Abstract:

Many researchers have documented deaf students' struggles with reading, writing, and communication in the classroom over the last twenty years (Long & Beil, 2005; Antia, et al., 2005; Mallory & Long, 2002; Mallory et al., 2006, Johnson & Johnson, 1986; Karchmer & Mitchell, 2003). With the advent of email and text pagers, students today need to be exposed to the communication technologies of the future (Marschark et al., 2002; Bruce & Levin, 2003); especially deaf students, who will more typically rely on technology in the workplace for communication than hearing people (Wood, 2002). This exploratory research study with deaf undergraduate students examined whether computer-mediated communication (CMC) facilitated equitable participation and learning outcomes in a classroom activity. The study also examined the students' perceptions of CMC as a valid instructional approach and whether they felt they could communicate easily via CMC. Results showed that participation was significantly more balanced within the CMC group pairs than within the comparison group pairs. It was also found that learning outcomes were significantly greater for the CMC group than the comparison group. In addition, students using CMC agreed that they could communicate easily and that CMC was an enjoyable method of communication in the classroom.

Introduction:

Since the inception of PL-94-142 (the Education for All Handicapped Children Act) in 1975, the mainstreaming of students with disabilities, including deaf and hard-of-hearing students, has become more and more common. Currently, around seventy-five percent of deaf and hard-of-hearing (hereafter referred to as “deaf”) students are mainstreamed in public schools across the United States (Karchmer & Mitchell, 2003). This trend toward integration of the school environment has forced mainstream teachers to seek methods of instruction that accommodate the learning needs of all students in their classrooms. Student-centered cooperative learning lessons have been designed to meet some of these learning needs (Sherman, 2000).

As conceived by social and cognitive psychologists Piaget, Bruner, Vygotsky, Lewin, and others, the social constructivist theories of how people learn have contributed greatly to the development of cooperative learning practices used in schools today (Sherman, 2000). Yet while cooperative learning strategies are powerful teaching tools in the classroom (Bransford, et al., 2000; Slavin, 2001; Felder, 1995), the foundation for a cooperative learning system is communication – the very element which can pose a stumbling block to mainstreamed deaf students’ participation and hence could interfere with their learning in a cooperative classroom environment (Long & Beil, 2005; Antia et al., 2005). Deaf and hard-of-hearing students arrive in school from many different communication backgrounds and continue to develop various communication preferences throughout their school experiences. These students often find communicating with their partners or small groups difficult (Johnson & Johnson, 1986; Long & Beil, 2005). Thus, it has become imperative to find ways to facilitate dialogue and participation of students with varying communication needs or styles in any cooperative learning lesson.

Can computer-mediated communication (CMC) help facilitate communication during group work for students with different communication backgrounds and preferences? Just as the advent of the

TTY (or TDD) revolutionized telephone communication for deaf people, the technological advances of email, IM, and text pagers, have revolutionized the way deaf people can and do communicate with both hearing people and each other (Power & Power, 2004). Many computer programs have been developed capitalizing on communication technologies to make them available to students within the classroom (Bruce & Peyton, 2002). These synchronous and quasi-synchronous programs have brought instant messaging text-as-you-type communication capabilities to students' fingertips. Communication strategies such as these may eliminate some of the communication barriers that exist between deaf students who are relying on amplification devices such as FM systems and/or who depend on interpreters, and non-signing students and teachers in the classroom. An examination of theories and practices in cooperative learning, computer-mediated communication, deaf students' writing, and social issues related to deaf education follows in the literature review. The attempt here is to examine the potential success of using synchronous IM technology to help reduce communication barriers that exist in cooperative learning environments with deaf students in the mainstream or deaf students with diverse communication modes.

A Review of the Literature:

Cooperative Learning and Deafness

“When students are engaged in a creative open-ended task, the more that they talk and work together, the more they will learn” (Cohen, 2002).

Elizabeth Cohen's quote from the conference for the International Association for the Study of Cooperation in Education in June 2002, describes cooperative learning in a nutshell. Active collaboration in the classroom involves students exchanging ideas, comments and insights, then synthesizing a stronger conceptual understanding of academic material. Research on collaborative group activities has shown that students recall and comprehend curricular content more effectively than when they work individually, which leads to higher academic achievement and a more positive student perception of the educational

experience (Johnson & Johnson, 1986; Felder, 1995). Cooperative learning strategies and applications have been shown to facilitate more efficient acquisition of knowledge and problem solving methods, and to improve human relations within groups of diverse learners (Sherman, 2000). In theory, teachers have some power to ensure that no student is isolated or alienated from his or her peers (Johnson & Johnson, 2002). In the past thirty years, educational and social psychologists have developed volumes of research supporting the success of many different small group cooperative learning frameworks at the elementary and secondary education levels, and more current research efforts involve post-secondary/university learning environments (Sherman, 2000).

As the name implies, cooperative learning incorporates what Sherman (2000; p. 3) calls “cooperative goal structures,” where two or more students are grouped heterogeneously and given a task that requires positive interdependence of all in the group. Heterogeneous grouping implies specifically sorting individuals by diversifying characteristics such as academic ability, gender, ethnic background, and real or perceived disability. For deaf students in the mainstream, heterogeneous grouping would consider deafness a diversifying characteristic. For deaf students in a residential setting or university setting, communication preference (ASL, signed English, cued speech, oral method) and student background would be diversifying characteristics. Sherman (2000) goes on to suggest that cooperative goal structures must include face-to-face interactions, individual accountability (for participating in the group and contributing toward the goal), and group processing of information that incorporates each participant’s views and ideas surrounding the task at hand.

The communication barriers faced by heterogeneous groups of deaf and hearing students or heterogeneous groups of deaf students with varying communication preferences pose challenges to Sherman’s cooperative goal structures that must be addressed. First, face-to-face interaction can be awkward for both hearing and deaf students who communicate with each other through interpreters

and/or FM systems, and therefore a less than desirable level of information may be exchanged in the process (Johnson & Johnson, 1986). Schull, Axelrod, and Quinsland note that, “When deaf and hearing individuals converse in combined groups, conversational strategies often conflict and fail, despite interpreter’s Herculean efforts” (Schull, et al., 2006, p. 3). Second, when a deaf student is paired or grouped with other students and is accustomed to a communication mode different from those students, he or she may miss information that is being transmitted (Long & Beil, 2005). Under these circumstances, communications may be kept short and cover less depth of content. The potential for greater learning is truncated and educational outcomes are limited, because the key to successful cooperative learning situations is fluid communication between participants.

Group processing of information, and therefore learning, is also compromised by poor access to communication. Cooperative learning helps students develop higher-order thinking (Vygotsky, 1978). A group’s ability to mull over and reflect upon information together leads to a refinement of ideas and new ownership of the materials on a more personal level for the participants. Freedom and ease of communication are required for more complex reasoning to occur within the group and for students to share personal information and opinions, both of which will lead to increased social interaction and greater transfer of learning. Research by Long and Beil (2005, p. 6) has found that if communication breaks down, students are “less likely to become engaged, active learners,” and the exchange of ideas is limited. In a study of US and Thai information technology students collaborating on a group project, Sarker (2005) found that both the US and the Thai students perceived that US members of the team transmitted more learning and information, even though capability and experience levels were equal. She suggests this resulted from a communication/language barrier, because the language medium was English. Although the Thai members of the team could potentially have contributed to the whole team’s learning, it was perceived by both sides that they did not contribute in proportion to their potential. Even

the Thai team members felt they had not been able to make a substantial contribution to the team's learning outcomes. Sarker (2005) stated that it is possible the Thai team members experienced frustration with the language barrier and could not share their knowledge effectively. In the same way, deaf students in a predominantly hearing setting or deaf students in a group that has differing preferences in communication modes may experience the same feeling of not being able to contribute to the group's learning. This feeling underscores the necessity of providing a mode of communication where all group members feel they can express themselves well and communicate their ideas to their peers.

Computer-Mediated Communication and Deafness

Sherman (2000, p. 6) notes, "meanings are historically situated and constructed and reconstructed through language." In other words, communication is vital for learning to take place. The act of communication involves a reciprocal process of dialogue where individuals engage another's perception of reality (Schmuck & Schmuck, 1997). Therefore, communication can be considered an interdependent activity and an integral aspect of the cooperative learning environment. If deaf students experience communication barriers, they may not be able to participate fully in the learning environment. Therefore, they may not be able to contribute effectively to their cooperative group. The whole group suffers when one member cannot contribute to their full or optimum potential.

Computer-mediated communication (CMC) seeks to break down these language and communication barriers by leveling the playing field – bringing equal access to participation through one shared mode of communication (Mallory & Long, 2002; Liu et al., 2003). All students are required to practice the same skills in thinking and writing (Cohen, 2002). In CMC, face-to-face dialogue is replaced by synchronous or asynchronous written interaction via computer technology. Discussion threads and shared collaborative writing documents are created on a computer or internet site via Instant Messaging

software programs specifically designed for classroom use. Students' typed messages are sent immediately to others in the group for them to respond, elaborate, or inquire about the material. Communication in CMC is accomplished through informal register "social" English, i.e. the language of Instant Messaging. An informal study done by Rosemary Stifter (2005) on deaf college students found that practice using social English facilitates the development of deaf students' academic English. Participants overcome anxiety related to writing and become more willing to share their input (Stifter, 2005; Bishop et al., 2000; Hertz-Lazarowitz & Bar-Natan, 2001). Students who may not have completely polished English writing skills need not worry about minor spelling or grammatical errors, as long as they can be clearly understood. Deaf and hearing students at all levels of English proficiency can benefit from writing exercises where they practice expressing their opinions and ideas in writing (Liu et al., 2003; Lang, 2004). In a study that surveyed deaf students in undergraduate classes using computer-mediated communication at the National Technical Institute for the Deaf, students said CMC provided "ease of communication" both with their instructor and their peers (Mallory, et al., 2006, pp. 6-7). In testing an innovative new CMC program, Schull, et al., (2006) found "three to four times as many discrete utterances (turns taken)" were exhibited in discussions using the program in comparison with discussions facilitated by an interpreter (Schull, et al., 6). This indicates a greater participation level by students using CMC.

One major benefit of computer-mediated communication is that a transcript of the dialogue is available to the students and the professor, both during and after the dialogue has taken place. While face-to-face discussions are fleeting and permit no permanent record unless taped or recorded in some way (Sherman, 2000), CMC software creates verbatim documentation of dialogue texts. Participants have the benefit of immediate live printed feedback, and they can scroll back in the created transcript to see what has been said before. The transcripts can also be analyzed at a later date by instructors/researchers for

content and quality as well as higher-level thinking. Teachers can monitor or join any of the group discussions with the click of a mouse, and can re-direct the discussion thread or clarify any confusion. CMC discussions also provide an exact record of student responses, which instructors can use to adjust their lesson plans for following sessions, note student affect and motivation, monitor the group collaboration process, or even use for remedial purposes if they notice a student who is not understanding main concepts of the lesson being presented. Transcripts can be edited and given back to students as an outline or as notes for the day's proceedings. CMC records also help make plain students' metacognitive processes as they work through the discussion with their peers. With time for reflection, students can review transcripts of their CMC activity and discuss how to improve their cooperative skills.

Though very little research on computer-mediated communication has been done with deaf students, Mallory, et al., (2006) found that asynchronous CMC has shown improved communication between deaf & hearing students. Stephenson (1997), in a case study of a Deaf Listserv, found that CMC minimized differences in hearing status and communication modality, enabling participants to focus on the content of the topic rather than the mode by which information was being presented. Several studies in distance education support the use of CMC as an educational tool that provides motivation and positive interactive learning outcomes (Sorg & McElhinney, 2000; Chou, 2001). These studies and the research done by Mallory, et al., (2006) provide evidence that computer-mediated communication can be a viable method of communication for group work involving deaf students.

The use of computer-mediated communication is not without some difficulties. Research on the captioning of filmstrips, conferences, and television has shown that captioning speeds of up to two hundred words per minute, such as the typical adult news program, are very challenging for deaf people (Marschark, Lang, & Albertini, 2002). This, combined with the fact that a deaf person must divide his or her attention between the speaker and the text, makes reading captions an arduous activity, especially for

deaf middle school and high school students. Yet with computer-mediated communication, the problem of reading text typed in by another user is alleviated by the fact that the entire screen is devoted to the text conversation (not only a small section of the screen, as in captioning). There is no need to divide attention between a speaker and the written word. Because the users are students themselves, their typing rate will be far slower than a professional captionist. Additionally, text remains on the screen for an extended period of time, allowing students the convenience of reading at their own pace and reflecting on their answers before responding (Mallory, et al., 2006). Also, if the student misses a point or wants to re-read something typed previously that has scrolled off the screen, she or he can scroll back to find the information. These features are not often available with captioning.

Another potential difficulty of computer-mediated communication is that it comprises a cue-reduced environment in which to hold a discussion. Quan-Haase, Cothrel, and Wellman (2005) pinpoint a key issue in communication, particularly with deaf individuals – that of social presence. When dialogue occurs via computer technology, many visual cues are missing. Quan-Haase and her colleagues remind us that, “low social presence means diminished cues about the characteristics of a person...and no information on a person’s facial and bodily expressions” (2005, p. 4); criteria that greatly enhance comprehension for deaf students whose native language is sign language (either ASL or a form of signed English). Without those visual cues, which add meaning to utterances, misunderstandings are possible. However, research by Nowak, Watt, and Walther (2005) suggests that a low cue environment may not have as many drawbacks as feared. Participants in groups using low cue, synchronous CMC as the mode of communication rated their conversations as being more effective, felt their partners were more credible, and reported more involvement in the interaction process as compared to groups communicating face-to-face (Nowak, et al., 2005). Although their research was conducted with hearing individuals, it

suggests benefits in communication for learning that may equal or even outweigh the liabilities associated with cue-reduced environments.

An additional drawback to using CMC in the classroom might involve the users' keyboarding proficiency. By the time students enter high school, many have had practice with keyboarding through word processing programs and email. A study by Pilkington and Walker (2003) observing teenagers using CMC found that the participants adapted as they gained more experience and the learning curve was steep. Regardless of students' present keyboarding capability, CMC is a skill they will need as they ascend the educational ladder into college or the workplace, and therefore it can be legitimately incorporated into the classroom curriculum and activities. Bruce and Levin (2003, p. 3) state, "The process of digitization, of incorporating new information and communication technologies into our social practices, has not only continued, but accelerated, over the last decade." Marschark, Lang, and Albertini (2002, p. 210) add, "Schools in the United States and in other countries are making substantial investments in computer technology for Internet access and are moving forward with classroom activities and interactive, collaborative academic projects that utilize the Internet." Societal changes in technological literacy practices have implications for education (Bruce & Levin, 2003, p. 4). Email and instant message style communication is exploding in America – on the busiest day of the year in 2001, America Online reported 300 million messages were sent – up from only 50 million in 1998 (Mount, 2001, pp. 44-45, cited in Mallory & Schmidt, 2003). According to a September 2004 study "How Americans Use Instant Messaging," by Shiu and Lenhart in the Pew Internet & American Life Project, 53 million adults send instant messages on a daily basis, and 24 percent of them use IM more frequently than email. These changes in the way America communicates should be mirrored in the classroom. Thus, teaching students new skills in computer-mediated communication is necessary to prepare them for interaction with communication technologies of the future.

The necessity of learning about and becoming skilled at technological innovations for communication and collaboration has been known for more than ten years. Elizabeth Dole, as US Secretary of Labor, presented the “SCANS” report (The Secretary’s Commission on Achieving Necessary Skills, 1991) that listed future goals for public education. Sherman (2000, p. 7) adds, those goals “include the ability to use sophisticated technology to communicate and collaborate.” Currently, employees in many organizations collaborate using instant messaging programs to complement or even replace email communications, because it adds speed and ease to communication in the workplace (Quan-Haase, et al., 2005). Leslie Rach (2000) in the English Department at Gallaudet reported research that found deaf graduates can be required to participate in 17 different reading and writing activities in general in their places of work. She suggests that technology is the most efficient tool for such text-based tasks. Computer-mediated communication is an important communication mode of the future. It is being used by many companies as a way to facilitate internal contact between departments and individuals (Sarker, 2005; Cho et al., 2005). Cooperative learning that incorporates computer-mediated communication meets the SCANS report criterion and helps prepare students, hearing and deaf, for the work environments of the future.

Computer-Mediated Communication, Deafness, and Writing

Deaf student’s reading and writing levels lag far behind those of their hearing peers (Antia, et al., 2005), and any constructive, well-designed reading and writing activity in the classroom which can provide an appropriate opportunity for practicing these skills is worthwhile (Lang, 2004). Computer-mediated communication activities require that students use their reading and writing skills to complete the assignment. Properly developed cooperative learning situations incorporating CMC help students practice reading and writing skills for problem solving and constructing knowledge in a real environment

(Mercer, 2003). “Real audiences and meaningful goals can stimulate the development of competency in written communications as well as enhancing motivation” (Bruce & Levin, 2003, p. 18). The members of the collaborative group make up the “real audience” to whom the student is writing and the “meaningful goals” are those involving group exploration of the learning task. Students are accountable to discuss a topic as in a face-to-face discussion, by providing details, explanations, reasoning, and support for their argument, albeit in written form. Stephen Nover and his associates point out that CMC “is significant since it allows the students to communicate spontaneously and to socially interact with others using a form of English. It provides an opportunity for students to attach their opinions, feelings, and ideas to English” (1998, p. 69). Collaborative writing with CMC helps all students develop social writing skills and stimulates students to think about writing as they write, and also provides students alternative methods for problem solving, asking for help, and information exchange (Quan-Haase, et al., 2005).

In the last five years, many studies have focused on collaborative writing in English, in some instances through the use of CMC (Nover, et al., 1998; Brown & Long, (1992); Hertz-Lazarowitz & Bar-Natan, 2001; Yang, et al., 2005; Antia, et al., 2005; Bruce & Levin, 2003; Liu, et al., 2003). Research with collaborative exercises using computer-mediated communication conducted over the period of a year with hearing Jewish and Arab students in Israel, showed improved ELA scores, confidence in writing, and quality of writing, with the greatest gains made by most challenged students (Hertz-Lazarowitz & Bar-Natan, 2001). Liu, et al’s (2003, p. 251) review of the literature was comprised of 21 journals and 246 articles related to computer use in the ESL classroom. They found seventy research-based articles that focused on the use of computer technology to support second and foreign language learning, many of which addressed the use of CMC in the classroom. Since deaf students’ struggles with English reading and writing are akin to those of English language learners (Antia, et al., 2005), strategies proven by research to improve the writing and language use of English language learners may also be beneficial to

deaf students. Liu, et al (2003, p. 252) found that “CMC seems to promote meaningful human interaction that can foster the language learning process.” Computer-mediated communication has also been found to reduce anxiety about writing and increase the perception of social integration (Bishop, et al., 2000; Hertz-Lazarowitz & Bar-Natan, 2001). Thus, CMC provides language benefits and social benefits as well.

Social Aspects of Combining Cooperative Learning with Computer-Mediated Communication

Legislators enacting the mainstreaming law (PL 94-142) were trying to bring equality in education to children who were traditionally sent to special schools. They were aiming for better socialization, better academics, and more complete integration of these students with their peers. Yet simply placing students together in a mainstream educational setting does not guarantee true integration of all students within the educational community (Sherman, 2000). In fact, the diversity of backgrounds, cultures, and personal characteristics represented by students in the mainstream today can sometimes hinder social acceptance and create feelings of isolation, loneliness, and general dissatisfaction with the educational experience (Kluwin, et al., 2002). Deaf students often feel isolated and frustrated with the lack of communication with their hearing peers, which leads to withdrawal, low motivation, and avoidance of interaction (Long & Beil, 2005). Since the basis of socialization is communication, deaf students can sometimes exhibit developmental delays in socialization from the lack of interaction with their peers (Johnson & Johnson, 1986). Social psychologists have responded to this (Hewstone & Brown, 1986), and educational researchers have developed theory-based pedagogical applications aimed at improving communication, human relations, and integration in these diversified educational settings. Studies of these applications have shown that “specially designed interventions, such as certain types of cooperative learning, can increase interaction” between deaf and hearing students (Kluwin, et al., 2002, p. 206). Cooperative learning scenarios are seen in jigsaw techniques, reciprocal peer learning models such

as collaborative strategic reading groups, group investigation models, and scripted peer dyads (Sherman, 2000; Dansereau, 1988; Klingner & Vaughn, 1998). Any or all of these scenarios can incorporate computer-mediated communication.

In a study by Johnson and Johnson (1986), all the deaf students who participated in a cooperative learning scenario reported that they learned something about their hearing classmates, compared to forty percent of deaf students in an individualistic learning scenario. Deaf students themselves have reported, as observational assessment has shown, that they are more socially active with hearing students when they have had cooperative contact with them in their classes (Kluwin, et al., 2002). If we can promote deaf/hearing social compatibility, then active learning in mixed groups will be more successful. Research conducted at the National Technical Institute for the Deaf in Rochester, NY, in classrooms having both deaf and hearing students, has shown several positive features of using computer-mediated communication both synchronously and asynchronously (Mallory, et al., 2006; Mallory & Long, 2002). Deaf students reported they learned more about other students from online discussions, and felt that both the amount and quality of interaction increased when using CMC (Mallory, et al., 2006). Deaf students from the same research project are quoted as saying, “I liked how I was able to interact more with other students, especially the hearing” and, “I think the online discussion is the best part of this class” (Mallory, et al., 2006, p. 7). Cooperative learning activities facilitated by CMC can help avert the feelings of isolation and alienation that some deaf students experience in the mainstream classroom due to communication barriers (Bishop, et al., 2000).

Also important to consider is the goal of decreasing prejudice and discrimination against people perceived to be “different” due to medical science labeling them “disabled.” One of the major goals of mainstreaming is to familiarize public school students with those students who used to attend separate schools because of their physical or mental abilities. Yet, as was mentioned before, simply placing

students in the same classroom may not have any impact on their perceptions or stereotypes of each other. However, research has shown that cooperative learning involving heterogeneous groups of students increases interracial trust and good will (Slavin, 2001). It follows that cooperative learning situations involving heterogeneous groups of deaf and hearing students will expose both groups of students to each other such that cross-cultural interactions become more comfortable, frequent, and conducive to learning. In their research, Bishop, et al. found that about seventy-one percent of the deaf participants in their study felt they were judged first because they were deaf rather than on what they had to say in face-to-face communications (4). Fifty-four percent of their participants reported it was easier to communicate using CMC than with face-to-face situations. (Bishop, et al., 2000).

Other studies have found similarly positive results relating to the social benefits of using CMC both in and out of the classroom. Stephenson (1997) showed asynchronous CMC can build a sense of community among the users and therefore better socialization with feelings of belonging. Synchronous CMC used over the course of a semester in a college class promoted a strong sense of community and added continuity to the class (Schwier & Balbar, 2002). Everyone felt they could participate, and each person's contributions were respected (Schwier & Balbar, 2002). In Chou's (2001, p. 79) study of distance learning, she found that "incorporation of synchronous activities can enhance learning interests and interpersonal relationship." Seventy-four percent of respondents in a blended learning study (using both classroom discussion and online work) reported that CMC helped students participate in the class and in discussions (Cox, et al., 2004). Students using English as their second language found opportunities to participate that were lacking in their face-to-face discussions (Cox, et al., 2004). In a study of electronic conferencing in both deaf and hearing classrooms, Mallory and Schmitz (2003, p. 216) reported that, "Passive students who are often dominated by their more aggressive peers in traditional classrooms frequently blossom in an online environment." Thus, a major benefit of using CMC with

cooperative learning in a heterogeneous, multicultural, multilingual academic setting is that the students can use each other as a resource (Cohen, 2002) – tasks and concepts can be explained and expanded, challenging ideas can be respected and discussed from a variety of viewpoints, and each student can add to the discussion from his or her background and experience. Deaf students can independently participate and feel part of the learning community.

According to the research, computer-mediated communication has significant potential to benefit deaf learners in cooperative learning situations both in the mainstream and in a classroom of deaf students who have different communication preferences. Donald Dansereau (1988) iterates the fact that social interaction and communication with peers, instructors, and experts produce the quickest, longest lasting, and most transferable learning outcomes. It is under these guidelines that this research project focuses on incorporating computer-mediated communication into an existing cooperative learning computer activity for deaf students in an Environmental Science class at the National Technical Institute for the Deaf.

Questions posed by this investigation are:

- 1) Does computer-mediated communication (CMC) facilitate equitable communication between partners during group work?
- 2) Does CMC facilitate learning outcomes in small group work?
- 3) Do deaf students perceive they can communicate easily via CMC?
- 4) Do deaf students perceive CMC as an effective instructional approach?

The expectation is that positive results will be obtained for student participation, student affect, ease of communication, and group learning outcomes.

Methodology:

This project focuses on an exploratory research endeavor that analyzed how a classroom cooperative learning activity used networked computers for communication between participants and cooperative writing summaries, via macromedia Breeze on the RIT network. The activity and intervention were introduced in a single lesson during the third week of classes of winter quarter.

Participants:

Thirty deaf and hard-of-hearing undergraduate students enrolled in three sections of an Environmental Science class were asked to voluntarily participate in the study. The first and second sections of the class (an early morning and a later morning section held on the same day) were selected to receive the intervention of computer-mediated communication, and the third section (a later morning section held on the following day) was chosen to be the comparison group. Students were first- to third-year NTID undergraduates who were non-science majors. Twenty-one students (fourteen males and seven females) agreed to participate in the study. Table 1 displays the distribution of students on major characteristics for the intervention and comparison groups. The median age for both groups was 21 years old. Out of the twenty-one students, fourteen identified themselves as deaf and seven identified themselves as hard-of-hearing. All of the participants indicated that they owned a computer with high-speed internet access and had used IM or email for personal communication on a daily basis in 2005. None of the participants had experience with the Breeze environment previous to this intervention. Fourteen of the twenty one students reported owning text pagers at the time of the evaluation, and thirteen of these reported using their text pagers on a daily basis for personal communication in 2005. Thus, students in both groups were familiar with the purpose and function of chat rooms and instant messaging for communication.

Sixteen students were in the intervention group and five were in the comparison group. As seen in Table 2, in the intervention group, one student had deaf parents and two had deaf siblings. Ten out of sixteen students reported ASL as their preferred mode of communication.

In the comparison group, two students in the comparison group said they had deaf parents. Three out of five students reported ASL as their preferred communication mode. One interesting difference between the groups was that the comparison group reported more frequent use of sign language in the home than the CMC group.

TABLE 1 Student Characteristics

Item:	Intervention Group (N=16)	Comparison Group (N=5)
Self-reported hearing status:		
Deaf	9	5
Hard-of-Hearing	7	0
Gender:		
Male	11	3
Female	5	2
Age:		
Mean	21.9	21.6
Deaf family members:		
Parent(s)	1	2
Sibling(s)	2	0
Text pagers:		
Own one	11	3
Use it daily	10	3

TABLE 2 Student Personal Communication (Frequency Distribution)

	Intervention Group (N=16)				Comparison Group (N=5)			
	Never	Some-times	Often	Always	Never	Some-times	Often	Always
How often is sign language used in your home?	6	1	4	5	0	0	2	3
	ASL	Signed English	Sim-Com	Speech	ASL	Signed English	Sim-Com	Speech
The communication mode I am most comfortable using is:	10	0	5	1	3	1	1	0

Measures:

After agreeing to participate in the study, participants filled out a Student Communication Background Form developed by the investigator especially for this study. This form provided information on the students' communication preferences and experience. Participants were asked to indicate whether they were deaf or hard-of-hearing, their major, their age, their preferred communication mode, and whether or not they had any deaf family members. Other questions were related to the participants' ownership and use of computers, text pagers, and the Internet. This form helped the researchers identify potential partners for each student during the group activity, according to their communication preference, as well as providing important background information with which to analyze participants' responses to the Activity Evaluation Form.

An instrument used to document and classify student participation during the activity in the comparison group was developed by the investigator. The Observation Coding Sheet identified which group was being observed, the students involved, and the time the observation was made. Student interactions were coded into five categories: 1. Which student was communicating, 2. To whom they were communicating (partner, teacher, another student, another group, or the whole class), 3. What type

of interaction it was (an initiation, a response, a question, a clarification, a repeat of something, or a non-verbal interaction such as pointing or head shaking), 4. The content of the message (assignment-related or social-related), and 5. The mode of communication (sign language only, speech only, simultaneous communication, gesture, as in a wave or a point, or touch, as in getting attention or a high-five).

During the actual classroom activity, two observers coded student interactions simultaneously – the investigator and an additional trained observer having no vested interest in the study at hand. Both observers coded the same two sets of partners during the Web search activity and the same debate group. Training in the use of the coding sheets was provided, and a one-hour coding practice session was completed in the same science class two days before the actual target activity was done. The coded observation sheets from both the author and the outside observer were compared for the practice session, resulting in an eighty percent agreement in codes. The greatest number of disagreements between the observers showed up when deciding whether a gesture should be coded as an initiation, response, or non-verbal message. It was determined that this type and level of disagreement would not influence the key factors being considered in this study. After further discussion and explanation of the categories on the Coding Sheet, the two observers proceeded to code student interactions independently for the research activity with the comparison group. An eighty-seven percent interrater agreement was achieved for the coding of the research activity.

Videotaped observations were conducted for all three sections of the class as they performed the classroom activity and debate. This was done to eliminate the effect on student interaction that might have resulted from videotaping one group and not another as well as to provide an accurate record of what actually occurred during the activity. For the comparison group, videotapes were analyzed and a five-minute segment was re-coded in slow motion by the author using additional Observation Coding Sheets. The re-coded sheets were then compared to the original coding sheets of both raters for accuracy

of coding categories. If a difference of more than five percent had been found, the full activity would have been re-coded from the videotape by the investigator for a more accurate analysis of student participation. This was not necessary. Using the original coding sheets from the comparison group, student interactions were tallied for research activity with the comparison group.

Printed transcripts of each intervention groups' Web search discussion and debate were also reviewed and student interactions were tallied. For several instances in the transcript, students posted two or three responses designating only one thought (for example: a student might type, "I found a website that says," and post that statement, following it with a second posting of "the septuplets received lots of free gifts."). Interactions such as this were counted as only one response, because these types of interactions would have been expressed as only one response in the face-to-face environment. The interaction data from both the CMC groups and the comparison group were compared and statistically analyzed for any existing differences. Differences are displayed as tabular data in the Results section.

An additional measure was developed by the researchers to evaluate participants' perceptions of the classroom activity. This portion of the study focused on questions using five-point Likert ratings scales (Strongly Agree – Agree - No Opinion – Disagree - Strongly Disagree, and, Never – Once in a while – Sometimes – Often – Always). These questions focused on the students' affect during the activity, communication between partners and groups during the activity, and a general evaluation of the activity. All participants were asked to complete this part of the questionnaire. Students in the intervention group were asked to respond to five additional questions related to the students' use of the IM environment where the discussion was held. Some of the findings and frequency distributions are reported in the results section. The questionnaire is in Appendix C.

The Classroom Activity:

The classroom activity was carried out on Macintosh G-4 laptops with high-speed wireless Internet connections in the NTID science lab. The intervention of computer-mediated communication utilized a program available on the RIT network called Macromedia Breeze. Breeze is similar to Microsoft's NetMeeting. Users can communicate with each other via IM-style chat rooms, share files, write collaboratively, or import files and Internet links. Breeze also has the capability to simulate video relay technology where the users can see each other with Internet video cameras and/or use the speakers to listen to each other. Printable transcripts of student interactions are available when sessions are over. This CMC classroom research activity utilized only the chat room and collaborative writing functions of Breeze.

In the CMC group, printed transcripts of student interactions and comments were collected as data after class sessions were over. For collecting data in the comparison group, two observers who were trained in using the Coding Sheet independently coded student interactions. The research activity was videotaped for both the CMC group and the comparison group.

The instructor's lesson plan called for a two-part activity – a Web search for information and a debate based upon facts students found related to multiple births (septuplets) and human population control. For both the CMC and comparison groups, students were purposefully paired with others having communication preferences different from their own, as noted on their Student Communication Background Form (eg. Students who prefer simultaneous communication paired with students who prefer ASL). This deliberate pairing was designed to simulate the communication barriers that may be present for a deaf student who is partnered with a hearing student, or a deaf student partnered with another deaf student having a different preferred communication method. Each set of partners was assigned to search for information that either supported (pros) or refuted (cons) the appropriateness of multiple in-vitro

pregnancies. Students in the intervention groups entered the Breeze meeting room through Mozilla Firefox, an Internet browser, and then opened the internet browser a second time to accommodate the Web search activity. All students searched the Web for data related to the McCaughey septuplets and multiple births, then discussed it with their partners in terms of their assigned “pro” or “con” position, so that they were prepared to debate an opposing team. Each dyad needed to produce a written summary list of pros or cons to use during the debate activity. Students in the CMC group were instructed to communicate with their partner through Breeze and only use face-to-face communication if there was a misunderstanding or clarification was needed, while students in the comparison group used only face-to-face communication for the activity. As students collected information supporting their designated pro or con stance on multiple births, they compiled a list in Microsoft Word. For the intervention groups, this list was then copied and pasted into Breeze, where partners could discuss it, edit it as needed, and compose a final written summary. The Web search activity lasted for thirty minutes, at the end of which partners printed a copy of their written summary. The classroom teacher graded these summaries and assigned scores for each “pro” or “con” point listed.

The debate activity began after a five-minute break. Students were placed with their original partners in a debate group with an opposing team (pro vs. con). Students were assigned to debate the appropriateness of multiple in-vitro pregnancies using the ideas from their summary sheets and website research. The intervention sections held their debate electronically in Breeze, typing in the chat room. In both groups, each team was to present and then discuss their supporting points one at a time. Any team member could make comments on any of the points. When each team had discussed all of their points, and a group vote was taken on the appropriateness of multiple in-vitro pregnancies, the debate was over. In both the intervention section and control section, all groups finished the debate activity within fifteen

minutes. At this point, the teacher debriefed the activity for five minutes, reviewing important central points. The participants completed their activity evaluation forms immediately after the debriefing.

Results:

Data analysis consisted of descriptive statistics, parametric t-tests, and a Mann-Whitney U for one set of data. Descriptive statistics included frequency distributions, measures of central tendency, and standard deviations. Eta squared was used as the index of effect size. Interpretation and generalization of results must take into consideration their being based on a small *N*.

In regard to the question of whether CMC facilitates equitable communication, the interactions of the CMC group were analyzed in relation to those of the comparison group. An equitable communication score was calculated by obtaining the discrepancy between the proportion of interactions that a student made and the proportion that was an equal share of the comments; that is 50 percent each for individuals in groups of two, and 25 percent each for individuals in groups of four. For example, if the student's portion of interactions was 75 percent for the two-person group, the student's equitable communication score was 25 (75 percent minus 50 percent). Table 3 shows the mean interaction scores for the planning and debate sessions. In the planning session, the mean number of interactions for the two groups were not significantly different from each other, $t(17) = .392$. However, the equitable communication score of the CMC group was significantly lower than that of the comparison group, $t(17) = -10.44$, $p < .0001$, $ES = .87$. Note that a lower score means that the proportion of communication was closer to a 50/50 split between partners.

In the debate session, similar results were found. The mean number of interactions for the two groups was not significantly different, $t(20) = 1.60$. Yet again, the equitable communication score of the CMC group was significantly lower than that of the comparison group, $t(20) = -2.56$, $p < .019$, $ES = .25$.

Lower scores in the debate session indicated that the proportion of communication was closer to an even split between the individuals participating in the debate (two sets of partners).

TABLE 3 Interaction and Participation during Group Work

	CMC Group			Comparison group		
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>
<i>In Planning Session</i>						
Number of Interactions	11.14	3.72	14	10.40	3.36	5
Equitable Communication Score	4.29	1.73	14	12.80	.84	5
<i>In Debate Session</i>						
Number of Interactions	23.18	7.90	16	16.00	11.83	5
Equitable Communication Score	5.41	3.76	16	11.60	7.50	5

In examining the student interactions, the number of times students requested clarification was also evaluated. Requests for clarification on student transcripts were tallied and coded clarifications from the comparison group were counted in each of the two sessions. Two of seventeen students requested clarification in the intervention group, for a total of two clarifications. Four out of five students requested clarification in the comparison group, for a total of seven clarifications. Table 4 shows the descriptive results. Because the distribution was highly skewed, a Mann-Whitney U analysis (asymptotic, 2-tailed) was used to determine if significant differences existed between the two groups. In the planning session, students in the CMC group requested significantly fewer clarifications than those in the comparison group, $U = 19.000, p < .006$. Also, in the debate session, students in the CMC group requested significantly fewer clarifications than those in the comparison group, $U = 19.500, p < .007$.

TABLE 4 Number of Student Clarifications during Group Work

	CMC Group				Comparison group			
	<i>Mean</i>	<i>Mean</i>	<i>Mean</i>	<i>Mean</i>	<i>Mean</i>	<i>Mean</i>	<i>Mean</i>	<i>Mean</i>
	<i>Mdn</i>	<i>Rank</i>	<i>Range</i>	<i>N</i>	<i>Mdn</i>	<i>Rank</i>	<i>Range</i>	<i>N</i>
<i>In Planning Session</i>								
Number of Clarifications	0.00	10.12	0-1	14	1.00	16.20	0-2	5
<i>In Debate Session</i>								
Number of Clarifications	0.00	10.15	0-1	16	1.00	16.10	0-2	5

Student perceptions of equitable interaction reflect similar findings. Tables 5 and 6 demonstrate student responses to items on the questionnaire related to perceptions of equitable interaction and communication. Significant differences existed between the two groups. All the of students in the comparison group agreed that some students allowed other students to do most of the work, where students in the CMC group perceived participation and work load were more evenly shared, $t(19) = 2.45, p < .024, ES = .240$. Students in the CMC group felt they had more equal participation by group members than those in the comparison group, $t(19) = -4.90, p < .0001, ES = .558$.

Table 5 Student Perception of Equitable Participation – Frequency Distribution

Statement:	Intervention Group (N=16)					Comparison Group (N=5)				
	1	2	3	4	5	1	2	3	4	5
Some students let others do all the work.	2	1	6	6	1	3	2	0	0	0
Each team member was able to contribute equally to the debate.	5	10	1	0	0	0	1	1	3	0

For Table 5, the heading numbers 1-5 indicate a scale of 1=strongly agree, 2=agree, 3=no opinion, 4=disagree, and 5=strongly disagree.

Table 6 Student Perception of Equitable Participation – Descriptives

Statement:	Intervention Group (N=16)			Comparison Group (N=5)		
	Median	Mean (<i>m</i>)	SD	Median	Mean (<i>m</i>)	SD
Some students let other students do all the work.	3	3.19	1.11	1	1.8	1.10
Each team member was able to contribute equally to the debate.	2	1.75	.58	4	3.4	.89

For Table 6, the mean and median figures are based on the same scale: 1=strongly agree, 2=agree, 3=no opinion, 4=disagree, and 5=strongly disagree.

In regard to whether CMC facilitates learning outcomes, the quality ratings of student summaries were compared for the CMC and comparison groups. The mean summary rating for the CMC group shown in Table 7 ($M = 11.43$, $SD = 2.21$, $N = 14$) was significantly higher than that of the comparison group ($M = 7.6$, $SD = 1.34$, $N = 5$), $t(17) = 3.61$, $p < .002$, $ES = .433$.

TABLE 7 Summary Scores

	CMC Group			Comparison group		
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>
Summary Scores	11.43	2.21	14	7.60	1.34	5

In regard to the question of whether students perceived CMC as facilitating communication between partners during group work, student responses to the evaluation questionnaire were analyzed. Table 8 shows the means and frequency distribution of student responses for questions relating to students' perceived ease of communication. Significant results were found in several areas. First, students in the comparison group were in greater agreement with the statement that students could not understand each other during the debate, compared to those in the CMC group, $t(19) = 4.64, p < .0001, ES = .531$. Second, students in the CMC group tended to agree with the statement that they could communicate easily with their partners, in relation to the comparison group. Analysis of this comparison shows that it approached significant, $t(19) = -1.90, p < .072, ES = .16$. Third, self-reports indicated that students with differing communication preferences could understand each other significantly better in the intervention group than in the comparison group, $t(19) = 7.41, p < .0001, ES = .743$. All students in the comparison group strongly agreed that it was hard for students with different communication preferences to understand each other. Fourth, significant differences were obtained regarding students' perception of the need for clarification or repetition during the activity. Students in the comparison group reported less need for clarification from their partner, $t(19) = 2.15, p < .045, ES = .195$, less need for repetition by the other team during the debate, $t(19) = 2.41, p < .026, ES = .234$, and less need to repeat at the request of the other team during the debate, $t(19) = 1.96, p < .064, ES = .169$. Significant differences were not found for statements B and E.

Table 8 Perceived Ease of Communication – Means & Frequency Distribution

Statement:	Intervention Group (N=16)					Comparison Group (N=5)								
	M	SD	Strongly Agree			Strongly Disagree		M	SD	Strongly Agree			Strongly Disagree	
			1	2	3	4	5			1	2	3	4	5
A. Some students could not understand the other students during the debate.	3.69	.87	0	1	6	6	3	1.60	.89	3	1	1	0	0
B. I understood the other team during the debate.	1.44	.51	9	7	0	0	0	2.00	1.23	2	2	0	1	0
C. My partner and I could communicate easily.	1.69	.60	6	9	1	0	0	2.60	1.67	2	0	2	0	1
D. Students with different communication preferences could understand each other clearly.	3.81	.83	Never			Always		1.00	.00	Never			Always	
E. How often did your partner ask you to clarify what you said?	1.81	.75	6	7	3	0	0	1.20	.45	4	1	0	0	0
F. How often did you ask your partner to clarify what your partner said?	1.69	.70	7	7	2	0	0	1.00	.00	5	0	0	0	0
G. In your group debate, how often did your team ask the other team to repeat what they said?	1.75	.68	6	8	2	0	0	1.00	.00	5	0	0	0	0
H. In your group debate, how often did the other team ask your team to repeat what you said?	1.56	.63	8	7	1	0	0	1.00	.00	5	0	0	0	0

For statements A - C, the heading numbers 1-5 indicate a Likert Scale of 1=strongly agree, 2=agree, 3=no opinion, 4=disagree, and 5=strongly disagree.

For statements D – H, the heading numbers 1-5 indicate a DIFFERENT Likert Scale of 1=never, 2=once in a while, 3=sometimes, 4=often, and 5=always.

Table 9 shows the students’ evaluation of the instructional method. Overall students indicated that using CMC for communication in the classroom was a positive experience. Mean student ratings fell between agree and strongly agree for the statement about feeling comfortable working on the computer.

All but one student agreed that the pace of the discussion via CMC was comfortable for them to read. While five of sixteen students indicated learning the new software was difficult, these students also noted that their problems were the result of working on a Macintosh computer as opposed to a PC. This difference in hardware could account for the students' perceived software struggles. Although there are concerns related to deaf students' reading levels and CMC, where students are required to communicate via reading and writing, ten of sixteen students reported it was not hard to follow the discussion on the computer monitor. Ninety-four percent of participants agreed that this approach to communication was an enjoyable experience.

Table 9 Student Perception of Instructional Method – Means and Frequency Distribution Intervention Group

Statement:	Median	Mean (<i>m</i>)	SD	N	Scale Value (n=16)				
					1	2	3	4	5
I felt comfortable working on the computer.	1	1.75	1.07	16	9	4	1	2	0
The pace of the discussion/debate was comfortable for me to read.	1	1.56	.81	16	9	6	1	0	0
The new software was difficult to learn.	3	3.38	1.36	16	1	4	4	2	5
It was hard to follow the discussion on the computer monitor.	4	3.69	1.08	16	0	3	3	6	4
I enjoyed this approach to communication.	1	1.56	.81	16	9	6	1	0	0

For Table 8, the heading numbers 1-5 indicate a Likert Scale of 1=strongly agree, 2=agree, 3=no opinion, 4=disagree, and 5=strongly disagree.

* Five of the sixteen students noted on their evaluation form that it was not the software that caused difficulty, but rather using a Mac that was difficult for them, as they were more comfortable with PC computers.

Discussion:

The goal of this study was to investigate the usefulness of computer-mediated communication in enhancing communication and participation between partners in a cooperative learning environment - in essence, whether CMC provides a more level playing field in which increased learning can occur.

The study produced clear answers to the research questions. First, in regard to the question of whether CMC facilitated equitable participation, results from the study showed that CMC allowed the students to participate in the group discussions and classroom debates on a more equally proportional basis. In the CMC group, both partners felt comfortable expressing themselves, and felt they could communicate easily. Students in the CMC group felt they shared equal responsibility to contribute to the conversation, while students in the comparison group reported responsibility and participation was not equally shared. Participation by each student is important for learning to occur in cooperative learning activities (Johnson & Johnson, 1986). These results confirm the findings of Mallory and Long (2002) and Liu, et al. (2003), which reported that CMC helps provide equal access to participation through one common mode of communication. As a vehicle that encourages participation and equally shared responsibility for the task, CMC seems to be a worthwhile communication method.

Transcripts of the CMC sessions show that students typically used informal, conversational English and “online jargon” – terms used in emails or IMs specifically for those purposes (eg. LOL = laughed out loud). The use of informal English may have had a positive effect on the participation level of the deaf students in the study, because they did not need to struggle with formal written English or be embarrassed about the level of their writing skills. The students possibly felt comfortable participating online because their English was not being evaluated. Participating in the IM environment also was something all the students were familiar with, and so their comfort level using it as a medium for communication was high. These results are consistent with prior research involving deaf and hearing students, which has found that CMC can help students overcome writing-related anxiety and feel more comfortable sharing their ideas (Stifter, 2005; Bishop, et al., 2000; Hertz-Lazarowitz & Bar-Natan, 2001). These factors may have contributed to the more equal participation rates between partners.

The second question was whether CMC facilitated learning. Students in the CMC group produced summaries with more pertinent points related to their assigned topic, compared to students in the comparison group. There are at least two explanations for this phenomenon. One explanation is that students in the CMC group were able to flesh out more facts from the data in their Web searches because they could communicate more easily in the CMC environment. Active participation by all students involved could have produced the better summaries. Another explanation could be that students found it easier to “copy and paste” their findings related to the Web search from the transcripts of their communications in the messaging feature of Breeze to their summaries in Microsoft Word. In the comparison groups, conversations were face-to-face, with no written record of what points had been discussed (as is the case with the CMC transcripts). Although students were given paper and encouraged to take notes during their discussions to use when creating their summaries, these notes were not collected by the teacher and thus were not included in the grade for the summaries. It may have been easier for the CMC students to remember and include pertinent points in their summaries than for the comparison group. This possibility is recommended as the subject of further research.

A third question was whether deaf students perceived communication was easy with CMC. Students using CMC perceived themselves as more able to communicate easily with their partners than those in the comparison group. Fifteen out of sixteen students in the CMC group agreed that they could communicate with their partner easily, as opposed to only two of five students in the comparison group. When asked if students with different communication preferences could understand each other during the activity, those in the comparison group unanimously reported “never.” Eleven out of sixteen students in the CMC group reported “often” or “always” for the same question. Students using CMC reported highly positive perceptions of the ease of communication through the IM environment.

One interesting finding that first appeared inconsistent was that students in the CMC group perceived a greater need for clarification of comments than the comparison group. Looking back at Table 8, for questions involving the need for clarification, the CMC group responded with answers consisting of “never,” “once in a while,” or “sometimes,” while the comparison group almost unanimously chose “never.” Ironically, student perceptions seem to contradict the data from the coded student interactions. Information from the coded observation sheets of the comparison group and coded student transcripts from the CMC group show that the number of clarifications needed for the comparison group was three and a half times more than the CMC group. There are several reasons why student perceptions may differ so greatly from their observed behavior. It is possible that the students in the comparison group did not understand what the questions were asking for. None of the items on the Activity Evaluation Form were translated into ASL for the students. For questions regarding requests for clarification in ASL, it is very clear who is requesting clarification and from whom it is being requested. For deaf students, the written English may not always be clear. Although emphasis was provided on the form by underlining the subject and object of the verb, it is possible that the question still was not clear.

It could also be possible that the students in the comparison group perceived fewer actual requests for clarification because they purposefully didn’t ask for clarification when they needed it. Although this scenario is a conjecture, students may have mulled over in their mind the decision to ask for clarification and decided against it, thinking that they might not understand the response they would have received. Thus, in this scenario, the resulting requests that occurred were mere happenstance and did not occur with conscious forethought. In other words, if a student did not understand something his or her partner said, he or she may have thought, “I don’t understand that. But if I ask, I won’t understand anyways, so I guess I will just keep quiet.” Then, perhaps, the next time the same student didn’t understand something, he or she just automatically signed “What?” without thinking. If this were the case,

then students in the comparison group may have perceived that they did not ask for clarification consciously. This suggestion is plausible because the wording of the question was, “How often did you ask your partner for clarification...?” Since the question refers to the number of times clarification was “officially” requested, it may be entirely true that students believed they “never” asked for clarification.

Another explanation of this apparent discrepancy is related to the way deaf people communicate both with each other and with hearing people. There is a great variety of communication preference among deaf people. In circumstances where people with different preferences need to communicate with each other, both parties try to match communication methods to the other person’s needs. An example of this is contact signing, which occurs when a person who prefers ASL needs to communicate with a person who prefers signed English – both parties tend to use a contact variety sign language that both can understand (Lucas & Valli, 2000). It is possible that clarification and/or repetition have been a necessity of enough lifetime conversations, that it now goes unnoticed to those asking or being asked. It may have become a natural part of the communication process in sign language between people with different communication preferences. Each group in the study consisted of partners with a variety of communication preferences. While students in the comparison group may not have noticed the need for clarification, those students in the CMC group who did notice that one or two clarifications were necessary might have realized this because the communication was in written form. Even though students in the CMC group perceived clarification was needed as often as “sometimes,” they still believed they could understand and communicate with their partners easily. This is an interesting area for more research.

The study focused on partner groups with different communication preferences as sometimes occurs in deaf-hearing dyads in mainstream schools or deaf-deaf dyads where each deaf student prefers a different method of communication. Previous research had found that when students with differing communication preferences were grouped together, information being transmitted could be missed by

either party (Long & Beil, 2005; Johnson & Johnson, 1986). Communication problems are a hurdle that must be overcome if instructors wish to use cooperative learning in their classroom activities. Thus, the importance of this study must be emphasized, since it seeks to find methods of breaking down communication barriers for deaf students in school.

Lastly, when asked their perceptions related to their use of CMC in the classroom, all students responded positively. They felt the discussion was easy to follow and enjoyed using CMC during the activity. The deaf students in the study who used CMC (which involves reading and writing for communication) agreed they felt comfortable in the online environment and were comfortable with the pace of the discussion. This was in spite of the struggle some deaf students experience with reading and writing.

Five of the sixteen students using CMC reported that the new software was difficult to learn. However, each of these students also indicated on their Activity Evaluation Form that their concern was with using a Macintosh computer instead of a PC, and not necessarily a problem with learning the software. Each of these five students had distinct preferences for PC-type computers and was uncomfortable working on a Mac. Future research should make use of computer hardware that students are familiar and comfortable with to eliminate the potential bias of such a factor on the results. Regardless of the students' preference for PCs, each of them said they enjoyed using CMC as an approach to communication. The results of this study support the findings of Mallory, et al. (2006), where deaf students said CMC provided ease of communication, as used in out of class, online learning. It follows that computer-mediated communication can be one viable instructional method for communication during cooperative learning with deaf students.

Limitations of the Study:

Limitations of this study are found in several areas – sample size, scorer reliability, and the use of a single activity. First, the study used a total sample size of twenty-one students, with only five students in the comparison group. The data obtained from this sample point to the necessity for further research with a larger sample to confirm the results before they can have a high degree of generalizability.

A second limitation of the study involves agreement between the observers coding the comparison group's interactions. For this study, rater reliability training consisted of a two-hour practice session that explained the developed Coding Sheet and also involved actual coding of student interactions in class. The practice session resulted in an eighty percent agreement in codes between the researcher and the other observer. This level of agreement was deemed satisfactory for the purpose of coding student interactions since the research activity was going to be videotaped to record actual student participation for comparison purposes. Actual agreement between raters for the coded research activity was eighty seven percent. Greater familiarity with the Coding Sheet and several more practice sessions would have increased interrater agreement for the study.

Third, due to time constraints the effects of using CMC in the classroom were studied using only a single activity for data collection and evaluation purposes. Students using CMC had no previous experience with the computer program being used for the activity. Had the project involved several activities over the entire quarter, levels of student comfort with both the online environment and the presence of observers in the classroom might have increased, raising the credibility of the results.

Suggestions for Further Research:

The influence of computer-mediated communication on actual and perceived communicative access in the classroom is an intriguing topic worthy of future research to further define its effectiveness

with deaf students. Clearly it is not a method that should be used in all circumstances. For example, some deaf students with disabilities that impact their use of computers or reading and writing online may find CMC frustrating. Students without sufficient keyboarding skills might find typing difficult and quickly become disengaged from the activity. Our recommendation is to continue the research with deaf students in high school or college, who have at least minimal proficiency with computers and are familiar with email and IM environments. Students should be challenged by the class material, not by how to use the program or their personal keyboarding skills.

For a stronger reliability and inferential capability, another recommendation is to use a larger sample size. Selecting a sample made up of at least eighty students with a minimum of forty students in each group would provide greater credibility. This could be done by organizing a research project involving all the deaf college students enrolled in several different classes of the same subject area (e.g. three sections of an Astronomy class, three sections of an Environmental Studies class, and three sections of a Biology class). Students in this sample should be randomly assigned to the experimental and control group.

Also, if the research is to be replicated on a larger scale, another recommendation is to lengthen the duration of the study to include at least several activities. Quarter-long, semester-long, or yearlong projects would be preferable. In this manner, groups could be switched – the first group of students to use CMC could be the comparison group in the second activity, thus providing data from the same students for both types of communication methods. Research projects of longer duration have been done in the past. Mallory, et al.'s (2006) study of the use of CMC with deaf students involved quarter-long blended learning classes. Hertz-Lazarowitz and Bar-Natan's (2001) study of the use of CMC with hearing students comprised a yearlong project where CMC was used consistently as a communication method for specified activities. Projects of longer duration enable the collection of data in a wide variety of areas including the

influence of using CMC on students' writing ability and perceptions related to writing, socialization both on- and off-line, and learning outcomes across the entire school year. Studies longer duration would also increase the inferential capability of the results.

Conclusion:

This pilot study yielded results that point to several benefits of using CMC with deaf students, including more equal participation and improved performance. Results suggest CMC is a valuable tool for teachers to use to facilitate communication among deaf students with diverse communication characteristics, and may also work in groups with deaf and hearing students. This project merely “scratches the surface” with respect to the many ways that CMC can be used to benefit deaf students. Further development of activities and technologies incorporating CMC, and the evaluation of those activities and technologies, is a project worth undertaking.

Bibliography:

- Antia, Shirin D., Susanne Reed, and Kathryn H. Kreimeyer. (2005). Written Language of Deaf and Hard-of-Hearing Students in Public Schools. *Journal of Deaf Studies and Deaf Education*, 10 (3), 244-255.
- Bishop, J.M., L. Taylor, and F. Froy. (2000). Computer-Mediated Communication Use by the Deaf and Hard-of-Hearing. *Kybernetes*, 29, 1078-1086.
- Bransford, John D., Ann L. Brown, and Rodney R. Cocking, eds. (2000). *How People Learn - Brain, Mind, Experience, and School*. Washington: National Academy Press.
- Brown, Paula M. and Gary Long. (1992). The Use of Scripted Interaction in a Cooperative Learning Context to Probe Planning and Evaluating During Writing. *The Volta Review*, 95, 411-424.
- Bruce, Bertram C. and James A. Levin. (2003). Roles for New Technologies in Language Arts: Inquiry, Communication, Construction, and Expression. In Flood, Lapp, Squire, and Jensen (Eds.) *Handbook of Research on Teaching the English Language Arts* (2nd ed.) (pp. 649-657). Mahwah: Lawrence Erlbaum Assoc.
- Bruce, Bertram C. and Joy Kreeft Peyton. (2002). Literacy Development in Network-Based Classrooms: Innovation and Realizations. *International Journal of Educational Technology*, 1 (2). Retrieved July 12, 2005 from <http://www.outreach.uiuc.edu/ijet/v1n2/bruce/index.html>
- Bruce, Bertram C., Joy Kreeft Peyton, and Trent Batson, Eds.. (1993). *Network-Based Classrooms: Promises and Realities*. New York: Cambridge University Press.
- Cho, Hee-Kyung, Matthias Trier, and Eunhee Kim. (2005). The Use of Instant Messaging in Working Relationship Development: A Case Study. *Journal of Computer-Mediated Communication*, 10 (4). Retrieved July 10, 2005 from <http://jcmc.indiana.edu/vol10/issue4/cho.html>
- Chou, C. Candace. (2001). Model of Learner-Centered Computer-Mediated Interaction for Collaborative Distance Learning. *Paper presented at the National Convention of the Association for Educational Communications and Technology*, Atlanta, GA, November 2001. (ERIC Document Reproduction Services No. ED 470 075).
- Cohen, Elizabeth G. (2002). Cooperative Learning and the Equitable Classroom in a Multicultural Society. *Plenary presentation of the IASCE in Manchester, England*, June 2002. Retrieved July 10, 2005 from <http://www.iasce.net/publications/manchester-keynote.shtml>
- Cox, Glenda, Tony Carr, and Martin Hall. (2004). Evaluating the Use of Synchronous Communication in Two Blended Learning Courses. *Journal of Computer Assisted Learning*, (20), 183-193.
- Dansereau, Donald. (1988). Cooperative Learning Strategies. *Learning and Study Strategies: Issues in Assessment, Instruction, and Evaluation*. San Diego: Academic Press, 103-129.

- Dowaliby, Fred and Harry G. Lang. (1999). Adjunct Aids in Instructional Prose: A Multimedia Study With Deaf College Students. *Journal of Deaf Studies and Deaf Education*, 4 (4), 270-282.
- Egelston-Dodd, Judy and Lynn Schaeffer. (1999). Interactive Technology: Empowering Teachers and Motivating Students. In Rittenhouse and D. Spillers (Eds.) *The Electronic Classroom: Helping Teachers Enhance the Curriculum for Students* (pp. 206-228). Washington, NQ: Omega Publications.
- Felder, Richard M. (1995). A Longitudinal Study of Engineering Student Performance and Retention: Instructional Methods and Student Responses to Them. *Journal of Engineering Education*, 84 (4), 361-367.
- Fisher, Mercedes, Gregory Thompson, and David Silverberg. (2005). Effective Group Dynamics in E-Learning: Case Study. *Journal of Educational Technology Systems*, 33 (3), 205-222.
- Geelan, David R. and Peter C. Taylor. (2001). Embodying Our Values in Our Teaching Practices: Building Open and Critical Discourse through Computer Mediated Communication. *Journal of Interactive Learning Research*, 12(4), 375-401.
- Hara, N., Bonk, C. J., & Angeli, C., (2000). Content Analyses of On-line Discussion in an Applied Educational Psychology Course. *Instructional Science*, 28(2), 115-152.
- Hewstone, M. and R. Brown, (eds). (1986). *Contact and Conflict in Intergroup Encounters*. New York: Basil Blackwell.
- Hertz-Lazarowitz, Rachel, and Irit Bar-Natan. (2001). Writing Development of Arab and Jewish Students Using Cooperative Learning (CL) and Computer-Mediated Communication (CMC). *Computers & Education*, (39), 19-36.
- Johnson, D.W., and R.T. Johnson. (2002). Technology-Assisted Cooperative Learning. *The Cooperative Link*, 17, 2-7.
- Johnson, D.W., and R.T. Johnson. (1986). Mainstreaming Hearing-Impaired Students: The Effect of Effort in Communicating on Cooperation and Interpersonal Attraction. *The Journal of Psychology*, 119 (1), 31-44.
- Karchmer, M. and R.E. Mitchell. (2003). Demographic and Achievement Characteristics of Deaf and Hard-of-Hearing Students. In M. Marschark and P.E. Spencer (Eds.), *Oxford Handbook of Deaf Studies, Language and Education* (21-37). New York: Oxford.
- Klingner, Jannette K. and Sharon Vaughn. (1998). Using Collaborative Strategic Reading. *Teaching Exceptional Children*, 30 (4), 32-37.
- Kluwin, Thomas N., Michael S. Stinson, and Gina Mason Colarossi. (2002). Social Processes and Outcomes of In-School Contact Between Deaf and Hearing Peers. *Journal of Deaf Studies and Deaf Education*, 7 (3), 200-213.

- Kneser, Cornelia, Rachel Pilkington, and Tamsin Treasure-Jones. (2001). The Tutor's Role: An Investigation of the Power of Exchange Structure Analysis to Identify Different Roles in CMC Seminars. *International Journal of Artificial Intelligence in Education* (12), 63-84.
- Lang, Harry. (2004). Writing to Learn Seminar. NTID at Rochester Institute of Technology, Rochester, NY. December 6, 2004.
- Liu, Min, Zena Moore, Leah Graham, and Shinwoong Lee. (2003). A Look at the Research on Computer-Based Technology Use in Second Language Learning: A Review of the Literature from 1990-2000. *Journal of Research on Technology in Education*, 34 (3), 250-273.
- Long, Gary and Donald Beil. (2005). The Importance of Direct Communication During Continuing Education Workshops for Deaf and Hard-of-Hearing Professionals. *Journal of Postsecondary Education and Disability*, 18(1), 5-11.
- Lucas, Ceil, and Clayton Valli. (2000). *Linguistics of American Sign Language*. Washington: Gallaudet UP.
- Mallory, James, Karen Vignare, and Gary Long. (2006). Access to Communication for Deaf, Hard-of-Hearing, and ESL Students in Blended Learning Courses. *Paper presented at the Instructional Technology and Education of the Deaf Symposium*, Rochester, New York.
- Mallory, James and Gary Long. (2002). Evaluating the Effectiveness of Online Instructional and Delivery Technologies for Deaf and Hearing Students. In C. Crawford, D. Willis, R. Carlsen, I. Gibson, K. McFerrin, J. Price & R. Weber (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2002* (pp. 220-224). Chesapeake, VA: AACE.
- Mallory, James R. and Kathryn L. Schmitz. (2003). Electronic Conferencing in the Classroom. In Flood, Lapp, Squire, & Jensen (Eds.) *Handbook of Research on Teaching the English Language Arts* (2nd ed.) (pp. 215-219). Mahwah: Lawrence Erlbaum.
- Marschark, Mark, Harry G. Lang, and John A. Albertini. (2002). *Educating Deaf Students*. New York: Oxford.
- McAllister, Simon, Andrew Ravenscroft and Eileen Scanlon. (2004). Combining Interaction and Context Design to Support Collaborative Argumentation Using a Tool for Synchronous CMC. *Journal of Computer Assisted Learning* (20), 194-204.
- Mercer, D. (2003). Using Synchronous Communication for Online Social Constructivist Learning. A paper presented at the *Canadian Association for Distance Education Conference*, St. Johns, Newfoundland.
- Nover, Stephen M., Kathee M. Christensen, and Li-Rong Lilly Cheng. (1998). Development of ASL and English Competence for Learners Who Are Deaf. *Topics in Language Disorders*, 18 (4), 61-71.

- Nowak, Kristine, James Watt, and Joseph B. Walther. (2005). The Influence of Synchrony and Sensory Modality on the Person Perception Process in Computer-Mediated Groups. *Journal of Computer-Mediated Communication*, 10 (3). Retrieved July 10, 2005 from <http://jcmc.indiana.edu/vol10/issue3/nowak.html>
- Parks, M. R., and K. Floyd. (1996). Making Friends in Cyberspace. In *Journal of Communication*, 46 (1), 80-97.
- Pilkington, R. and A. Walker. (2003). Using CMC to Develop Argumentation Skills in Children with a Literary Deficit. In J. Andreissen, M. Baker, & D. Suthers (eds.), *Arguing to Learn: Confronting Cognitions in CSCL Environments* (144-176), London: Kluwer.
- Power, Mary R. and Des Power. (2004). Everyone Here Speaks TXT: Deaf People Using SMS in Australia and the Rest of the World. *Journal of Deaf Studies and Deaf Education*, 9 (3). Oxford UP. 333-343.
- Puntambekar, S. and R. Hubscher. (2005). Tools for Scaffolding in a Complex Learning Environment: What Have We Gained and What Have We Missed? *Educational Psychologist*, 40 (1), 1-12.
- Quan-Haase, Anabel, Joseph Cothrel, and Barry Wellman. (2005). Instant Messaging for Collaboration: A Case Study of a High-Tech Firm. *Journal of Computer-Mediated Communication*, 10(4). Retrieved July 31, 2005 from <http://jcmc.indiana.edu/vol10/issue4/quan-haase.html>
- Rach, L. A. (2000). Literacy Skills on the Job: Reading and Writing in the Workplace. *Odyssey*, Fall-02, 11-16.
- Rourke, Liam, Terry Anderson, D. R. Garrison, and Walter Archer. (2001). Methodological Issues in the Context Analysis of Computer Conference Transcripts. *International Journal of Artificial Intelligence in Education*, 11 (3). Retrieved November 11, 2005 from http://www.communitiesofinquiry.com/documents/2Rourke_et_al_Content_Analysis.pdf
- Sarker, S. (2005). Knowledge transfer and collaboration in distributed U.S.-Thai teams. *Journal of Computer-Mediated Communication*, 10(4). Retrieved July 10, 2005 from <http://jcmc.indiana.edu/vol10/issue4/sarker.html>
- Schmuck, R.A., and P.A. Schmuck. (1997). *Group Processes in the Classroom* (7th ed.). Dubuque, Iowa: Wm. C. Brown.
- Schull, Jonathan, Mike Axlerod, and Larry Quinsland. (2006). Multichat: Persistent, Text-as-you-Type Messaging in a Web Browser for Fluid Multi-person Interaction and Collaboration. From the *Proceedings of the 39th Hawaii International Conference on System Sciences*. Retrieved May 5, 2006 from <http://csdl2.computer.org/comp/proceedings/hicss/2006/2507/03/250730060.pdf>

- Schweir, Richard A. and Shelly Balbar. (2002). The Interplay of Content and Community in Synchronous and Asynchronous Communication: Virtual Communication in a Graduate Seminar. *Canadian Journal of Learning and Technology*, 28 (2). Retrieved November 11, 2005 from http://www.cjlt.ca/content/vol28.2/schwier_balbar.html
- Sherman, Lawrence W. (2000). Cooperative Learning and Computer-Supported Intentional Learning Experiences. *CyberPsychology and Behavior: Special Issue*, 3 (1). Retrieved July 17, 2005 from http://www.users.muohio.edu/shermalw/wolf_chapter-draft3-25.htm
- Shi, S., Mishra, P., Bonk, C., Tan, S., & Zhao, Y. (2006). Thread Theory: A Framework Applied to Content Analysis of Synchronous Computer Mediated Communication Data. *International Journal of Instructional Technology & Distance Learning*, 3(3). Retrieved June 24, 2005 from http://punya.educ.msu.edu/punyaweb/publications/submitted/thread_theory.pdf
- Shiu, Eulynn, and Amanda Lenhart. (2004). How Americans Use Internet Messaging. *Results of the Pew Internet & American Life Project*, Washington, D. C. Retrieved May 5, 2006 from http://www.pewinternet.org/pdfs/PIP_Instantmessage_Report.pdf
- Siegel, L. (2000). The Educational and Communication Needs of Deaf and Hard of Hearing Children: A Statement of Principle on Fundamental Educational Change. *American Annals of the Deaf*. 145(2), 64-77.
- Singhal, Meena. (1998). Computer-Mediated Communication (CMC): Technology for Enhancing Foreign Language/Culture Education. *On-Call*, 12(1), 10-15.
- Slavin, R.E. (2001). Cooperative Learning and Intergroup Relations. In J. Banks and C. McGee Banks (Eds.) *Handbook of Research on Multicultural Education*, San Francisco: Jossey-Bass. 597-615.
- Sorg, Judith J. and James H. McElhinney. (2000). A Case Study Describing Student Experiences of Learning in a Context of Synchronous Computer-Mediated Communication in a Distance Education Environment. Fort Wayne, IN: Purdue University, Learning Environments. (ERIC Document Reproduction Services No. ED 447 794).
- Stephenson, Chris. (1997). Building Deaf Community in Cyberspace: A Case Study of a Deaf Listserv. *Paper presented at the American Educational Research Association*, March, 1997. (ERIC Document Reproduction Services No. ED 406 803).
- Stifter, Rosemary. (2005). *Technology in the ASL/English Bilingual Classroom*. In Press.
- Tan, Gabriel, Patrick B. Gallo, George M. Jacobs, and Christine Kim-Eng Lee. (1998). Using Cooperative Learning to Integrate Thinking and Information Technology in a Content-Based Writing Lesson. *Paper Presented at Singapore Educational Research Association*, Singapore, November, 1998.

The Secretary's Commission on Achieving Necessary Skills, (1991). What Work Requires of Schools: A SCANS Report for America 2000. Washington, D.C.: US Department of Labor.

Toscano, Rose Marie. (2005). Personal Interview. June 28, 2005.

Veerman, A. L. (1999). Collaborative Learning through Computer-Mediated Argumentation. *Paper presented at the Computer Support for Collaborative Learning (CSCL) 1999 Conference*. Palo Alto, CA: Stanford University. Retrieved November 11, 2005 from <http://d3e.open.ac.uk/cscl99/Veerman/Veerman-paper.html>

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Process*. Cole, Michael et al. (ed.). Cambridge, Mass: Harvard University Press.

Wood, Kathleen M. (2002). Bringing Technology to English Class. *Odyssey*, 3, 4-7.

Wortham, D. W. (1999). Nodal and Matrix Analyses of Communication Patterns in Small Groups. *Proceedings of the Computer Support for Collaborative Learning (CSCL) 1999 Conference (681-686)*. Palo Alto, CA: Stanford.

Yang, Jie Chi, Hwa Wei Ko, and I Ling Chung. (2005). Web-Based Interactive Writing Environment: Development and Evaluation. *Educational Technology and Society*, 8 (2), 214-229.

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