AN EXPLORATION OF COLLABORATION IN AN EDUCATIONAL ENVIRONMENT USING COMPUTER-MEDIATED COMMUNICATION

by

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
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Qing Li, Doctor of Philosophy, 2001

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ABSTRACT

This study was intended to contribute to knowledge in the area of collaborative learning in the context of computer-mediated communication (CMC). In the present study, collaborative learning was explored in terms of students' interaction in their learning process. The primary purpose of this study was to examine relationships between language functions associated with the messages generated in the context of CMC and participants' interaction. Language function was defined as "ways we can use language to achieve a communicative purpose" (Olsen, 1992). The secondary purpose was to learn the extent that participants interact in the context of CMC. The third purpose was to explore the use of language functions in relation to teacher-student interactions.

The subjects for this study were selected from students who participated in the "Knowledge Forum Knowledge Building Community Project" in 1999. It was a fifth- and sixth- grade classroom in an inner city elementary school in Toronto, Ontario. A measure of interaction was developed in this study. Along with other three indexes, this measure was applied for the analysis of the data - the entire corpus of electronic messages from the student mathematics and science course from September 1998 to April 1999.

Results of this study indicated that participants (including teachers, students, researchers, and scientists) were actively participating in collaborative learning in the context of CMC.
of five language functions examined, three language functions used by participants in the context of CMC showed no relationship with participants' interaction. However, participants' use of 'giving explanation' and 'expressing disbelief' was positively associated with their interaction. One interesting finding of teacher-student interaction was that with teacher and helping adult involvement, participants were more likely than students alone to make suggestions. When scrutinizing the pattern of the use of language functions in first messages, it appeared that students' strategy was to ask a lot of information. while with teachers and helping adults engagement, participants used 'presenting opinion' most frequently.

Educational implication of this study was discussed. In addition, recommendations for future research about collaborative learning in the context of CMC were made.
ACKNOWLEDGEMENTS

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"From the bottom of my heart, thank you indeed."

...Dr. Phillip Nagy. Your keenness in the study right from its "infancy to adulthood" and positive feedback helped me a lot. I wish therefore to express my sincerest appreciation and gratitude.

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My father, mother and sisters are also acknowledged in this work. My mother and father, who know the importance of a good education, made it possible for me to continue my own education. Thank you, mom and dad.
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CHAPTER I: THE PROBLEM

1.1 Introduction

This study is intended to understand collaborative learning in a context that enables communication by computer text messaging. Particularly, the study seeks to determine the extent of collaboration in a classroom that uses computer-mediated communication (CMC), as well as to examine the relationship between the language functions associated with CMC generated messages and the collaborative learning process. In this study, "language functions refer to ways we can use language to achieve a communicative purpose" (Olsen, 1992). It is what people "can do with language" (McDonell, 1992), or "what people want to do with the language" (Finocchiaro & Brumfit, 1983, p.13), such as: asking information, giving information, making suggestion, apologizing, etc.

The use of CMC as a teaching-learning tool has increased dramatically in recent years as more educational institutions gain access to the Internet (Murphy, et al. 1996). While there are a wide variety of useful methods to investigate collaborative learning processes, the specific focus of this study is on the in-depth analysis of message content which is very crucial to student learning process (Henri, 1992).

"The process of how people learn - cognitive psychology - is not new, but the context - computer-mediated communication (CMC) - is relatively new." (Burge, 1993). In fact, Murphy et al. (1996) claim that CMC is still in its cultural infancy. The process of collaborative learning in relation to language functions associated with messages in the context of CMC has rarely been explored.

This study is an exploratory rather than a definitive work. It is prompted by several questions and guided by several bodies of literature. This chapter presents the research
questions and provides the background for this study. Definitions of the key terms are needed first to help set the context.

1.2 Definition of Terms

One of the key terms for this study is collaborative learning. Collaborative learning is one of the instructional methods that grew out of a solid theoretical base in social psychology (Deutsch, 1949). According to Roschelle and Teasley (1995), collaboration is a broadly used term that describes a wide variety of behaviors. In the most general sense, collaboration is said to have occurred when more than one person works together on a single task. Olsen and Kagan (1992) point out that no one has proposed a universally accepted definition of collaborative learning. Instead, researchers usually describe key elements, characteristics, or principles that contribute to achievement, socialization, and other gains. However, several proposed definitions are provided here to represent of the scope.

For the purpose of this study, the author considers collaborative learning as learning that takes place as an outcome of people working together, no matter whether learning is the main explicit goal or an incidental result of the collaboration. That is, the term collaborative learning is used in this study to mean:

the acquisition by individuals of knowledge, skills, or attitudes occurring as the result of group interaction, or put more tersely, individual learning as a result of group process.

(Kaye, 1992, p.4)

Olsen and Kagan offered a different definition. For them, collaborative learning is

group learning activity organized so that learning is dependent on the socially structured exchange of information between learners in groups and in which each learner is held accountable for his or her own learning and is motivated to increase the learning of others.

(1992, p.8)

In the collaborative model.
Education does not consist merely of "pouring" facts from the teacher to the students as though they were glasses to be filled with some form of intellectual orange juice. Knowledge is an interactive process, act as an accumulation of Trivial Pursuit answers; education at its best develops the students' abilities to learn from themselves... Another way to say this is that collaboration results in a level of knowledge within the group that is greater than the sum of the knowledge of the individual participants. Collaborative activities lead to emergent knowledge, which is the result of interaction between (not summation of) the understandings of those who contribute to its formation.

(Whipple, 1987, p.5)

According to the Oxford English Dictionary, the terms "cooperative" and "collaborative" share the same meaning and have equivalent etymologies. Researchers, in citing work related to collaborative and cooperative learning, often refer to collaborative learning and cooperative learning interchangeably and without distinction. Likewise, the author of this study takes the same point of view and uses collaborative learning to include research in both collaborative learning and cooperative learning.

The second key term for this study is computer-mediated communication (CMC). According to Burton:

Computer mediated communication (CMC) is any communication using computers. This broad definition has been commonly refined to mean those communications that occur with the use of electronic media, such as:

- Electronic mail
- Bulletin boards
- Discussion lists
- Multi-user Domains (MUDs, MOOs)
- Conferencing Software
- World Wide Web (WWW) using a dialogue software such as HyperNews

Teaching using CMC includes some or all of these methods. The computer mediates part or all the communications of the class, which may be a face-to-face classroom, an asynchronous discussion that takes place electronically via computers, a synchronous discussion that takes place using Internet Relay Chat, a form of distance tutoring, a world-
wide conference conducted entirely "on-line," multi-user domains or any combination.”

Similarly. Paulsen (1995) defined CMC as the “transmission and reception of messages using computers as input, storage, output, and routing devices. CMC includes information retrieval, electronic mail, bulletin boards, and computer conferencing.” This study focuses on the computer applications for direct. “human-to-human communication, sometimes referred to as computer based conferences” (Nawratil, 1999).

The use of CMC as a teaching-learning tool is increasing dramatically. It has been claimed that CMC is a "device which provides a framework for group collaboration from a distance and which, in pedagogy. can enhance collaborative learning." (Henri. 1996). Wells states that CMC can:

...provide students with opportunities for convenient course-related or social interaction with peers...enable collaborative group work by distance students ... facilitate interaction with an instructor ... decrease turnaround time for instructor feedback ... allow students access to on-line resources. e.g.. databases, library catalogues. and course registration ... and enable students to upload and download assignments and take on-line quizzes and tests ...

(Wells. 1992, p.2)

Kaye summarized the advantages of using CMC in education in terms of:

- the convenience of an asynchronous communication mode, which liberates users from both time and space constraints;
- its value as a medium of written communication. within a system in which students are graded essentially on the quality of their written work;
- the enhanced levels of interactivity between and amongst students. tutors, course developers, and other members of a widely dispersed learning community;
- the reduction of the isolation felt by many distance learners. and the potential of CMC for collaborative learning.

(Kaye. 1990. p228)
The third key term of this study is language functions. To Olsen (1992), "language functions refer to ways we can use language to achieve a communicative purpose". It is what people "can do with language, such as giving and receiving information, asking for clarification, and expressing agreement or disagreement" (Mcdonell, 1992) or "what people want to do with the language" (Finocchiaro & Brumfit, 1983, p.13).

Saville-Troike (1996) indicates that the functions of language generally provide the primary dimension for characterizing and organizing communicative processes. They further elaborate that without understanding why a language is being used as it is, one cannot understand the meaning of its use in the context of social interaction. This study considers the following five language functions: ‘asking information’, ‘giving information’, ‘making suggestions’, ‘presenting opinions’, and ‘expressing disbelief’.

The fourth key term of this study is interaction. In this study, the definition of interaction in operational terms is used in order to be able to identify it in CMC. To do so, the following analytic model to distinguish between two types of messages established by Henri (1995) is employed.

1). Interactive messages: these answer or interpret a previous statement - they refer to the theme of the teleconference and are also connected explicitly or implicitly, to one or more other messages.

2). Non-interactive or independent messages: their content relates to the theme of the teleconference, but is not connected to other messages of the teleconferences.

(Henri, 1995, p.152)

The definitions of the categories and sub-categories of the model are helpful in analyzing CMC messages. Table 1.0 presents the Analytic Model of Interactive Behavior developed by Henri (1995, p. 153).
**Table 1.0 Analytic Model of Interactive Behavior**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. EXPLICIT INTERACTION</td>
<td>Any statement containing a specific reference to another message, to another person or to a group of persons</td>
</tr>
<tr>
<td>1.1 Direct Answer</td>
<td>Any statement answering a question in an explicit or obvious manner by referring to it directly.</td>
</tr>
<tr>
<td>1.2 Direct Comment</td>
<td>Any statement referring to and furthering an idea which has been raised, by direct reference to it.</td>
</tr>
<tr>
<td>2. IMPLICIT INTERACTION</td>
<td>Any statement containing an implicit reference to another message or to another person or group of persons.</td>
</tr>
<tr>
<td>2.1 Indirect Answer</td>
<td>Any statement which obviously answers a question, but without referring to it by name.</td>
</tr>
<tr>
<td>2.2 Indirect Comment</td>
<td>Any statement referring to and furthering an idea which has been raised without referring to the original message.</td>
</tr>
<tr>
<td>3. INDEPENDENT MESSAGE</td>
<td>Any statement dealing with the subject under discussion, but not answering or commenting.</td>
</tr>
</tbody>
</table>

Although the intention of this study is to explore collaborative learning in CMC environments, collaboration itself, however, is not operationally defined. This suggests that collaboration is not a measurable structure. According to Harasim (1990), collaborative learning theory highlights group interaction. Interaction is a very important indicator of collaborative learning and interaction is often cited as the major learning factor in collaborative learning (O'Donnel & Dansereau, 1992). In general, there appears a consensus in the literature that interaction is a strong indicator of collaboration and "the analysis of interactivity can lead to an evaluation of the levels of collaboration at work among learners" (Henri, 1992, p.128). Because interaction is highly correlated with collaborative learning, and because CMC is
essentially an interactive process (Henri, 1992), in the present study, therefore, collaborative learning is explored in terms of students' interaction in their learning process. That is, in this study, interaction – not a synonym but a major indicator of collaboration – is measured and explored. I argue that this is reasonable given the fact that this major indicator of collaboration is operationally defined and therefore measurable.

The fifth key term of this study is degree of interaction. In CMC environments, interactions are usually examined in terms of participation, for instance, number of messages generated in computer conferences, time spent on task, length of messages. However, as Henri (1995) argued, to measure participation is not to measure interaction. Furthermore, although numerous studies have explored interaction and collaborative learning, few studies, if any have given a full theoretical or operational definition of degree of interaction. To what extent do students interact in a CMC environment? How can we measure it? In this study, therefore, I propose to measure degree of interaction in CMC environments using four different indexes, i.e. size, level, Interactivity Value, and T-units of a message tree. Detailed descriptions of these four indexes are provided in chapter 3.

1.3 Theoretical Rationale

Numerous studies dealing with collaborative learning have suggested that students need appropriate social skills in order to be successful in their collaborative learning (Johnson & Johnson, 1989; Coelho, 1992). Johnson and Johnson (1989) emphasize that collaboration is the most important and basic form of human interaction, and the skills of collaborating successfully are the most important skills anyone needs to master. "There is no way to overstate this point" (Johnson & Johnson, 1989a). Coelho (1992) explains that good social skills can promote collaborative learning and some negative behaviors can shut off future collaboration. In
addition, the literature on collaborative learning emphasizes the need to teach social skills. Students need assistance in acquiring those social skills and many of these social skills can be regarded as communication skills. For example, Olsen and Kagan (1992) state that "social skills include ways students interact with each other to achieve activity or task objectives (e.g., asking and explaining) and ways students interact as teammates (e.g., praising and recognizing)."

As demonstrated by Coelho (1992), the language functional categories described by applied linguists look remarkably parallel to the social/collaborative skills described by collaborative learning experts. Among various taxonomies of language functions are these examples of functional categories given by Finocchiaro (1983) (See Table 1.1). Table 1.2 provides a list of specific social skills for students to practice recommended by Olsen and Kagan (1992).

Comparing the functional categories of language (Table 1.1) and the list of social skills (see Table 1.2) needed for collaborative learning, we can see some striking similarities. This implies the importance of language functions in relation to collaborative learning. Since language functions can be addressed as part of a social skills strand (Olsen, 1992), teaching people and building their awareness of language functions thus can improve their social skills, and this in turn, promotes their collaborative learning. This suggests that we can focus on the corresponding language functions in order to provide opportunities for people to develop specific social skills for the enhancement of their collaborative learning.

However, all these conclusions are based on the works that have been done in traditional face-to-face settings. Are these conclusions still true in the CMC environment? This remains to be answered and it raises important questions in the field of collaborative
learning in this new learning environment. This study, therefore, explores student interaction in relation to their communication in a CMC environment.

Table 1.1 Examples of Finocchiaro's taxonomy of language functions

<table>
<thead>
<tr>
<th>Referential</th>
<th>Interpersonal</th>
</tr>
</thead>
<tbody>
<tr>
<td>paraphrasing/summarizing, asking for explanations, explaining, clarifying, reporting facts, evaluating results</td>
<td>indicating agreement/disagreement, sharing feelings</td>
</tr>
</tbody>
</table>

Table 1.2 Olsen and Kagan's List of Social Skills

<table>
<thead>
<tr>
<th>Task-Related Social Skills</th>
<th>Group-Related Social Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>asking for clarification</td>
<td>acknowledging others' contributions</td>
</tr>
<tr>
<td>asking for explanations</td>
<td>appreciating others' contributions</td>
</tr>
<tr>
<td>checking understanding of others</td>
<td>asking others to contribute</td>
</tr>
<tr>
<td>elaborating ideas of others</td>
<td>praising others</td>
</tr>
<tr>
<td>explaining ideas or concepts</td>
<td>recognizing others</td>
</tr>
<tr>
<td>giving information or explanations</td>
<td>verifying consensus</td>
</tr>
<tr>
<td>paraphrasing and summarizing</td>
<td>keeping the group on task</td>
</tr>
<tr>
<td>receiving explanations</td>
<td>keeping conversation quiet and calm</td>
</tr>
<tr>
<td>requesting clarification</td>
<td>mediating disagreements or discrepancies</td>
</tr>
</tbody>
</table>

1.4 Purpose and Research Questions

One of the main purposes of this study is to determine the degree of interaction in the context of CMC. Furthermore, the study examines the relationship between participants' interaction and the language functions associated with their messages in the CMC context.

This study is guided by the following questions:
1. What is the degree of interaction in an elementary classroom that uses CMC?

2. Are there any frequency patterns in participants’ (including teachers, students, and helping adults) use of language functions in relation to the degree of interaction in the context of CMC? If so, what are the patterns?
   a). Are there any frequency patterns in participants’ use of "asking information" in relation to the degree of interaction? If so, what are the patterns?
   b). Are there any frequency patterns in participants’ use of "giving information" in relation to the degree of interaction? If so, what are the patterns?
   c). Are there any frequency patterns in participants’ use of "making suggestion" in relation to the degree of interaction? If so, what are the patterns?
   d). Are there any frequency patterns in participants’ use of "presenting opinion" in relation to the degree of interaction? If so, what are the patterns?
   e). Are there any frequency patterns in participants’ use of "expressing disbelief" in relation to the degree of interaction? If so, what are the patterns?

3. Are there any changes in frequency patterns in participants’ use of language functions in relation to the degree of interaction with adult (including teachers and helping adults) involvement in the online discourse? If so, what are the patterns?

1.5 Context of the Study

The focus of the study is elementary student collaborative learning in mathematics and science using CMC. The actual system used was the Knowledge Forum. The medium is an example of a more generic type commonly referred to as CMC media.

"Computer Supported Intentional Learning Environment (CSILE) is the first network system to provide across-the –curriculum support for collaborative learning and inquiry.” (Smith-Lea & Scardamalia, 1997). Knowledge Forum, the second generation of CSILE, expands on CSILE’s ability to facilitate students in knowledge construction through collaborative learning in a dynamic way (Smith-Lea & Scardamalia, 1997). “As a knowledge-
building environment. Knowledge Forum participants can naturally gravitate towards solving problems collaboratively and moving the knowledge of the group, not just the individual, forward" (Smith-Lea & Scardamalia, 1997). Because knowledge Forum is an environment that supports student collaborative learning, it provides an ideal setting for the current study. This study, therefore, explores student collaborative learning in the context of Knowledge Forum.

Knowledge Forum is essentially a participant generated communal database. According to Scardamalia and Bereiter (1996), the key features of the system include tools for the creation and storage of messages, and means to direct students toward collaboration. Taking together these elements. Knowledge Forum supports a more purposeful processing of information. In Knowledge Forum, students and their teachers can generate text or graphic messages to share their ideas. They can also create views to represent different aspects of their collaborative work. This communal database allows every participant to access these messages and work collaboratively to build higher levels of understanding. The system has the organization for any number of small groups to carry on discussions and debates among themselves and with each other, for students to join in the discussions of whatever group they are interested in, and to realign themselves with other groups as the need arises, and it allows the teacher as well as other students to monitor and contribute to the developing lines of inquiry of each group.

(Lamon, Reeve, & Caswell, 1999)

It provides 1) the means that encourage theory formulation and sustained inquiry and 2) database search mechanisms that assist students generating collaborative communities in which they work to advance the ideas in them (Scardamalia and Bereiter 1996).

More importantly, Knowledge Forum facilitates knowledge generation and construction. It assists students to form questions, process information for the database, study the information in the database, and find gaps. In Knowledge Forum, according to Scardamalia and Bereiter (1996), knowledge construction rather than knowledge retrieval or navigation is the key issue. Thoughts are dynamic, concrete things that get stored, retrieved or navigated. In such a
dynamic setting, students are constantly engaged in "higher-level cognitive processes: 1) explanation, problem finding, problem solving, etc.; 2) in-depth understanding of informative texts; 3) active, intentional learning; 4) literacy and literacy-related problems." (Scardamalia & Bereiter, 1996, p. 36).

In Knowledge Forum, various structures were designed to enhance student collaborative knowledge building. One of these built-in software structures is a "scaffold". According to Anton and Dicamilla

The concept of scaffolding originates with the work of Wood et al. (1976) and serves as a metaphor for the interaction between an expert and a novice engaged in a problem solving task. Scaffolding involves the expert taking control of those portions of a task that are beyond the learner's current level of competence, thus allowing the learner to focus on the elements within his or her range of ability. (1999, p. 235)

Now the term "scaffolding" is used in a much broader sense. In essence, "scaffolds are thoughtful ways of assisting students in experiencing successful task completion" (Watts-Taffe & Truscott, 2000). In Knowledge Forum, a "scaffold" is designed as a cognitive developmental tool to help students' collaborative knowledge construction. This design of scaffolds assisted students' ability to communicate their ideas as well as the nature of these ideas. It also provided "flexible ways of structuring notes" (Scardamalia & Bereiter, 1999).

For the purpose of the current study, scaffolds include both the "scaffolds" (i.e. "theory building", etc.) and the "thinking-type labels" (i.e. "my theory", "problem", "I need to understand", "new learning", etc.) as described by the Knowledge Forum/Knowledge Building Community Project team (Scardamalia & Bereiter, 1999).

Assessments indicate that individual students in classrooms using Knowledge Forum scored higher in standardized tests, reading comprehension, and several other measures than those in control classrooms (Scardamalia et al, 1994).
The present study concentrates on elementary student mathematics and science collaborative learning. I choose this focus because, as the work on misconceptions indicated, most people (including students and adults) usually do not have a good understanding of basic principles of the subjects (Bruer, 1993). In addition, teaching for understanding in these subject areas is still a problem for a lot of teachers (Lamon, Reever, & Caswell, 1999). Moreover, previous research (Quinn & Molloy, 1992) and several significant reports including those by the American Association for the Advancement of Science (1989), National Council of Teachers of Mathematics (1989, 1991), and National Research Council (1989) have promoted collaborative teaching and learning in mathematics and science. Hence, it is important to have a thorough understanding of student collaborative learning in mathematics and science in the context of CMC.

1.6 Backgrounds and Significance of the Study

Computer-mediated communication (CMC), first developed in 1970 by Murray Turoff (Harasim, 1990), is an effective electronic means of connecting learners without time and location constrains using computers (Machtmes & Asher, 2000), so that they may collectively participate in a learning experience where the interaction is mediated. Despite its relatively short history, much of interest has been shown in this technology.

Courses offered by CMC are gaining favor in schools and institutions of higher education (Barrett & Lally, 1999; Emms & McConnell, 1998). Students can interact without time and location constraints (Henri, 1995; Harasim, 1990; Flores, 1990), and socially connect with others engaged in the same experience. CMC promotes interactive activities such as active dialogue and sharing of information and knowledge, which help develop a learning community (McConnell, 1997; Davie, 1987; Burge, 1993). The CMC can be used as a
powerful communication and collaborative learning tool (Crook, 1995; Kaye, 1989). The collaborative learning environment promotes active mental engagement in the experience (Grabowski, 1990). The learning through social construction and sharing of understanding is a unique feature of CMC that distinguishes itself from other forms of distance education (Levinson, 1990; Harasim, 1990). The freedoms associated with CMC lead to feelings of learner empowerment. These are characteristics of CMC that are identified by learners and facilitators alike (Lauzon, 1991; Kicks, 1992).

Because CMC is still in its cultural infancy, new understandings of students' learning and teachers' teaching in the context of CMC are needed in order for us to maximize the usage of this new technology. Harasim (1990) claimed that "on-line education is a new environment, with new attributes, and requires new approaches to understand, design and implement it."

Leading researchers in this field contended that CMC is not mere replication of a conventional classroom, but a new form of social interaction that makes different demands of both teachers and students (Collis, 1998). Turoff (1990) argued: "the approaches that teachers take in the face-to-face classroom are not appropriate". He further elaborated:

> the teaching methods and approaches to communication with students are different from those suited to the face-to-face environment: the instructor is more a facilitator of group communications, organizer of group learning activities, and resident consulting expert. ... Another significant problem is that the workload for faculty is linearly dependent upon the number of students: leaving grading aside, the amount of communication generated is a direct function of the number of students. ... Moreover, the initial effort of developing material in electronic form is similar to the complete development of a new course or of a small book. On the other hand, the cumulative memory of the computer is a distinct advantage for maintenance and updating of courses.

(Turoff, 1990, p. xii)

Having been a learner in a couple of CMC courses, I experienced the way in which this medium can dissolve geographic distances and facilitate meaningful connections with others.
Time for reflection, synthesis and integration of the diverse perspectives shared on-line into a personal and meaningful framework was at a premium. Nevertheless, the voluntary engagement in these activities became very challenging because of the asynchronous medium. My learning was enhanced however, through work in a collaborative learning group with three colleagues on the same project. We shared a learning space that enabled conversation to take place, promoted reflection and collaboration, and facilitated the construction of knowledge. The deliberately planned collaborative activities also enhanced my learning and brought new insights regarding my role as an educator and learner to my conscious awareness. However, I also found that it is not an easy job to collaborate successfully, especially in the context of CMC since the communication relies solely on text-based messaging. Students' communication with each other plays such an important role in their collaboration. How to write messages - to respond, to make suggestions, to raise questions, etc. - becomes so critical in enhancing students' collaborative learning in a CMC environment. Because of the lack of visual cues, I noticed that the peculiarities of using CMC in education do not always make it possible to apply the factors that ensure success of collaborative learning. Previous research studies have supported this view (Perdue & Valentine, 2000). For instance, some communicative techniques of collaborative learning in a conventional face-to-face environment (such as using body language like eye contact and gesture) simply are not appropriate anymore.

In cognitive and social psychology, we already know much about how students communicate and the relationship of communication with collaborative learning, but the context has usually been the traditional face-to-face setting with its paralinguistic cues to facilitate communication. What we do not yet know in published details is how people learn collaboratively and how this collaborative learning relates to the communication in the CMC context. Aviv and Golan (1998) indicate that questions asked to identify the patterns of participants' communication should be “posed - and solved - well before the task of setting up an operational telelearning system within the educational framework can be tackled. (p. 203)” As Burge (1993) points out, despite the large body of literature on peer learning and teaching,
there are few acknowledgments of how well CMC may support collaborative learning. In addition, O'Malley (1995) calls for studies of collaborative learning that "focus more on the processes involved in successful peer interaction, rather than just on learning outcomes".

Therefore, this study seeks to understand how people learn collaboratively and how their collaborative learning relates to their communication in the context of CMC. These questions are considered to be "one of the most important issues" in research of CMC (Aviv and Golan, 1998). By asking these research questions, I assume that if we, as educators, know more about the process of collaborative learning in a computer-mediated communication environment, we have a better chance of developing practical guidelines for facilitating learning. In addition, the information obtained from the study may contribute to the present understanding of student learning in CMC environment and may suggest future studies in the area. Once we have an idea of how students go about communicating and learning in the CMC environment, we might then compare the CMC learning strategies with those reported for face-to-face classroom contexts. That way we can search for new practices to facilitate collaborative learning and which are better suited to the CMC context. In addition to practical implications, this study may provide theoretical contributions to the field of collaborative learning using CMC. The result of the study may hold promise both for advancing the theory base of collaborative learning in mathematics and science in CMC settings and guiding research in the future. And only when we have a better understanding of computer mediated learning, can we make a better use of CMC.
CHAPTER II: LITERATURE REVIEW

The literature review of this study is divided into two main sections. The first part deals with collaborative learning. In this part, I discuss the concept of collaborative learning in terms of interaction, compare the similarities and differences between the basic elements of collaborative learning described in traditional face-to-face settings and CMC environments, sketch out the theoretical models of collaborative learning, and examine the benefit of collaborative learning. Whenever possible, links are made to CMC. The second part explores the literature related to computer-mediated-communication that may inform the study. The emphasis is CMC in relation to collaborative learning. Theoretical and descriptive literature is presented. The review of related literature ends with a summary.

In compiling research reports for this review, the main criterion is topical – that is, the educational research literature is examined for reports of research on collaborative learning and CMC whose titles and abstracts suggest that a primary focus of the research is related to either collaborative learning and/or CMC. The reports of research included in this review constitute a mixture of published journal articles, books, and less widely available conference papers and doctoral dissertations.

2.1 Collaborative Learning

2.1.1 Interaction

According to Harasim (1990), collaborative learning theory highlights group interaction. Interaction is a very important indicator of collaborative learning and is often cited as the major learning factor in collaborative learning (O'Donnel & Dansereau, 1992). Analysis
of interaction allows us to describe the actual structuring of CMC content. Moreover "the analysis of interactivity can lead to an evaluation of the levels of collaboration at work among learners, of their active participation in the accumulation of knowledge, and of their skills in structuring the information presented on-screen." (Henri, 1992, p.128). The importance of the concept of interaction in CMC made it imperative for us to provide some in-depth analysis. For the purpose of the present study, therefore, collaborative learning is explored in terms of students' interaction in their learning process. However, as Henri (1992) pointed out, while there appears to be consensus that CMC is essentially an interactive process, few studies has provided a full theoretical or operational definition of the interactive process.

The review of literature also shows that most researchers equate the interaction to participation in CMC: when they present on an experiment in training with CMC, they imply that to measure participation is to measure interaction. Thus it is presumed that any and all messages recorded in a teleconference are interactive. It is assumed that if students participate in group discussion through CMC, they are necessarily interacting in the construction of computer conferencing content regardless of whether learning results from it. But is it really this simple? The answer is no. Henri (1995) argued that participation does not equal interaction. What is interaction then? In this study, the following definition of interaction in operational terms (Henri 1995) is used in order to be able to identify it in CMC.

1). Interactive messages: these answer or interpret a previous statement - they refer to the theme of the teleconference and are also connected, explicitly or implicitly, to one or more other messages.

2). Non-interactive or independent messages: their content relates to the theme of the teleconference, but is not connected to other messages of the teleconferences.

(Henri, 1995, p.152)
2.1.2 Basic Elements of Collaborative Learning

2.1.2.1 General

To fully understand the concept of collaborative learning, some views about the basic elements of collaborative learning are given here to represent the scope of the concept.

Kaye sees the following six elements as being the most important in defining collaborative learning:

1. Learning is inherently an individual, not a collective, process, which is influenced by a variety of external factors;
2. Learning is simultaneously a private and social phenomenon;
3. Learning collaboratively implies peer exchange, interaction amongst equals, and interchangeability of roles, such that different members of a group might take different roles at different times, depending on needs;
4. Collaboration involves synergy, so that learning collaboratively has the potential to produce learning gains superior to learning alone;
5. Not all attempts at collaborative learning will be successful, as, under some circumstances, collaboration can lead to conformity, process loss, lack of initiative, misunderstanding, conflict, and compromise;
6. Collaborative learning does not necessarily imply learning in a group, but rather the possibility of being able to rely on other people to support one's own learning and to give feedback, as and when necessary, within the context of a non-competitive environment.


Johnson and Johnson (1989) suggest that the four basic elements of collaborative learning are:

1. **Positive interdependence.** Fostering a positive interdependence among group participants is the first key element in successful collaborative learning. Students in the group must perceive that they need each other to accomplish the task at hand. This can be done through establishing mutual goals; dividing labor; sharing resource, materials, and information; assigning students different roles; and giving joint rewards.
2. **Face-to-face communication.** Collaborative learning involves face-to-face interaction among students. Verbal interchange and interaction patterns among students are important. Positive interdependence promotes these interactions, and they in turn affect educational outcomes.
3. **Individual accountability.** Another key element of collaborative learning is individual accountability for mastering the assigned materials. Everybody in the
group is responsible for learning the material and providing appropriate support and assistance to one another in order to maximize the achievement of each student.

4. Interpersonal and small group skill. Collaborative learning requires that students appropriately use interpersonal and small group skills. Students must be taught and motivated to use the social skills (which include: communication, leadership, trust, etc.) needed for collaboration. Furthermore, students must be given the time and procedures for analyzing how well their learning groups are functioning and the extent to which students are using the social skills to help all group members to achieve and maintain effective working relationships within the group.

(p.12).

Some researchers (Waggoner, 1992) also categorize a fifth element called "group processing" which is extracted from the final aspect of Johnson and Johnson's "interpersonal and small group skills" element. According to Waggoner,

group processing provides the members with the time and procedures for analyzing the functioning of their group and their own use of interpersonal and small group skills. This helps alter the focus of the individual to the larger group and to make judgments about overall effectiveness and his or her relative contributions to the achievement of the group goal.

(1992. p.139)

Abrami and Bures reinforce that

using collaborative learning means that students are responsible for their own learning as well as for the achievement of peers. Collaborative learning does not exist when learners are solely dependent on other students for their performance or when learners co-act with others solely to enhance their own achievement.

(1996)

2.1.2.2 In the Context of CMC

Moving from a conventional face-to-face setting into a computer-mediated environment, some of these basic elements of collaborative learning have to change as well. Derived from the research of Johnson and Johnson (1985), Harasim (1987) and Slavin (1985), Waggoner (1992) argues that there are still five basic elements in collaborative learning in a computer-mediated environment. However, he also claims that four out of these five elements differ drastically from the five basic elements of collaborative learning in a conventional face-to-face setting.
First, the "face-to-face communication" element is obviously lost when moving into a CMC environment. Communicating by computer text messaging where "interaction is disembodied from nonverbal cues... delayed due to members interacting from difference places at different times" (Waggoner, 1992), significantly impacts collaborative work. Therefore we need to design and evaluate monitoring to explore the new opportunities and to improve the negative effects that this medium brings about.

Second, though "individual accountability" is still a key element, since we have permanent records of much of the individual performance and interactions for close analysis and feedback, the CMC environment makes individual assessment much easier than in traditional settings.

Third, the teaching of "interpersonal and small group skills" is more complicated in a CMC environment because of the loss of the nonverbal aspect of communication. New strategies for teaching these skills in a CMC environment thus are needed.

Last, but not least, the change in the communication environment changes the "group processing". It needs alteration of monitoring and intervention strategies that differ significantly from a traditional face-to-face setting (Waggoner, 1992, p. 138).

For Henri and Rigault, factors that ensure success of collaborative learning in a face-to-face setting do not guarantee the success of collaborative learning in CMC environment. In addition to the importance of collaboration in CMC context, they argue that the reality calls for a flexible functioning of computer-conferencing requiring participation, cohesion, a sense of belonging and the desire that all should complete their activity, rather than having interdependence as the pivot of functioning.

(1996, p. 54).

For the purpose of this study, both views developed by Waggoner (1992) and Henri and Rigault (1996) are considered to be representative of collaborative learning in CMC.
Collaborative learning is an old idea; it is as old as human kind (Johnson & Johnson, 1987). As early as the first century, Quintilian stated that students could improve themselves from teaching peers. In nineteenth century, colonel Francis Parker “brought to his advocacy of collaborative learning enthusiasm, idealism, practicality, and an intense devotion to freedom, democracy, and individuality in the public schools.” (Johnson & Johnson, 1995, p.87) He brought into the classroom the regenerating spirit, and created a truly collaborative classroom atmosphere.

In contemporary research in collaborative learning, two major theoretical perspectives have dominated this field. They are socio-cognitive theory derived from Piaget and social-cultural theory derived from Vygotsky (O’Malley, 1995). Piaget (1932) realized, in his early study, the effects of social interaction in individual development - especially in the egocentric to de-centered thinking development and the logical thinking growth. The associates in Geneva took up his early ideas on social interaction and cognitive development (Perret-Clermont. 1980; Doise & Mugny. 1984).

The second major theoretical perspective of collaborative learning research originates from Vygotsky. Vygotsky's theory emphasizes that every individual development stems from social process. For Vygotsky, to understand students' cognitive development, we must consider the social origins of both the thinking tools that students learn to use and the social interactions that direct them in their use. He suggests that individual cognitive processing is derived from the social activity, rather than derived primarily from the individual's characteristics and considered social influences only a plus.

Though both Piaget and Vygotsky believe that the individual and the environment are inseparable parts in the understanding of cognitive development, they differ in the centrality of the environment role. They also differ in the way in which they considered of such role and the individual. A Piagetian approach to collaborative learning views social interaction is only a
catalyst for cognitive development, whereas a Vygotskian approach sees that inter-psychological processes are not only a catalyst for change but are themselves internalized by the individual involved (O'Malley, 1995). In a nutshell, while both Piaget and Vygotsky consider social and personal processes in development, Piaget focused on the individual, sometimes with social interactions with others, whereas Vygotsky centered on social processes.

This study analyzes collaborative learning from the Vygotskian social-cultural perspective. It takes the point of view that formal learning is a social, therefore communicative activity, whether or not it is mediated over time and distance by instructional technology.

2.1.4 Why Collaborative Learning?

"The enthusiasm for collaborative learning has become so widespread that most researchers and educators believe that students learn better when they work in groups as compared to when they work autonomously." (Coleman, 1995).

Because of the belief that students learn better in the collaborative learning environment, collaborative learning has been studied for several decades. Thousands of research studies have investigated the impacts of collaboration, competition, and individualistic interdependence. Of these, eight-two percent have been published since 1960, and fifty-four percent since 1979 (Johnson, Johnson, & Smith, 1996). Overall, it has been proved that collaborative learning helps improve affective social skills and academic cognitive outcomes within school settings (Lazarowitz, 1995). Because the educational application of collaborative learning is well researched and documented in the literature, in the following section I only synthesize the many advantages that collaborative learning holds for teaching and learning in conventional face-to-face context. First, I discuss the issues of how collaborative learning contributes to student academic achievement. Then I review the benefits of collaborative learning in relation to student personal and social development.
2.1.4.1 Academic achievement

Previous research has first identified the positive effect of collaborative learning in relation to students' academic achievement. This issue has been very well documented in the existing research literature on collaborative learning. Several studies using meta-analysis have shown that students achieve more in a collaborative learning environment.

In 1981, a meta-analysis of 122 achievement-related studies indicated that collaborative learning promotes higher achievement than competitive or individualistic learning across all age levels and subject areas (Johnson et al., 1981). Later, Johnson & Johnson (1989) conducted another larger meta-analysis of 349 studies. The studies that were analyzed involved subjects in public schools (53 percent), colleges (41 percent), adults (5 percent) and preschools (1 percent). The study confirmed the earlier results. They found that students in collaborative learning outscored students in competitive or individualist situations.

Similarly, Slavin (1983) analyzed forty-six controlled research studies conducted over an extended time in regular elementary and secondary classrooms. Among these studies, 63 percent showed that collaborative learning provided better outcomes; 33 percent showed no differences; and 4 percent showed higher achievement for the traditional groups. Of the studies that employed group rewards for individual achievement (individual accountability), 83 percent showed improved achievement. When individual accountability was absent, no achievement difference was found. In the meta-analysis of sixty-five peer-tutoring studies, Cohen and Kulik (1981) found that 87 percent of studies showed that both tutors and tutees do better than control students in the tutoring process. Particularly, studies illustrated the greatest gains in collaborative learning among minority students (Lipponen & Hakkarainen, 1997; Slavin & Oickle, 1981) and among medium- and low-achieving students (Sharan et al., 1984; Smith et al., 1984; Nevin et al. 1982).

More importantly, we should notice that high-achieving students generally perform at least as well with collaborative learning as in traditional classrooms, if not better. At first
glance, this may somewhat sound odd - high-achieving students spent time working with low-achieving students, yet they gained the same or better achievement than if they were working alone all the time. However, this is not surprising when we think about how teaching and re-teaching academic content can improve our own knowledge and understanding. Explaining ideas to peers enhances understanding, especially when it requires elaborative explanations instead of terminal responses like short answers, or cognitive elaboration work such as organizing thoughts and being certain about concepts (Webb, 1985, 1988; Dansereau, 1985).

Process gain (i.e. generating new ideas and solutions) is another indication of achievement. Ames and Murray (1982) concluded that the students in the collaborative learning settings have higher process gain than the students in all the other conditions.

2.1.4.2 Personal development

Previous research in collaborative learning suggests that the higher achievement found in collaborative situations contributes to an overall sense of personal success, efficacy, control, esteem, and competence, etc. (Johnson & Johnson, 1989). It has been reported that a collaborative learning approach offers lots of advantages to students. These advantages include but are not limited to—greater cognitive skills development; better understanding/acquisition; and healthier psychologically outcomes.

As Slavin (1990) suggested, personal and social benefits also emerged through collaborative learning. Students engaged in collaborative learning activities tend to attribute failure to lack of effort and believe that they have personal control. They also believe that if they exert the effort, they will achieve their goals (self-efficacy); and feel less anxiety (Johnson and Johnson, 1995). They tend to grow satisfaction in relation to learning experience; build up positive attitudes towards the subject studied and the learning experience; strengthen self-esteem (Cooper et al., 1990); increase self-expectations (Kagan, 1988), and increase sense of intellectual competence (Kagan, 1989).
Among these variables, student self-esteem has attracted researchers' special attention. Since the 1950s there have been over 80 studies comparing the relative impact of collaborative, competitive, and individualistic experiences on self-esteem (Johnson & Johnson, 1995). The meta-analysis conducted by Johnson and Johnson (1989) showed that collaborative learning promotes student higher self-esteem than do other forms. Johnson and Johnson (1995) concluded that in collaborative efforts, students not only realize that they are accepted and liked by the peers, but also know that they have contributed to the success of the group.

Activity related to academic performance and achievement is also improved through collaborative learning. For instance, peer tutoring (Cohen & Kulik, 1981), frequency and type of practice (Armstrong et al., 1981), and comprehension of task structure (Stebbins et al., 1977) are all enhanced. In re-framing stressful experiences, students tend to provide and receive more help (Johnson and Johnson, 1995). Particularly, over 30 studies measured student time-on-task. These researchers suspected that students in collaborative learning activities might have spent more time on task, and this in turn improved their achievement. The meta-analysis conducted by Johnson and Johnson (1989) does show that students in collaborative learning setting spend considerable more time on task than do students working competitively or individualistically.

2.1.4.3 Social development

As contended by Johnson and Johnson (1995), collaborative learning promotes not only academic achievement but also social development. When students engaged in collaborative learning, their communication skills as well as social and interpersonal skills are improved (Johnson and Johnson, 1989; Cooper, 1990). Additionally, they have enhanced adjustment of cultural and racial differences (Cooper et al., 1990). For instance, researchers (Johnson and Johnson, 1986; Kagan, 1977) have proved that collaborative learning improves students' social development and pro-social behaviors. These include increased liking for co-students (Slavin, 1979), and class (Slavin, 1983a); found meaning and purpose through
collaborative work: increased one's ability to take the perspective of others (Johnson and Johnson, 1995). They also included experiences to support others (self-disclosure); gained the social competencies and skills necessary for establishing productive relationships with others (Johnson and Johnson, 1995); and reduced racial stereotyping and discriminations (Allport, 1954; Cohen, 1980)

In summary, collaboration has been used extensively to enhance student learning. The most significant result in the literature is that the research evidence in collaborative learning in conventional face-to-face environment promotes higher achievement as well as personal and social development. Thus, collaborative learning must be considered as an effective teaching and learning strategy.

Despite the extensive degree of literature written on collaborative learning, there is only limited research suggesting ways in which collaboration may be deliberately promoted within CMC courses. In addition, the phenomenon of collaborative learning in terms of the language functions associated with the messages within a CMC context has rarely been explored. This study, therefore, seeks to understand how students communicate in their learning process in a CMC context as well as to examine this communication in relation to student collaborative learning.

2.2 Computer-Mediated Communication

The purpose of this section is to review the literature on CMC in education that may inform the study. The main emphasis is computer-mediated communication with relation to student collaborative learning. This has been dealt in terms of the advantages of CMC related to collaborative learning.

Do CMC systems such as computer conferencing introduce a unique set of capabilities that enable us to enhance our social and intellectual capacities? This section examines CMC from the perspective of how it facilitates collaborative learning where the activity takes place primarily online, in a computer conferencing system.
Previous research has suggested that the very nature of CMC - its capacity to support interaction between and among students and instructors - fosters a collaborative approach to learning (Anderson, 1994; Burge, 1994, Waggoner, 1992). As indicated by Hiltz (1990), "Computer-mediated-communication is particularly suited to the implementation of collaborative learning strategies or approaches". In his review of literature, Nawrati contended that the research studies reviewed generally support the view that CMC:

1. increases inter-student and student-teacher interaction;
2. supports in-depth, personal and complex interaction; and
3. supports collaborative work.

(1999, p. 83)

In general, the potential of CMC can be explored through five attributes that both delineate its differences from existing educational modes and characterize education as a unique mode: 1). many-to-many communication, 2). place independence, 3). time independence, 4). text-based. and 5). computer-mediated interaction (Harasim, 1990).

Following Harasim, I review the literature from these five perspectives.

First, CMC is a many-to-many communication tool. It provides an effective medium for collaborative learning.

Computer conferencing software...is currently one of the most appropriate online environments for learning collaborations. Conferencing was designed to support "collective intelligence" and meeting of minds through the topical structure of the system. This structure provides that shared space essential to group interaction... The files are a commonly shared object...The shared file holds the individual members of the group together and enables a "conversation" to take place. It also generates a dynamic record or transcript of the interaction. The theoretical framework of collaborative learning suggests that conferences can provide a fertile forum for interaction.

(Harasim, 1990, p.45)

In a computer conference, the emphasis on interaction is shifted to the exchange of information due to the absence of the nonverbal cues. CMC itself encourages active
information searching and discovery: "users of computer-mediated communication systems often are freer to search for those information exchanges that provide satisfactory resources in return than they would be in typical organization or communication contexts" (Rice, 1982, p. 927).

Secondly, CMC enables place independent learning and collaboration. This allows group activities and collaborations for geographically discrete people. By enabling students to access and collaborate with experts and peers anywhere, CMC expands access to learning and intellectual resources. Furthermore, CMC enlarges personal/professional networks into a global community. Students are empowered because of the expanded access and their enriched resource base (Machtmes & Asher, 2000). Participants can thus collaborate on the basis of shared interests and expertise rather than being constrained by time and location (Harasim, 1990).

Thirdly, CMC allows time independent communication. This feature of CMC affects group dynamics and learning processes. Asynchronized communication enhances self-pacing and self-directed learning. Students have better control and more flexibility to read and respond to a message. Asynchronicity of CMC also provides more opportunities for student input and this in turn may enhance learning. Asynchronous collaborative learning can also reduce competition among students because time restrictions or turn taking is no longer an issue. Rice (1980) pointed out that more reserved students may finally gain access to discussions.

Fourthly, text-based communication features of CMC offer cognitive benefits. Compared to talking, writing comments provides more reflective interaction.

The need to verbalize all aspects of interaction within the text-based environment can enhance such metacognitive skills as self-reflection and revision in learning. Metacognitive skill requires the opportunity to make explicit to oneself the aspects of an activity that are usually tacit... The text-based environment is such a narrow bandwidth of information
that, to compensate, clear and explicit articulation is essential for effective group interaction.

(Harasim, 1990, p.49)

Furthermore, a text-based environment affects the learning process. Because text based communication lacks the social or physical cues, focuses of communication are then on the content of messages rather than on the presenters (Harasim, 1987). This diminishes the stereotyping such as race, gender, physical handicap, and high external social status, which in turn improves equity (Harasim, 1986; Siegel et al., 1986).

Finally, the most significant attribute of CMC is computer-mediated learning (Harasim, 1990). CMC itself is interactive and encourages active involvement. It offers control abilities to present, receive, process, and manage information (Kozma, 1987). The revisable, archival, and retrievable feature of CMC changes student control over the substance and process of interactions (Harasim, 1990). One striking feature of CMC is its capacity of maintaining and storing a written transcript of the entire activity. Students, therefore, have better control over the interactions than they have in face-to-face settings. Additionally, transcripts can be used for detailed analysis. Using learning strategies such as synthesizing and critical reviewing key themes in a conference encourages different ways to analyze transcripts to enhance analytical and critical thinking (Harasim, 1990).

The literature suggests that the nature of CMC - its capacity to support interaction - promotes and facilitates collaborative learning. However, studies addressing how students communicate in their learning process and how this communication relates to collaborative learning in a CMC context are limited. In particular, even less research is conducted on communication in terms of the language functions of messages and its relationship with collaborative learning in the CMC context. Therefore, the following section reviews the literature that is concerned with student communication using CMC, although they may not relate to collaborative learning.
2.3 Student Communication Using CMC

Since CMC is still a new phenomenon, there are limited studies exploring student communication patterns using CMC. In 1991, Moore studied fifth graders' electronic dialogues with educators enrolled in a graduate computing course. The research results showed that the benefits of the online dialogue for teachers and students are parallel to the conclusions of previous studies for the use of traditional dialogue journals. Particularly, as online dialogue continued, effective questioning, response modeling, and student-centered discussion emerged.

Duin (1994) studied eight college student mentors. This is a study of mentors' strategies for and perceptions of giving feedback on ninth-graders' essay writing. It showed that each mentor demonstrated unique and predictable patterns of response to students' work. The patterns did not correspond with their original plan. Mentors with teaching experience provided more feedback than those without. In addition, those mentors, who frequently asked feedback from peers on their own work, offered fewer constructive comments to students than those who rarely ask response from others. Mentors also have improved writing as they helped students writing essays.

Rueda (1992) explored online communication between students with learning disabilities in fourth- to sixth- grades and their teachers. The result showed that teachers dominated communication. Rueda compared the number of different language function types in the following three groups: 1) teacher-initiated messages that led to extended topic chains; 2) student-initiated messages that led to extended topic chains; 3) teacher-initiated messages that did not lead to extended topic chains. He found that teachers wrote more, asked more questions, and introduced more new topics than students did. In addition, teachers were more conversational and informal in online communication than in face-to-face communication.

Harris and Jones (2000) conducted a descriptive study of the online communication of teachers, students (K-12 grades), and subject matter experts. They found that, although students' inquiry was the focus of online projects, adults (including teachers and subject matter
experts) dominated the communication. Patterns of using certain language function are associated with participants' roles as teachers, students, or experts. Overall, more than 90% of all messages contain information reporting, and about 50% requesting information. In addition, almost 80% of all messages used other language functions including salutation, planning, apologizing, complaining, thanking or some combination of these language functions. Only a small portion of total language functions identified related directly to curriculum content. Furthermore, some language functions showed very different patterns over time.

Bonk et al (1998) studied undergraduate educational psychology students' electronic communication. The findings suggest that students were actively participating in electronic writing. Diverse educational stakeholders – students, instructors, supervisors, and cooperating teachers were all involved in communicating with each other using CMC. In addition, student peer feedback was extremely conversational and opinionated, whereas instructor’s mentoring was concentrated on high level questioning, and course related advice.

Piburn & Middleton (1998) examined interaction patterns between pre-service science teachers and faculty in collaborative activity on a listserv. They found that electronic dialogue has characteristics that are different from traditional face-to-face communication. Teachers’ and students’ roles are exchanged, with students initiating conversations, teachers answering questions, and students reacting.

Aviv and Golan (1998) investigated pedagogical interaction patterns between 60 engineering students and their tutors in Israel. It was found that students differentiated between two ways -- personal and group -- of using CMC. The personal dimension allows students to communicate to seek help and advice. The extent to which a student uses this channel depends on the extent to which he or she benefits from it. The group dimension lets students participate in group projects and discussions. The importance of the collaborative work in the learning process along with the performance of team leaders determines the extent of students’ collaboration.
2.4 Summary

The review of literature indicates that on the one hand, collaborative learning has positive effects on student learning. It can be concluded that collaborative learning generally results in higher achievement, more frequent use of higher-level reasoning strategies, and more frequent process gain and collective induction (Johnson and Johnson, 1990). In short, collaborative learning promotes student higher achievement as well as personal and social development. On the other hand, CMC provides an environment that is particularly suited to implement and facilitate collaboration. Its ability to support interaction between and among students, tutors, and instructions helps students learn collaboratively and more effectively.

Because collaborative learning brings about all these benefits, numerous studies have identified and tried to teach strategies including the communicative strategies and techniques that are most appropriate for the effective implementation and facilitation of collaborative learning.

Nevertheless, all these strategies, techniques and suggestions are based on research done in conventional face-to-face settings. That is, while there appears to be consensus that CMC can provide a rich and particularly suited environment for student collaborative learning, the strategies that contribute to effective collaborative learning in CMC contexts are still unknown. Though CMC continues to gain favor in academia, the exploration of students' communication in their learning process, particularly the communication related to collaborative learning in a CMC context is extremely limited. Obviously, for teachers, an understanding of the communication processes and strategies that support and encourage student interaction and collaboration is essential for successful implementation of collaborative learning in CMC settings. Thus we need to understand people's communication in their learning processes in relation to their collaborative learning in order to identify those communicative strategies that are most effective to enhance collaborative learning in the context of CMC. Additionally, the unique feature of CMC - its capacity to keep a permanent
class communication record - makes it an idea environment to examine the relationship between collaborative learning and their communication in the learning processes.

The current study, therefore, seeks to determine the degree of interaction in the context of CMC. More importantly, the study examines the relationship between the collaborative learning process and the language functions associated with their CMC generated messages. Exploring student communication and collaborative learning in the CMC context is important in order to arrive at deeper understandings of the complexities associated with the processing a new emerging context. The emergent knowledge will make a fundamental contribution to future educational designs of CMC courses. In addition, this study may provide teacher and student practical guidelines and suggestions for the effective implementation of collaborative learning in the context of CMC.
CHAPTER III: METHODOLOGY

3.1 Introduction

This research is an investigation of collaborative learning and communication in an elementary classroom using CMC. The intent is to identify from messages generated in CMC, the degree of interaction, and to examine the relationship between collaborative learning and the language functions associated with the messages generated in an elementary classroom using CMC. A quantitative approach to analyzing the transcripts of CMC content is used to conduct this study. Because collaboration is not operationally defined, and because interaction is the major learning factor in collaborative learning (O'Donnel & Dansereau, 1992), in the present study, therefore, collaborative learning was explored in terms of students' interaction in their learning process. That is, in this study, interaction - not a synonym but a major indicator of collaboration - was measured and explored.

This chapter describes the methodology employed by the research. Section 3.2 begins with a discussion of the rationale for the utilizing of content analysis. Section 3.3 provides the operational classification of the language functions that was used for the analysis of the study. This is followed in section 3.4 with a description of the development of a measure of interaction and its coding scheme. Finally, section 3.5 sketches the data collection, analysis, and interpretation strategies for the research proposed. Taken together these sections provide an account of both the assumptions underlying the methodology and the conditions under which the methodology were applied.

3.2 Rationale for the Selection of Content Analysis

Content analysis is a technique for gathering and analyzing the content of text. The content refers to words, meanings, pictures, symbols, ideas, themes, or any message that can be communicated. The text is anything written, visual, or spoken that serves as a medium for communication. (Neuman, 1997, p.272)

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Martindale and Mckenzie (1995) defined content analysis as tabulating the frequency of types of words, sentences, etc. in a text for the purpose of getting at the denotative or connotative meaning of the text. They further elaborated that the reason for the use of lexical statistics and function words is that authors do not consciously monitor things such as sentence length or exactly which function sentences they employ.

The permanent transcript is a feature that distinguishes CMC from traditional instruction and other forms of educational technology. The transcript is a complete class proceeding record that is automatically maintained by the software and available to all class members (Wells, 1992). According to McCreary (1989), the value of CMC lies in its use of text-based communication that demands exactness, coherent organization of thought, and clear, restrained and authentic expression.

Henri (1996) pointed out that the most obvious source of data available for the research in facilitating collaborative learning in CMC is the transcripts. She further expressed that an attentive educator can find information unavailable in any other learning situations by reading the transcripts. An in-depth study of the meaning of messages teaches us much of interest and importance of the content, and tells us about students and their learning processes. Thus informed, we are, as educators, in positions to offer immediate and long-term support to students and their collaborative learning (Henri, 1992). She emphasized that

only when we have a better understanding of computer-mediated learning, will we be in a position to say that we are making the best use of CMC-using its full potential. We believe that this understanding can come only from a finer grained content analysis.

(Henri, 1992)

Kaye (1992) echoed this opinion and argued that "to establish whether any meaningful form of collaborative learning is occurring, it is necessary to undertaken an analysis of the messages in a conference (p. 18)."
However, as indicated by several researchers, there are few studies that use content analysis. For example, Wells (1992) said "unfortunately, there is almost a complete dearth of published information regarding its (transcripts') educational and administrative value". Henri (1992) stated that "at present, educators are not making use of the content of CMC exchanges to further the learning process." Mason also pointed out that

the most obvious data available to conferencing evaluators-the transcript of all conference interactions-is paradoxically the least used. There are astonishingly few comments, let alone analysis, in the literature of this central core of the whole enterprise

(1992, p.107)

The above discussion of the literature reveals that, on the one hand, many researchers show great interest in and are in full agreement on the importance of analysis of the transcripts of CMC, especially with relation to the students' collaborative learning. On the other hand, few researchers make use of this kind of analysis.

The present study is an attempt to understand students' collaborative learning with relation to their communication in their learning processes, therefore fits closely with content analysis for the following reasons:

1). content analysis provides us a useful tool to better understand students' learning processes, and this in turn, will have potential to help us, as educators, support and facilitate students' collaborative learning;

2). there is little investigation of students' learning process in CMC using content analysis; and

3). the goal of this study is to seek deep understanding of computer-mediated learning through the exploration of the relationship between the students' collaboration and their communication in their learning processes.
3.3 Language Functions

Language functions refer to what the learner can do with language, such as giving and receiving information, asking for clarification, and expressing agreement or disagreement (McDonnell, 1992). Saville-Troike (1996) indicates that the functions of language generally provide the primary dimension for characterizing and organizing communicative processes. They further elaborate that without understanding why a language is being used as it is, one cannot understand the meaning of its use in the context of social interaction.

Group collaboration focuses on negotiation of meaning in which various language functions appear. Among them are the functions of asking information, giving information, and explaining. Giving and requesting information are basic functions used at group collaboration. People make suggestions, express opinions, agree and disagree about ideas. They negotiate means and try to arrive at a common understanding by discussing and debating. Although several researchers have subsumed the categories of language functions under different headings and elaborated them in diverse ways, their purposes are similar (Finocchiaro & Brumfit, 1986).

The classification of language functions used in the present study is the result of incorporating the work of Olsen (1992) and Olsen & Kagan (1992). The combination of their work provides a more complete category of language functions. Among the various language functions being categorized, the language functions of "asking information", "giving information", "making suggestion", "presenting opinion" and "expressing disbeliefs" were chosen for this study. The reasons to choose these particular language functions are twofold. On the one hand, they are viewed as the basic functions of group work and are essential in its use in mathematics and science contexts (Kessler, Quinn, Fathman, 1992). On the other hand, they are considered to be important language functions that support the social skills needed for collaborative learning (Olsen, 1992). The operational rules used in coding the language functions (see appendix) are adapted from Cookson (1995) and Olsen (1992). The integration
of the two categorizing systems allows a better fit with the needs of the study and is more appropriate to the context of the study—namely, mathematics and science learning using CMC.

3.4 Development of Interaction Measure

In this study, four measures of the degree of interaction (size, level, Interactivity Value, and T-unit) are proposed. Among these four measures, the analytic measure — Interactivity Value (IV) -- is developed in these chapter. Therefore, the emphasis of this section is the detailed definitions and explanations of the measure IV. Section 3.4.1 provides an overview of the four measures. Section 3.4.2 and 3.4.3 depict the method of coding IV with examples, for clarity. Section 3.4.4 discusses the validity of the IV measure.

3.4.1 Four measures of degree of interaction

Studies of collaborative learning in CMC environments usually explore interaction in terms of participation, for instance. number of messages generated in computer conferences, time spent on task, length of massages. However, as Henri (1992) argued, "it is not sufficient merely to count the number of messages if we are to give an accurate picture of student participation". Furthermore, to measure participation is not to measure interaction (Henri, 1996). To what extent do students interact in CMC environments? How can we measure it? In this study, therefore, the definition of interactive messages provided by Henri (1996) is applied to distinguish participation and interaction. and four different measures are proposed and used to quantify interaction in a CMC environment. These four measures are the size, level, IV, and total number of T-units of a message tree. Each of these measures is defined fully in the next two sections. These four measures quantify the degree of interaction from four distinct perspectives. First, the size of a message tree measures the number of messages each discussion involved. Secondly, the level of a message tree assesses the number of layers the
correspondences included. Thirdly, the measure IV evaluates the degree of interaction considering both the number of interactions that occurred and the depth of these interactions. At the same time, the IV takes both "reading" and "writing" messages into account. Lastly, the total number of T-units probes the length of messages in a discussion cluster. Taken as a whole, these four measures can provide a more accurate picture of interaction in the context of CMC.

The first three measures (i.e. size, level, and IV) are fully described in section 3.4.2 and 3.4.3. The fourth measure – T-unit – is defined as one

main clause plus what ever subordinate clauses happen to be attached or embedded within it. Thus "Mary hit John" is one T-unit, and "Mary hit John, but she is my best friend" is two T-units.

(Crookes. 1990. p 185)

A clause is

one subject or one set of coordinate subject with one finite verb or one finite set of coordinated verbs. Thus "I went home" is one clause, and so is "Jim and I went home and rode our bikes."

(Hunt. 1966. p. 735)

Appendix 2 and 3 provide detailed description of T-unit with examples.

3.4.2 Message Tree

A message tree is defined to be a group of messages that interact with one another either explicitly or implicitly. The definition of interactive messages used here is established by Henri (1995) and presented at section 2.1.2. A message takes a hierarchical structure as shown in Figure 3.0. The circles denote individual messages in a tree, while the arrows connecting different circles represent interactive relationships between messages and are explained in more detail later in this section.

The idea of using a "tree" metaphor to represent this structure is two fold. One is that the structure takes a "fruity tree" shape. The other is that I believe that the "tree" analogy
properly represents collaborative learning processes in the CMC context and is particularly suitable for this study. Generally speaking, messages are the outcomes of people's collaboration. People read, think, understand, summarize, elaborate, explain, question, and discuss, which all are part of their collaborative learning processes (branches), while the messages (fruit) hung on the “trees” stem from their collaboration (branches). Moreover, language functions associated with messages are the “seeds” contained in “fruits”. People plant “seeds”, grow “trees”, and finally they get “fruits”.

![Message Tree Diagram](image)

**Figure 3.0 A message tree**

For the analysis of the present study, a note was found to be a unit that is too big to codify. Therefore, I create a new work unit called message according to the following criteria.

For the remaining of the study, message refers to this specific work unit unless otherwise stated.

1. Every message belongs to one message tree (i.e. every fruit should hang on a tree).
2. A message cannot belong to more than one message tree (i.e. one fruit can only hang on one tree).
3. In cases where a message contains interactions with more than one message, and it deals with separate issues raised by different previous messages (i.e. the message does
not contain a synthesis of the earlier messages), the message is divided into several sub-messages according to the number of the interacted earlier messages. Each sub-message is assigned to one and only one tree and different sub-messages belong to different trees.

Figure 3.1a gives an example of separating a message cluster into two message trees. In figure 3.1a, the leftmost is a message cluster. The author of the message C has read both messages A and B, and he/she has responded to both messages A and B in his message C. In other words, the message C interacts with the earlier messages A and B. In this case, the message C is divided into two parts: sub-messages C1 and C2. Sub-message C1 refers only to the message A, and sub-message C2 is relevant only to the message B. Therefore, the original message cluster is divided into two message trees. The rightmost diagram of figure 3.1a shows the two message trees after the separation.

Figure 3.1a A message cluster is separated into two message trees

4. If a message is a synthesis of earlier messages, the message is retained and, therefore, the tree is not affected.

5. If one message raises a new idea evoking further discussion and also contains a reference to an earlier message, the message is divided into two sub-messages so that one sub-message connects to the referenced previous message, and the other sub-messages form the starting point (root) of a new tree.
Figure 3.1b gives an example of dividing a message cluster into two separate message trees. In the leftmost diagram in figure 3.1b, message C refers to the earlier message A. At the same time, in message C, a new issue is raised and this new issue is referred only to by message E. In this case, the message C is divided into two sub-messages C1 and C2. The message cluster is also separated into two message trees. The message C1 interacts only with messages A and D in a message tree, and the message C2 becomes the root of a new message tree. The rightmost diagram in figure 3.1b shows the two message trees.

The rationale for dividing a message into separated sub-messages as discussed above is to ensure an accurate statistical analysis. In this study, only three message clusters had to be divided into different message trees by dividing messages to sub-messages. To determine whether a message interacted with another message, I consider the implicit or explicit interactions of the messages as defined by Henri (1995) (see section 2.1.1). If a message has either explicit or implicit interaction with an earlier message, this message is "referenced" to the earlier message indicated by an arrow. The arrows pointing the messages from one to another in Figures 3.1a and 3.1b are the references of this type.
Figure 3.2 One message tree of size 5, one tree of size 3, and two trees of size 1

Figure 3.3 A message of size 9

Figure 3.4 another size 9 message tree
For the purpose of this study, a tree size is defined as the number of “inter-referenced” messages (i.e. number of fruits) in the tree. Moreover, only a non-referenced message is viewed as the message in a tree of size 1. Therefore, figure 3.2 contains four message trees (from left to right) with the first tree of size 3, second tree of size 5, and third and fourth trees of sizes 1, whereas figure 3.3 demonstrates a message tree of size 9.

As observed from the pilot study, it is highly possible that several message trees are included in one discussion. Also, students may send unrelated messages to a discussion. Because such messages do not explicitly or implicitly interact to previous messages, I treat them as “fruits” of new trees.

According to Hewitt (1996), “in a consideration of note clusters, it is reasonable to assume that the shape of a cluster provides some indication of the sort of interaction that students are engaging in.” For instance, if a student sends a message and receives 8 replies, then the tree would look short and stout as shown in figure 3.3. On the other hand, if a newly introduced idea is continually discussed, elaborated, questioned, or refined, then the tree would take a tall and relatively skinny shape as shown in figure 3.4.

Hewitt (1996) noticed in his study of elementary students' collaborative science learning in CSILE, students learn in an iterative fashion. He suggested, “students begin with broad questions and ask increasingly detailed ones as they gain deeper understanding. Questions inspire new explanations, and new explanations, in turn, inspire more questions.” (p. 41). Similarly, if an iterative pattern described above can be observed in this study, it is reasonable to argue that, in general, a tall tree (i.e. figure 3.3) should be more indicative of superior interactivity than a short and stout tree (i.e. a simple asking and replying exchange). That is, the depth of interaction should be considered as an essential indicator in the measurement of collaboration.

On the other hand, Sweller and Chandler (1994) in their study of “learning difficulty” concluded that the “extent to which elements interact for any given information can be estimated by counting the number of elements that must be considered simultaneously.”
addition, Burtis (1997) in his study of elementary mathematics and science study using CSILE, contended that the less-connected notes are typically knowledge-telling reproductions, whereas the highly-connected messages indicates "enthusiasm, intellectual curiosity, thoughtfulness, understanding, and pursuit of knowledge". Adapting from Sweller and Chandler's (1994) measurement of element interactivity, and following our common sense, I believe that the number of interactions that occurred should also be taken into account when measuring the degree of interaction in the CMC environments.

To sum up, in this measure, the degree of interaction should be not just a function of the number of interactions that have occurred but also a function of the depth of these interactions developed. Based on these beliefs, the following analytical measure (IV) is developed to assess one aspect of the degree of students' interaction.

3.4.3 Interactivity Value

3.4.3.1 Basic points

In this section I am developing a scheme for scoring message trees in order to quantify interaction in the context of CMC. This scoring scheme flows from the belief that the extent to which people interact in CMC environments depends on both the number of interactions occurring and the depth of these interactions.

For the purpose of the present study, both "reading act" and "writing act" are considered to be interactions. This consideration is based on the criteria suggested by Verdejo (1996). He proposed the following four criteria as collaboration indicators following Singer et al's (1988) study:

1. Shared control of resources;
2. Communicating ideas;
3. Focusing attention on similar aspects of the problem; and

(Verdejo, 1996, p. 87)
In the context of CMC, writing a message is a way of people "communicating ideas" and "sharing successes and failures". While reading a message indicates that this person paid attention to the problem and probably also shared feelings. Therefore, both "reading act" and "writing act" are taken into account of collaboration and given equal weight.

As observed in the pilot studies, at some occasions several students created co-authored messages. With respect to co-authored messages, it is cogent to argue that simply co-authoring a message implies that the authors might have "shared control of resources", "communicating ideas", "focusing attention on similar aspects of the problem", and "sharing success and failures". In another word, the authors have already collaborated. For this reason, a "co-authored" message is given extra points as is described in more detail in next section.

3.4.3.2 Scoring Scheme of Interactivity Value

a) Generations

For the purpose of this study, each message tree is first divided into "generations" from top to bottom following the tree analogy. For the remaining chapters, a message is used to include both a message and a sub-message according to the definition of the work unit as depicted in section 3.4.2 unless otherwise stated.

Every message in a tree is assigned a generation value according to its position in the tree. If a message does not refer to any other messages, it is the message at generation 1. Otherwise, if a message refers to an earlier message, it is at generation of that earlier message plus one (see Figure 3.5). For each message tree, the level of the tree is defined as the highest generation value of messages in the tree. Therefore, the level of the tree shown in figure 3.5 is 5.
b) Reading functions

As discussed above, reading a message is an important aspect of interaction in CMC settings. In this measure IV, the act "reading" plays an important role in assessing interaction. Constrained by the data, it was impossible for the investigator to fully determine whether a participant had read a message. Therefore, for the remaining chapters, "reading" a message refers to the act that a participant had opened the message on the screen. In addition, reading functions are defined to assist the researcher to quantify "interaction". "$r(A)$" is denoted to the "reading function" of the author A.

**Definition:** The reading function "$r(A_i)$" refers to whether the author A had read the earlier message at the previous generation "i" in its thread.

- $r(A_i) = 0$ if the author of the assigned message has not read the earlier message at the generation "i" in its thread.
- Otherwise, $r(A_i) = 2$. The weight 2 is used to eliminate decimals.

![Figure 3.5 A message tree with 5 levels](image)
In cases where the immediate preceding message was written by the same author A, \( r(A_i) = 1 \).

![Diagram](image)

**Figure 3.6**

The following example demonstrates the calculation of reading functions:

- In figure 3.6(a), the 2 reading functions for the message written by A at generation 3 are:
  
  1. \( r(A_1) = 0 \) if A had not read C’s message at generation 1:
      
      Otherwise, \( r(A_1) = 2 \).

  2. \( r(A_2) = 2 \), since A had to read B’s message at generation 2 in order to comment on it.

- In figure 3.6(b), the two reading functions for the message written by A at generation 3 are:

  1. \( r(A_1) = 2 \) since A had read the message at generation 1 for it is his/her own message;
2. \( r(A2) = 2 \), since A had to read B's message at generation 2 in order to comment on it.

- In figure 3.6(c), the 2 reading functions for the message written by A at generation 3 are:
  1. \( r(A1) = 0 \) if A had not read C's message at generation 1;
     Otherwise, \( r(A1) = 2 \).
  2. \( r(A2) = 1 \), since the message at generation 3 share the same author with its immediate preceding message.

It is important to note here at figure 3.6(c), the message written by A at generation 3 only gets 1 point for reading the immediate previous message which is his/her own message. That is, "A" scored one point less than normal by reading his/her own message at the immediate preceding generation. This is because I value interaction among people more than self-interaction. By "self-interaction" I mean a person commenting on his/her own message directly as shown in the leftmost tree in figure 3.7. In other words, I consider the leftmost tree indicates less interaction than the rightmost tree in figure 3.7.

![Figure 3.7](image.png)
e) "Depth"

Second, a "Depth" value is assigned to each message and is denoted by the letter "L". From now on, "Depth" only denotes to a special value, which is described next.

- **Single authored messages:**

  1. A message at generation 1 is always assigned a "Depth" value of 2 ("writing act").

  2. A message created by A at generation "k" that interacts to earlier messages is assigned a "Depth" value according to the following formula:

     \[ L(A_k) = 2 + r(A_1) + r(A_2) + \ldots + r(A_{k-1}) \]

     Here, \( r(A_i), i=1, 2, \ldots k-1 \) refers to the reading functions.

\[ \text{Figure 3.8 A 2-level tree with two authors} \]

For example, the tree in Figure 3.8 contains three messages written by students A and B. Then:

- At generation 1

  the "Depth" value of the message contributed by student A, is

  \[ L(A_1) = 2; \]

- at generation 2:

  the "Depth" value of the message contributed by student B, is

  \[ L(B_2) = 2 + r(B_1) = 2+2 = 4 \]
here, \( r(B_1) = 2 \), since B has to read the message at the generation 1 in order to comment on it.

Similarly, the "Depth" value of the message sent by student A at the generation 2, is 
\[
L(A_2) = 2 + r(A_1) = 2 + 1 = 3.
\]

Note that \( r(A_1) = 1 \) because the message shares the same author (i.e. A) with its immediate preceding message.

![Figure 3.9 A 3-level tree](image)

Figure 3.9 A 3-level tree

Now let's move to a more complicated example. The tree shown in Figure 3.9 contains 5 messages contributed by students A, B, C, and D.

Then,
- at generation 1:
  
  the "Depth" value of the message contributed by student A, is 
  
  \( L(A_1) = 2 \);

- at generation 2:
  
  the "Depth" value of the message contributed by student B, is 
  
  \( L(B_2) = 2 + r(B_1) = 2 + 2 = 4 \)
here, \( r(B1) = 4 \). since B has to read the message at the generation 1 in order to comment on it.

Similarly, the "Depth" value of the message sent by C at the generation 2, is
\[
L(C2) = 2 + r(C1) = 2 + 2 = 4.
\]

- at generation 3:
  a). For the message generated by D, the following two situations could happen:
  i). if D has read the earlier message at the generation 1, then the "Depth"
      value of the message is:
      \[
      L(D3) = 2 + r(D1) + r(D2)
      = 2 + 2 + 2 = 6.
      \]
      Here \( r(D2) = 2 \) because D has to read the previous message (i.e. C's
      message) at generation 2 in order to respond to it.
  ii). if D had only read the earlier message generated by C at the generation 2.
      but had not read the message at the generation 1, then the "Depth" value of
      the message is:
      \[
      L(D3) = 2 + r(D1) + r(D2)
      = 2 + 0 + 2 = 4.
      \]
  b). For the message generated by student A. its "Depth" value is
  \[
  L(A3) = 2 + r(A1) + r(A2)
  = 2 + 2 + 2 = 6.
  \]
  Here please notice \( r(A1) = 2 \). Though the same author A had created the
  messages at the generation 1 and 3 in this thread, there is a gap between their
  generations, i.e. the message at generation 1 is not its immediate preceding
  message. Hence \( r(A1) \) is 2 rather than 1. Again. \( r(A2) = 2 \) simply because A has
to read the previous message (i.e. B's message at generation 2) in order to
  comment on it.
Co-authored messages

With respect to co-authored messages, please note that the “Depth” of a co-authored message is first calculated the same way as a single authored message according to the rules described above. Moreover, bonus points are given to each co-authored message. The rules of calculating the extra points are expressed below:

If a message has been created by a group of people, and this group has no more than 4 people, 4 bonus points are added to the message, while each co-authored message with more than 4 authors adds only 2 bonus points.

The rationale of the decision is two fold. First of all, when students co-author a message, they have interacted and collaborated in their learning and knowledge constructing processes as discussed in section 3.4.2.1. Secondly, students achieve best results through collaboration if the size of the working group is small (i.e. less than 5 people) (Henri & Rigault, 1996).

The following example demonstrates the rule of calculating reading functions for co-authored messages.

The “Depth” value for BC's message at generation 2 in figure 3.10 (a) is

\[ L(BC2) = 2 + r(BC1) + 4 = 2 + 2 + 4 = 8; \]  \hspace{1cm} (3.1)

Here, please recall that the first number “2” refers to the “writing act” of BC. 

\( r(BC1) \) is the reading function of BC. It equals 2 since BC had to read A’s message at generation 1 to comment. These 2 terms are computed according to the rule specified for single authored messages. Only the last term number “4” in equation (3.1) is the bonus points given to the co-authored message.

The "Depth" value of BCD's message at generation 3 in figure 3.10 (b) is

\[ L(BCD3) = 2 + r(BCD1) + r(BCD2) + 4; \]  \hspace{1cm} (3.2)

An explanation of this equation is given next.

Recall BCD’s message should be first treated as a single authored message.

Hence,
\( r(BCD) = 0 \) if BCD had not read A's message at generation 1;

Otherwise, \( r(BCD) = 2 \).

while \( r(BCD2) = 2 \) since BCD had to read E's message at generation 2 in order to remark on it.

![Diagram](attachment:image.png)

**Figure 3.10 Trees with co-authored messages**

So far BCD's "Depth" value is calculated as a single authored message. Finally, 4 extra points need to be added to this co-authored message which is the last term "4" in the equation (3.2).

Therefore,

\[
L(BCD3) = 2 + 2 + 2 + 4 = 10;
\]

Or \( L(BCD3) = 2 + 0 + 2 + 4 = 8; \)

depending on whether BCD had read A's message or not.

The "Depth" value of BCDEF's message at generation 2 in figure 3.10 (c) is

\[
L(BCD1) = 2 + r(BCDEF1) + 2 = 2 + 2 + 2 = 6;
\]
Here, \( r(BCDEF1) = 2 \) because they had to read A's message at generation 1. While the last term number "2" is the bonus points given to the co-authored message with 5 authors B, C, D, E and F.

d) "Interactivity value (IV)"

Finally, after assigning the "Depth" value for every message, an "interactivity value" is calculated for each tree by adding the depth values associated with all of the messages (regardless of their status--"co-authored" or not) in the tree. Therefore, the "interactivity value" denoted by "I" for the tree shown in Figure 3.9 is

\[
I = L(A1)+L(B2)+L(C2)+L(A3)+L(D3) = 2+4+4+6 = 20;
\]

Or

\[
I = L(A1)+L(B2)+L(C2)+L(A3)+L(D3) = 2+4+4+6+6 = 22;
\]

This depends on whether or not D has read A's message at generation 1 as discussed earlier in the "Depth" section.

Similarly, the "interactivity value" denoted by "I" for the tree shown in

- Figure 3.10(a) is

\[
I = L(A1)+L(BC2) = 2+8 = 10;
\]

- Figure 3.10 (b) is

\[
I = L(A1)+L(E2)+L(BCD3)
\]

That is:

\[
I = 2+4+10 = 16;
\]

Or

\[
I = 2+4+8 = 14. \text{ depending on whether } BCD \text{ had read A's message or not.}
\]

- Figure 3.10 (c) is

\[
I = L(A1)+L(BCDEF2)
\]

= 2+6 = 8;

Because the purpose of the study is to examine collaborative learning in terms of interaction, the message tree rather than each individual student is chosen as the unit to be analyzed.
3.4.4 Validity of IV

To assure the validity of the measure IV, various methods were explored to test the soundness of this proposed measure of degree of interaction in CMC settings. Based on the fact that instruments developed so far to assess the degree of interaction in the context of CMC are extremely limited, any studies that are relevant to the measuring of collaborative learning and/or interaction were consulted. Though the amount of this type of research was restricted, these studies were informative. Next, several measuring schemes were developed to quantify the degree of interaction in the context of CMC based on my understanding of the concepts (such as collaborative learning, interaction, etc.) used in the study. After a number of rounds of discussion with several statisticians and mathematicians, it was noticed that the biggest difficulty here was the fact that there is not any universally accepted definition of collaborative learning. To overcome this obstruction, several examples were chosen from the actual database that represent the scope of the real data, and the measuring schemes developed were applied. Then the results were demonstrated to a few experts and deliberated with them. Most experts (85%) agreed that the original scoring scheme evaluates the degree of interaction. However, they also suggested several changes for the inclusion of more complicated cases. Based on the conclusions of these consultations, original scoring procedures were refined and revised, and this measure of degree of interaction was proposed.

3.5 Methods of Data Collection and Analysis

In this section, the methods of data collection and analysis, pilot studies as well as reliability are presented. In section 3.5.1, data collection and ethical concerns for the study are discussed. In section 3.5.2, data analysis methods are provided. In section 3.5.3, the pilot
studies conducted are explained. Finally, in section 3.5.4, the reliability of the study is reported.

3.5.1 Data collection and Ethical Concerns

The subjects for this study were selected from students who participated in the "Knowledge Forum Knowledge Building Community Project" in 1999. It was a fifth- and sixth-grade classroom in an inner city private elementary school in Ontario. The school serves an "ethnically and socio-economically heterogeneous population, with a higher-than average representation of children from educationally advantaged homes" (Scardamalia & Bereiter, 1993, p. 182). There were 22 students (11 males and 11 females) in the class.

The data - the entire corpus of electronic messages from their mathematics and science course from September 1998 to April 1999 - were used for the analysis. The interaction between students and adults (including teachers and researchers) as well as among students was analyzed for the study. There were total of four adults (two males and two females) involved in the interaction. These adults included one male teacher, two researchers (a male and a female), and a subject matter expert (female). These data were already collected and provided by the Knowledge Forum Knowledge Building Community Project team in electronic form. Access to the transcripts was secured at all times.

Only my thesis supervisor, the Knowledge Forum project team, and myself had access to the raw data. In order to maintain confidentiality, all names were deleted and replaced by pseudonyms known only to the investigator. Data were stored in electronic form whenever possible, the working source on an electronically secured personal computer, and backup disks in a secured environment. My copy of the raw data that is in electronic form on disk will be erased two years after the defense of the thesis. My copy of all other confidential print-based
data will be destroyed. Pseudonyms and pseudo locations are used throughout reporting. The social distance between the participants and the data they produce is maintained in such a way that identities cannot be associated with behaviors.

3.5.2 Data Analysis

The content of the transcripts was prepared for analysis in such a way that any single piece - a word, for example - can be examined along with any other elements of data, from a clutch of contiguous words, through to the text as a whole.

The transcripts were coded for language functions (e.g. asking information, giving information, making suggestion, presenting opinion and expressing disbelief) and interaction. The analysis unit for language functions was the T-unit, which is defined by Crookes (1990). Techniques proposed by Henri and Rigault (1996) were used for the content analysis. The analysis unit for the interaction was the message tree. First of all, every note was coded as a message or several messages depending on the nature of the note, and the definition of the unit -message -- is given in section 3.4.1. Each message was then identified as either an interactive message or an independent message following Henri’s (1995) definition as presented at 2.1.1. Following, message trees were generated and they were analyzed as the work units of interaction.

Since this study was an exploratory work, different analyses were administrated to explore the relationship between interaction and communication.

The data were analyzed from three perspectives:

a). Conducted descriptive statistics of the degree of students' interaction.

b). All message trees were sorted into three categories: short, medium and long trees according to their size, level, and Interactivity Value as describe in section 3.4. Both
total counts and ratio of each language function in each category were computed and
trends were explored.

c). Performed correlation analyses for the whole set of data as well as for each category
as describe in b) above. These studies explored patterns of certain language functions
used in messages in relation to collaborative learning.

Particularly, language functions in the following three different situations in relation to
interaction were examined to explore patterns:

1). Language functions used in all messages in all message trees,

2). Language functions only used in first messages in all message trees.

3). Language functions used both in all messages and only in first messages taking
scaffold into consideration.

Here, the term scaffold refers to a built-in software structure in Knowledge Forum.
designed as a cognitive developmental tool to enhance student collaborative knowledge
construction. For each of the above mentioned three situations, both descriptive and inferential
statistics as described in above perspectives b) and c) were performed.

3.5.3 Statistical Treatment

The data collected in this study were analyzed using the Statistical Package for the
Social Sciences (SPSS,1999). Descriptive statistics were calculated for all variables, frequency
polygons were generated, and distributions were examined for normality. The initial task in
reporting material was to display raw data and percentages for the total population. This
procedure addresses the first research question: What are the degrees of interaction in an
elementary classroom that uses CMC? In this effort, descriptive statistics were employed.
Then the data were further analyzed to address additional research questions.
Research questions two and three considered whether any pattern of participants’ use of language functions in relation to the degree of their interaction existed or not. Both descriptive and inferential statistics were conducted. Because data were not normally distributed, non-parametric statistics rather than parametric tests were employed for relevant portions of the study. Use of nonparametric tests also eases the problem that the measure “IV” may not necessarily reflect an interval level of measurement, as noted by Huck:

...converting raw scores to ranks is related to the fact that raw scores sometimes appear to be more precise than they really are. In other words, a study’s raw scores may provide only ordinal information about the study’s subjects even though the scores are connected to a theoretical numerical continuum associated with the dependent variable. In such a case, it would be improper to treat the raw scores as if they indicate the absolute distance that separates any two subjects that have different scores when in fact the raw scores only indicate, in a relative sense, which subject has more of the measured characteristic than the other.

(2000, p. 654)

Since the study was primarily exploratory and its main purpose was to identify patterns between variables, a series of correlational relationships were examined. Due to the different characteristics of some data distributions, Kendall’s rank correlation or chi-square analysis were considered to test for relationships and between variable dependencies. Whenever possible, Kendall’s rank order correlation was applied because chi-square analysis may bring about a “loss of information”. With respect to the unit of analysis of language function, both the ratio of each language function and the total number of T-units of each language function were employed depending upon the statistical analyses. The ratio of each language function of a message tree was defined as the total number of T-units using a specific language function in the message tree divided by the tree size. Obviously, the variable: the measure of language functions (i.e. the number of T-units using each language function) was related to the variable: the measures of interaction (i.e. size, level, IV, and T-unit). In order to perform a rank order
correlation, the two variables to be correlated should be disentangled. Accordingly, ratio rather than total number of T-units was used for the rank-order correlation.

Either Kendall's rank-order correlation coefficients (tau) or Pearson chi-square tests were used to describe the relationships between the two sets of variables (i.e. language functions and interaction) as research questions were addressed. Because multiple rank-order correlations were conducted in this study, there was inflated Type I error risk. According to Huck (2000), when multiple tests are administrated,

An adjustment must be made somewhere in the process to account for the fact that at least one Type I error somewhere in the set of results increases rapidly as the number of tests increases. Although there are different ways to effect such an adjustment, the most popular method is to change the level of significance used in conjunction with the statistical assessment of each $H_0$.

(p.223)

Therefore, a significance level of .01 instead of .05 was used. It was from these correlations and other statistical tests that the research questions were answered and the appropriate analyses were reported in the following sections.

3.5.4 Pilot Study

Two pilot studies had been conducted in January 1998 and spring of 2000 respectively to test designed instruments and to determine if appropriate data were being collected and analyzed using designed instruments. In spring 1997 I took a graduate level course offered by computer-conferencing. The instructor had integrated a collaborative group assignment into the course design and because there was a good fit with intents of my study, I analyzed the corpus of the electronic messages from our group in order to gain some insights into the research process that I was developing. This was my first pilot study.
There were masters and doctoral students in our group; some of us had previous experience with the medium. Because I had been an active participant in the course, I had developed rapport with other students.

In the spring of 2000, after I have received the approval from the KF project leaders, I conducted my second pilot study. I randomly picked five different message trees that represent the scope of the database and coded them using the rules specified in the study. I trained two other graduate students from OISE (one native English speaker) and asked them to code the same sample data. (See Appendix for details of the coding)

The pilot studies were very gratifying. Conducting the pilot was instrumental in helping me organize the processes I need to consider more thoroughly in terms of data organization and analyzing. I gained valuable insights regarding the data analysis. The themes emerged from the pilot study were helpful in guiding the development of further work that was required.

3.5.5 Reliability of the Study

Several steps were taken to verify the reliability of the study. First, specific coding rules were developed and sample data were coded. To check the feasibility of operational definitions and specific coding rules, a Ph.D. student at OISE who is a native English speaker was asked to code the same sample data according to the coding rules. Then her coded transcripts were compared with the author’s. The congruency rate was 81.7%. In addition, it was found that the discrepancies were all due to different understandings of the coding rule with respect to the language function “giving explanation”. To determine whether the coding rule of “giving explanation” should be retained or modified it to follow her comprehension, another group of graduate students at OISE (all native English speakers) were requested to code the same transcripts again using the operational definitions and coding criteria. The feedback
was analyzed and special attention was paid to the coding of the language function “giving explanation”. The results showed that the majority of these people (that is 5 out of 6) coded the language function “giving explanation” the same way as the author did. Hence it is reasonable to argue that most people (including the author) would have the common understanding of the coding rule with respect to “giving explanation”. For this reason, the coding rule of “giving explanation” was decided kept as it is (see appendix for details).

Next, two types of reliability tests – inter-rater reliability and intra-rater reliability -- were conducted. A sample set of data that represents the scope of the data set was randomly selected. Two other raters (one expert in the field and another a professional engineer with a graduate degree) were trained and coded the sample data. The inter-rater reliability was measured in terms of raw agreements. The raw agreement of language functions was 0.78 and the raw agreement of ‘Interactivity Value’ was 0.97. Both scores were very high according to Hartmann (1982). In addition, intra-rater reliability was also computed and the agreement rate was 0.92.
CHAPTER IV: ANALYSIS AND RESULTS

4.1 Introduction

This study was intended to investigate collaborative learning in the context of computer-mediated communication (CMC). The primary purpose of the study was to examine the relationships between communication and collaborative learning in CMC settings. The secondary purpose was to explore the extent of collaboration in the context of CMC. Because collaboration is not operationally defined, and because interaction is strongly correlated with collaboration and it is the major learning factor in collaborative learning (O'Donnel & Dansereau, 1992), in the present study, therefore, collaborative learning was explored in terms of students' interaction in their learning process. That is, in this study, interaction – not a synonym but a major indicator of collaboration – was measured and explored. The third purpose was to develop a new measure to quantify the degree of interaction, namely the IV, and to examine the usefulness of the IV. This chapter reports and analyzes the data collected relevant to the research questions posed in Chapter 1. Section 4.2 reviews some of the key terms of the study. Section 4.3 illustrates the characteristics of the subjects. Section 4.4 addresses the first research question regarding the degree of participants' interaction. Section 4.5 deals with the second research question as it examines the relationship between the language functions associated with messages generated in CMC settings and participants' interaction. Section 4.6 tackles the third research question as it investigates the changes of frequency patterns of participants' use of language functions in relation to their interaction with adult (including teachers and helping adults) involvement.
4.2 Review of Terms

Interaction is a key concept in this study. Four different measures: tree size, level, Interactivity Value, and T-units were used in this study to quantify interaction. Following is a brief review of these four measures and related terms.

One of the terms used in this study is message tree. A message tree was characterized as a group of messages that interact with one another. The definition of interactive message is provided by Henri (1995) and depicted in Chapter 3. The size of a message tree is the number of interactive messages in the tree. A message tree with greater value in size than other trees was interpreted as a "bigger" or "larger" tree. Depending upon the position of a message in a tree, the message was assigned a generation value. A message that did not refer to any other message was at generation 1. Whereas a message that referred to an earlier message was at the generation of that earlier message plus one. Detailed description of both size and generation were given in Chapter 3. The level of a message tree was defined as the highest generation value of messages in the tree. A "taller" tree referred to a tree with a greater level value than other trees.

Another frequently used term is "Interactivity Value" (IV). "Interactivity Value", a measure of degree of interaction, was developed in this study. 'Interactivity Value' was defined as a function of the number of interactions that occurred and the depth of these interactions developed considering both the 'act of reading' and the 'act of writing' to be interactions. Chapter 3 provided a detailed description of this measure.

The next term reviewed here is "scaffold". In this study, scaffolds refer to a built-in software structure, designed as a cognitive developmental tool to enhance student collaborative learning. This design of scaffolds assisted students' ability to communicate their ideas as well
as the nature of these ideas. It also provided “flexible ways of structuring notes” (Scardamalia & Bereiter, 1997). For the purpose of the current study, scaffolds include both the “scaffolds” (i.e. “theory building”, etc.) and the “thinking-type labels” (i.e. “my theory”, “problem”, “I need to understand”, “new learning”, etc.) as described by the Knowledge Forum/Knowledge Building Community Project team (Scardamalia & Bereiter, 1999). Because the rationale behind the design of the scaffold structure in Knowledge Forum is to promote collaborative knowledge building, the examination of the impact of such structure in relation to interaction is important. In part of the following data analysis, therefore, scaffold use was also taken into consideration.

The last term used frequently is “T-unit”. A T-unit was defined as "one main clause plus whatever subordinate clauses happen to be attached or embedded within it" (Crookes, 1990). The definition of the clause was "one subject or one set of coordinate subjects with one finite verb or one finite set of coordinated verbs." (Crookes, 1990, p.185). Appendices 2 and 3 provide detailed description and samples of T-units.

4.3 Characteristics of Message Trees

This section describes the characteristics of the data analyzed. The exploration of message trees by size, level, Interactivity Value, and total number of T-units are presented. In addition, the use of system provided scaffolds and the teacher/researcher involvement are also reported.

Of the 716 messages collected, 506 messages were analyzed. These messages were selected because they were considered to be dialogical: that is, the messages were interactive or showed an intention to be interactive. Interactive messages were defined those that “answer or interpret a previous statement—they refer to the theme of the teleconference and are also
connected, explicitly or implicitly, to one or more other messages” (Henri, 1995, p.152).

Messages that were not heading toward a dialogue (here called non-dialogical messages) were excluded. These non-dialogical messages constituted messages of merely “quotations” or “rise-above”, offered without comment. Again, “rise-above” is one of those standard scaffolds provided by the software. The 506 analyzed messages generated a total of 188 message trees.

Table 4.1 *Message tree (all sizes)*

<table>
<thead>
<tr>
<th>Tree Size</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54</td>
</tr>
<tr>
<td>2</td>
<td>53</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>188</td>
</tr>
</tbody>
</table>

The data in Table 4.1 list the frequencies of message tree sizes. Generally, the message trees were quite small, i.e. of sizes 1 or 2. The number of message trees of size one (54) was almost identical to the number of size 2 trees (53). About one third of the message trees were moderate in size — namely, of size three or four. Very large size trees, i.e. size seven and up were rare.

Table 4.2 *Tree size, level, Interactivity Value and number of T-units*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>2.69</td>
<td>1.80</td>
<td>9</td>
</tr>
<tr>
<td>Level</td>
<td>2.03</td>
<td>1.61</td>
<td>7</td>
</tr>
<tr>
<td>IV</td>
<td>10.77</td>
<td>13.37</td>
<td>82</td>
</tr>
<tr>
<td>T-units</td>
<td>8.65</td>
<td>6.61</td>
<td>32</td>
</tr>
</tbody>
</table>
The data in Table 4.2 detail the mean, standard deviation, and maximum value for variables: size, level, Interactivity Value, and total number of T-units of a message tree. The mean size of message trees was 2.69 (SD = 1.80) and the range was 1 to 9 messages. For the variable “tree level”, the mean score was 2.03 (SD = 1.61) and the range was 1 to 7. For the variable “Interactive Value”, the mean score was 10.77 (SD = 13.37) and the range was 2 to 82 points. For the variable “total number of T-units”, the mean score was 8.65 (SD = 6.61) and ranging from 1 to 32.

Because the intention of this study was to investigate students' collaborative learning, I was mostly interested in interactive messages. Therefore, message trees of size one were not considered for most of the data analysis. For the remaining analyses of data, message trees of size one are excluded unless specifically stated otherwise. Out of 188 message trees, a total of 134 message trees contained more than one message, and thus constituted the sample of the main study.

The data in Table 4.3 indicate the frequencies and percentages of the number of messages using scaffolds in message trees. As is shown in the table, system provided scaffolds were not used in most message trees. None of the messages in nearly 66 percent of the message trees employed scaffolds. About 23 percent of total message trees contained only one message using scaffolds per tree. Four is the maximum number of messages using scaffolds in a message tree, and the mean is 0.49 with a standard deviation 0.79.

Table 4.3 Frequency of Scaffolds

<table>
<thead>
<tr>
<th>Number of notes using scaffold</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>88</td>
<td>65.7</td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>23.1</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>9.0</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>134</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The frequencies and percentages of the number of teacher-contributed messages is reported in Table 4.4. For the remaining of the chapters, “teacher” trees refer to any tree containing at least one teacher-contributed messages. In general, the number of teacher message trees was relatively small (23.9%). Over seventy six percent of message trees were merely student messages. In addition, out of total of a 134 message trees, only two message trees (1.5 percent) have more than one teacher-contributed message per tree. Teacher-only tree refers to a tree containing only teacher-generated messages. None of the message trees was a teacher-only tree.

Table 4.4 Frequency distribution for message trees with teacher notes

<table>
<thead>
<tr>
<th># of teacher notes</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>102</td>
<td>76.1</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>22.4</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>134</td>
<td>100.0</td>
</tr>
</tbody>
</table>

4.4 Data Addressing Research Question 1

This section contains analyses that address the first research question. The research question is presented and followed by data dealing with the question.

Research question #1

What is the degree of interaction in an elementary classroom using CMC?

This section examines the degree of interaction in an elementary classroom using CMC. The frequencies of message trees by size, level, Interactivity Value, and total number of T-units are reported.

The first measure of degree of interaction in this study was tree size. The data in table 4.5 represent the frequencies and percentages of tree size. As shown in the table, message trees
were relatively small. Nearly 67 percent of message trees were of size two or three. The largest percentage, nearly 40 percent, of the message trees contained only two messages. About 17 percent of the message trees had four messages. Approximately another 17 percent of the message trees contained more than four messages.

Table 4.5 Message trees by size (size > 1)

<table>
<thead>
<tr>
<th>Tree size</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>53</td>
<td>39.6</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
<td>27.6</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>16.4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>134</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.6 Message trees by level (size>1)

<table>
<thead>
<tr>
<th>Tree level</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>68</td>
<td>50.7</td>
</tr>
<tr>
<td>3</td>
<td>39</td>
<td>29.1</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>9.7</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>6.7</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>134</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The second measure of degree of interaction used in this study was the level of message trees. The data in Table 4.6 report the frequencies and percentages of tree level. The variable "level" was defined in chapter three and reviewed in section 4.2. As appeared in the table, the majority of the trees tended to be of a very low level. Nearly 80 percent of the message trees yielded of 3 levels or less. Over half of the message trees only had 2 levels. In other words, most of the message trees were quite short. Only about 10 percent of the message trees were of
level 4, and approximately 10 percent yielded levels 5 to 7. In addition, when the tree level increased, the number of message trees decreased.

The Interactivity Value (IV) also measures interaction. The data in Table 4.7 detail the frequencies and percentages of message trees by IV. A grouped frequency distribution was computed to achieve a better understanding of the characteristics of the message trees involved in this study. Patterns identified by IV score were similar to those associated with both size and level. Again, most of the trees scored low in IV score. About 38 percent of the message trees had the lowest observed IV score (6). Over 38 percent of the message trees had IV scores between 10 and 19. The number of trees with IVs between 20 and 29 was almost identical to the number of trees with IV 30 and up.

Table 4.7 Message trees by Interactivity Value (size>1)

<table>
<thead>
<tr>
<th>Interval</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>50</td>
<td>37.3</td>
</tr>
<tr>
<td>10-19</td>
<td>52</td>
<td>38.8</td>
</tr>
<tr>
<td>20-29</td>
<td>16</td>
<td>11.9</td>
</tr>
<tr>
<td>30-39</td>
<td>8</td>
<td>6.0</td>
</tr>
<tr>
<td>40 &amp; up</td>
<td>8</td>
<td>6.0</td>
</tr>
</tbody>
</table>

* Total percentage may not equal 100 due to rounding.

As was noted, when tree size and level increased, the frequency of trees typically decreased. A slightly different pattern was noted with respect to IV. As it appeared in the Table 4.7, when IV increased from interval 0-9 to 10-19, the percentage of the message trees also increased (instead of decreased) from 37.3 percent to 38.8 percent. The largest group of message trees had IV ranging from 10 to 19, which did not fall into the lowest score range.

Table 4.8 Grouped frequency by total number of T-units (size>1)

<table>
<thead>
<tr>
<th>Interval</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>30</td>
<td>22.4</td>
</tr>
<tr>
<td>6-10</td>
<td>50</td>
<td>37.3</td>
</tr>
<tr>
<td>11-15</td>
<td>32</td>
<td>23.9</td>
</tr>
<tr>
<td>&gt;15</td>
<td>22</td>
<td>16.4</td>
</tr>
</tbody>
</table>
The fourth measure of interactivity used in this study was the total number of T-units in a message tree. To achieve a better understanding of the characteristics of the subjects involved in this study, a grouped frequency distribution was calculated. The data in Table 4.8 detail the frequencies and percentages of message trees by T-units.

Different patterns were identified with respect to the total number of T-units of a message tree. The largest group (37.3%) of message trees had a total number of T-units of between six and ten. The two second largest groups of message trees (approximately one-fifth of the trees) had a total number of T-units either between one and five, or between eleven and fifteen. Very large trees (i.e. more than 15 T-units) constituted about one-sixth of the trees. To summarize, trees generally tended to be short in terms of total number of T-units. Unlike the patterns identified in size and level, the largest group did not fall into the smallest score range.

Relationships among the four indexes of interaction (i.e. size, level, IV and T-unit of a message tree) are also explored. Kendall's tau was calculated to study these relationships. Table 4.8.1 reports the rank-order coefficients and the significance. The results show that the four indexes are highly correlated among each other.

Table 4.8.1 Rank-order correlation among the four measures (N=134)

<table>
<thead>
<tr>
<th></th>
<th>Size</th>
<th>Level</th>
<th>IV</th>
<th>T-unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>tau</td>
<td>tau</td>
<td>tau</td>
<td>tau</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>1.</td>
<td>.862*</td>
<td>.886*</td>
<td>.726*</td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Level</td>
<td>1.</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>.862*</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>.886*</td>
<td>.904*</td>
<td>1.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>T-unit</td>
<td>.726*</td>
<td>.775*</td>
<td>.891*</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
In summary, the frequencies of message trees by size, level, IV, and total number of T-units are calculated to examine the degree of interaction in this elementary classroom. The results show that in general, the degrees of participants' interaction are relatively in this computer-mediated environment.

4.5 Data Addressing the Second Research Question

Research question 2

Are there any frequency patterns in participants' (including students, teachers, experts, and researchers) use of language functions in relation to the degree of interaction in the context of CMC? If so, what are the patterns?

The second research question directed attention to relationships between the language functions associated with CMC generated messages and interaction. In this section, I examine these relationships considering all participants (including students, teachers, and helping adults). Additional analyses exploring the relationship between participants' use of language functions in the initiation messages and interaction were also conducted. Specifically, the relationships between the following paired variables were examined:

(1) language functions and tree size;
(2) language functions and tree level;
(3) language functions and tree IV; and
(4) language functions and T-units.

The following three sections report these relationships from three different perspectives. Section 4.5.1 explores these relationships regarding all messages. Section 4.5.2 describes the analysis of these relationships considering language function in first messages only. Section
4.5.3 examines these relationships taking scaffolding into consideration. When reading the following reports about these relationships, please note that correlation is a function of sample size.

4.5.1 Language Functions Related to Degree of Interaction

In this section, the analyses of the relationships between language functions used in all messages and all four measures of interaction (i.e. tree size, level, IV, and T-units) are presented. Descriptive statistics were first conducted to explore relationships. Rank-order correlations were then conducted to further investigate these relationships. Ratio of each language function was used as the unit of analysis for all rank-order correlation tests. The ratio of each language function of a message tree was defined as the total number of T-units using a specific language function in the message tree divided by the tree size. These explorations are described in the following section.

4.5.1.1 Language functions related to size

First, relationships between the participants’ use of each of language function and tree size are reported. At the outset, message trees were stratified into three categories by size to inspect patterns. To achieve a more balanced sample size in each category, the message trees were divided into the following three groups: size 2 (i.e. trees with only two messages, N=53), size 3 (trees with only three messages, N=37), and size 4 and up group (i.e. trees with more than 3 messages, N=44). The total number of T-units using each language function were computed and depicted in figure 4.1.
As illustrated in figure 4.1, in size-2 and size-3 groups the frequency pattern of 'asking information', 'giving explanation', and 'presenting opinion' were similar. While the occurrences of 'making suggestion' and 'expressing disbelief' were also similar but much less frequent than those of the other three language functions. In general, the patterns of using observed language functions were similar across size-2 group and size-3 group. Moving to the size-4 and up group, the frequencies of 'asking information' remained at the level seen in size-2 and size-3 group. Nevertheless, the use of 'giving explanation', 'presenting opinion', 'making suggestion' and 'expressing disbelief' increased drastically. The increasing total number of messages in the size 4 and up group can explain this phenomenon.

To summarize, the use of 'asking information', 'giving explanation', and 'presenting opinion' was observed more frequently than the use of 'making suggestion' and 'expressing disbelief' in all groups. As the message trees became bigger, surprisingly, the total number of T-units wherein information was sought and suggestions were made did not change.

Next, Kendall rank order correlations between language functions and tree size were calculated. These data are presented in table 4.9.
The Kendall rank correlation coefficients (tau) between the language functions associated with messages and size of message trees ranged from -.054 to .253 for the different language functions. Three language functions (i.e. 'asking information', 'presenting opinion', and 'making suggestion') show no statistically significant relationship with tree size (see Table 4.9). However, two significant relationships were discerned at the .01 level. First, the Kendall tau values of .253 (p=.003) indicates a significant relationship between 'giving explanation' and tree size. The larger the tree, the more likely it was for people to provide explanations. Secondly, the Kendall tau value of .253 (p= 0.003) indicates a significant relationship between 'expressing disbelief' and size. The more disbelief was expressed, the larger message trees tended to be in size.

4.5.1.2 Language functions in relation to level

Relationships between the participants’ use of each of the language functions and message tree level were investigated. To identify patterns, message trees were first stratified into three groups by level. To achieve a better balanced sample size in each group, message trees were divided into three groups as follows: level-2 group (i.e. trees with only two levels)
with sample size equal to 68, level-3 group (trees with only three levels) with sample size equal to 39, and level 4 and up group (i.e. trees with level higher than 3) with sample size equal to 27. The total number of T-units of each language function had been computed and the results are portrayed in figure 4.2.

Comparing language functions at difference size groups (figure 4.1) to language function at different level groups (figure 4.2), similar patterns were seen for the use of language functions. That is, in each level group, 'asking information', 'giving explanation', and 'presenting opinion' were used more extensively than were 'making suggestion' or 'expressing disbelief'. The frequency of using specific language function varied less by level group than size group. In other words, the use of different language functions remained relatively stable across each level-based group.

![Figure 4.2 Language functions at different level](image)

**Figure 4.2 Language functions at different level**

Kendall rank order correlation coefficients were then computed to test the relationship between language functions and level. These results are detailed in table 4.10.
Table 4.10  Rank-order correlations between language functions and level

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>134</td>
<td>.026</td>
<td>.766</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>134</td>
<td>.255*</td>
<td>.003</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>134</td>
<td>.042</td>
<td>.634</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>134</td>
<td>.068</td>
<td>.434</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>134</td>
<td>.230*</td>
<td>.007</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

The Kendall rank correlation coefficients (tau) between language functions and tree level ranged from .026 to .255. Three language functions (i.e. ‘asking information’, ‘presenting opinion’, and ‘making suggestion’) yielded no statistically significant relationship with level (see Table 4.10). However, two significant relationships were observed at the .01 level. First, the Kendall tau value of 0.255 (p=0.003) indicates a significant positive relationship between frequency of ‘giving explanation’ and level of the message trees. The taller the tree, the more likely it was for people to provide explanations. Secondly, the Kendall tau values of 0.230 (p=.007) indicates a significant relationship between ‘expressing disbelief’ and message tree level. The more disbelief had been expressed, the more likely the message trees were taller.

4.5.1.3 Language functions in relation to IV

Patterns of the participants’ use of language functions in relation to IV scores were studied. The preliminary examination of patterns was conducted by stratifying message trees into three groups by IV score. To achieve a better balanced sample size in each category, the message trees were divided into three groups as follows: IV-1 group (i.e. trees with IV equal to 6) with sample size equal to 50, IV-2 group (trees with IV greater than 6 but less than 17) with sample size equal to 49, and IV-3 group (i.e. trees with IV greater than 16) with sample size
equal to 35. The total number of T-units of each language function was computed and the results appear in figure 4.3.

![Figure 4.3 Language functions at different Interactivity Value](image)

**Figure 4.3 Language functions at different Interactivity Value**

In general, the patterns demonstrated in figure 4.3 are relatively similar to those associated with language functions by level (see figure 4.2). However, the frequencies of ‘presenting opinion’ and ‘making suggestion’ continually increased as a function of IV increasing. This pattern differs from that shown in figure 4.1 (for size) and in figure 4.2 (for level).

Next, Kendall rank order correlation coefficients were computed to explore the relationship between language functions and IV. These data are detailed in table 4.11.

**Table 4.11 Rank-order correlations between language functions and IV**

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘asking information’</td>
<td>134</td>
<td>-0.038</td>
<td>0.661</td>
</tr>
<tr>
<td>‘giving explanation’</td>
<td>134</td>
<td>0.264*</td>
<td>0.002</td>
</tr>
<tr>
<td>‘presenting opinion’</td>
<td>134</td>
<td>0.015</td>
<td>0.860</td>
</tr>
<tr>
<td>‘making suggestion’</td>
<td>134</td>
<td>0.155</td>
<td>0.074</td>
</tr>
<tr>
<td>‘expressing disbelief’</td>
<td>134</td>
<td>0.237*</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.
The value of Kendall tau between language function and IV score ranged from -.038 to .264. Analyses of three language functions (i.e. ‘asking information’, ‘presenting opinion’, and ‘making suggestion’) showed no statistically significant correlations with IV (see Table 4.11). However, two significant relationships were discerned at the .01 level. First, the Kendall tau value of 0.264 (p= 0.002) indicates a significant positive relationship between the number of explanations and IV, with higher IV scores associated with greater numbers of explanations. Secondly, a similar tendency was observed for more “disbelief” to be associated with increased interactivity, as indexed by IV score (p(0.232)=0.006).

4.5.1.4 Language function related to T-units

In this section, the analyses of relationships between language functions and the fourth measure of collaboration (i.e. total number of T-units) are presented. Initially, only size, level, and IV of a message tree were considered as dimensions to quantify interaction. As data coding and analyzing proceeded, the number of T-units emerged as a fourth dimension to quantify interaction. Therefore, one issue to be considered was whether there existed a relationship between number of T-units and participants’ use of language functions. Kendall rank order correlation coefficients were computed to explore the relationship between language functions and T-units. These data are detailed in Table 4.12.

No significant correlation coefficients were found in participants’ use of four language functions (i.e. ‘asking information’, ‘presenting opinion’, ‘making suggestion’, and ‘expressing disbelief’) and total number of T-units in message trees. However, a significant positive relationship was discerned at 0.01 level. The Kendall’s tau was 0.243 (p<0.001) between participants’ use of ‘giving explanation’ and total number of T-units in message trees. When people provided more explanations in their messages, the message trees tended to associate with larger number of T-units.
Table 4.12  Rank-order correlations between language functions and T-units

<table>
<thead>
<tr>
<th>Language Functions</th>
<th>N</th>
<th>Coefficient</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘asking information’</td>
<td>134</td>
<td>.046</td>
<td>.484</td>
</tr>
<tr>
<td>‘giving explanation’</td>
<td>134</td>
<td>.243*</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>‘presenting opinion’</td>
<td>134</td>
<td>.055</td>
<td>.393</td>
</tr>
<tr>
<td>‘making suggestion’</td>
<td>134</td>
<td>.128</td>
<td>.066</td>
</tr>
<tr>
<td>Express disbelief</td>
<td>134</td>
<td>.119</td>
<td>.090</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

In summary, a total of twenty tau's were calculated, accompanied by an equal number of significance tests. There were thirteen tests that were not statistically significant. However, there were significant relationships for seven tests—those between ‘giving explanation’ and size, level, IV and T-units of message trees, and ‘expressing disbelief’ and size, level, and IV of message trees.

4.5.2 Language functions in first messages

I suspected that the first message of a message tree might have a profound effect on the development of the message tree related to size, level, and IV of message trees. Thus, in this section, the issue of language functions appearing only in first messages is addressed. Both descriptive and inferential statistics were conducted. As discussed in section 3.4, because of the lack of variability of the variable: language functions in first messages, chi-square tests instead of rank-order correlations were used to uncover patterns. That is, chi-square tests were conducted to examine relationships between the language functions in the first messages and tree size, level, IV, and T-unit. However, since the variables “making suggestion” and “expressing disbelief” in first message did not show enough variances to make any inferential statistics, chi-square tests were not performed to these two variables. Language functions were collapsed into two categories: essentially making a binomial variable: those messages without the specific language function, vs. those messages used such language function. This examination of relationships is detailed as follows.
4.5.2.1 Language functions in first messages related to size

First of all, message trees were divided into three groups by size and preliminary exploration of patterns was conducted. The same process for all message trees were used here. Again, message trees were broken down into following three groups: size-2 group (i.e. trees with only two messages, N=53), size-3 group (trees with only three messages, N=37), and size 4 and up group (i.e. trees with more than 3 messages, N=44). The total number of T-units using each language function was calculated and the results are presented in figure 4.4.

Very interesting patterns appeared regarding the employment of language functions in first messages of different size categories (see figure 4.4). First of all, probably the most striking pattern across different size groups is the difference between the use of ‘asking information’ and ‘giving explanation’. When tree size was small (i.e. size=2), the incidences of giving explanation were only one fifth of ‘asking information’ in first messages. However, when message trees grew bigger, the differences between the frequencies of using the two language functions were much smaller.

Secondly, compared to what was found in all message trees (see figure 4.1), a couple of interesting patterns were discovered. One is that when tree size was small (size 2), a large proportion of ‘asking information’ (more than 80%) appeared in first messages. That is, smaller trees tended to associate with a lot of information seeking in initial messages. In general, over half of the occurrences of ‘asking information’ took place in first messages regardless of the size. In other words, the majority of information requesting was presented at the beginning of a discussion.
The relationships between participants’ use of language functions in first messages and tree size were analyzed using chi-square tests. A cross tabulation was first conducted with tree size. Eventually, the categories of tree size for the preliminary study as described above (i.e. size-2 tree, size-3 tree, and size-4 and up tree) were used since it is a median and an upper-quartile split on size. The use of this procedure reduced the number of low size cells. Thus, “small trees” were defined as those size-2 trees, “medium trees” were size-3 trees, and “large trees” were the size-4 and up trees. These data are detailed in table 4.13-4.15.

Table 4.13 Frequency of “asking information” in first messages and size

<table>
<thead>
<tr>
<th>Use “asking information”</th>
<th>Small tree</th>
<th>Medium tree</th>
<th>Large tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>33</td>
<td>26</td>
<td>31</td>
</tr>
<tr>
<td>yes</td>
<td>20</td>
<td>11</td>
<td>13</td>
</tr>
</tbody>
</table>

Chi-square(2,134)= 0.955, p=0.620.
Table 4.14 Frequency of “giving explanation” in first messages and size

<table>
<thead>
<tr>
<th>Use “giving explanation”</th>
<th>Small tree</th>
<th>Medium tree</th>
<th>Large tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>49</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>yes</td>
<td>4</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Chi-square(2,134) = 3.79, p=0.150.

Table 4.15 Frequency of “presenting opinion” in first messages and size

<table>
<thead>
<tr>
<th>Use “presenting opinion”</th>
<th>Small tree</th>
<th>Medium tree</th>
<th>Large tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>42</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>yes</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

Chi-square(2,134) = 0.164, p=0.921.

Pearson chi-square was used with an alpha of 0.05. None of the chi-square tests of association that examined whether use of different language functions (i.e. “asking information”, “giving explanation”, and “presenting opinion”) in first messages was associated with tree size was significant.

4.5.2.2 Language functions in first messages related to level

Secondly, relationships between language functions in first messages and tree level were analyzed. Similarly, preliminary examination of patterns by level was conducted. As was done for all trees, the message trees were divided into 3 groups: level-2 group (i.e. trees with only two levels) with a sample size of 68, level-3 group (trees with only three levels) with a sample size of 39, and level 4 and up group (i.e. trees with level higher than 3) with a sample size of 27. Total number of T-units using each language functions in first messages was computed and is shown in figure 4.5.

As observed in figure 4.5, “asking information” was almost always the language function used most frequently in first messages. “Asking information” occurred more than twice as often as any other language functions in level-2 trees. In level-3 and level-4 groups,
the number of 'asking information', 'giving explanation', and 'presenting opinion' comments were similar. In addition, both 'making suggestion' and 'expressing disbelief' were rare compared to those other three language functions. When message trees were relatively tall (higher than 2 levels), virtually no specific suggestions were made in first messages.

Comparing language functions which appeared in first messages to every message in trees (see figure 4.2), 'asking information' in first messages showed a lot of variation across different level groups. In level-2 and level-3 group, around sixty percent of the total number of 'asking information' appeared in first messages. In level-4 and up group, less than thirty percent of the total number of 'asking information' occurred in first messages. Comparing to the other four language functions, 'asking information' usually appeared in the first messages of short trees (level-2 and 3 group). This is particularly true for level-2 group. The use of 'giving explanation' demonstrated a somewhat different pattern. For level-2 trees, participants usually did not start with explanations. However, for level-3 trees, explanations given in first messages were drastically increased. This phenomenon was confirmed by a chi-square test between the tree level and the use of 'giving explanation' in first messages. The significant chi-square test showed a positive relationship between the use of 'giving explanation' in first messages and tree level in level-2 and level-3 tree groups.

The relationships between participants' use of language functions in first messages and tree level were analyzed using chi-square tests. A cross tabulation was first conducted with tree level. Eventually, the level categories used for the preliminary study as described above (i.e. level-2 tree, level-3 tree, and level-4 and up tree) were applied for chi-square tests since it reduced the number of low size cells. Thus, "stunt trees" were defined as those level-2 trees,
"short trees" were level-3 trees, and "tall trees" were the level-4 and up trees. These data are detailed in table 4.16-4.18.

![Bar chart showing frequency of different actions at different tree levels.]

**Figure 4.5 Language function in 1st message at different levels**

**Table 4.16 Frequency of "asking information" in first messages and tree level**

<table>
<thead>
<tr>
<th>Use &quot;asking information&quot;</th>
<th>Stunt tree</th>
<th>Short tree</th>
<th>Tall tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>45</td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>yes</td>
<td>23</td>
<td>13</td>
<td>8</td>
</tr>
</tbody>
</table>

Chi-square(2,134)= 0.160, p=0.923.

**Table 4.17 Frequency of "giving explanation" in first messages and tree level**

<table>
<thead>
<tr>
<th>Use &quot;giving explanation&quot;</th>
<th>Stunt tree</th>
<th>Short tree</th>
<th>Tall tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>63</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>yes</td>
<td>5</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Chi-square(2,134)= 6.87, p=0.032*.

*Significant at the .05 level.
Table 4.18  **Frequency of “presenting opinion” in first messages and tree level**

<table>
<thead>
<tr>
<th>Use “presenting opinion”</th>
<th>Stunt tree</th>
<th>Short tree</th>
<th>Tall tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>56</td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>yes</td>
<td>12</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
</table>

Chi-square(2,134)= 2.46, p=0.293

Pearson chi-square was used with an alpha of 0.05. Two of the three chi-square tests of association that examined whether use of different language functions (i.e. “asking information”, “presenting opinion”) in first messages was associated with tree level were not significant. The chi-square test shown in table 4.17 indicated a significant result on “giving explanation”. To examine how different tree groups are associated with one another, post hoc correlations were made. Each of these pair-wise correlations was conducted via a 2x2 chi-square test. A total of three such 2x2 chi-square tests were conducted among the three tree level groups. Two of these chi-square tests were not significant. However, Chi-squares revealed that the level of trees (stunt and short trees) was associated with participants’ use of ‘giving explanation’ in first messages (chi-square (1, 107)=6.877, p=0.009). This indicates that the “short” trees are more likely to have specific explanations in first messages than the “stunt” trees.

### 4.5.2.3 Language functions in first messages related to IV

Thirdly, relationships between participants’ use of each of the language functions in first messages and IV score were analyzed. A preliminary examination of patterns by IV score was conducted. The message trees were divided into 3 groups: IV-1 group (i.e. trees with IV equal to 6) with sample size equal to 50, IV-2 group (trees with IV between 7 and 16) with sample size equal to 49, and IV-3 group (i.e. trees with IV greater than 16) with sample size
equal to 35. This stratification provided a better balance of the sample size. Total numbers of T-units of each language function in first messages were computed and are shown in figure 4.6.

![Figure 4.6 Language function in 1st message at different IV](image)

**Figure 4.6 Language function in 1st message at different IV**

The pattern of language functions in each IV group was similar to those associated with level (see figure 4.5). As demonstrated in figure 4.6, 'asking information' was usually the language function under study that had been used most frequently in first messages. However, when an IV score increased, the frequency of 'asking information' tended to drop, while incidence of 'giving explanation' reached the highest point at IV-2 group. The dramatic increase of giving explanations in first messages from IV-1 to IV-2 group was confirmed by a chi-square test between the tree IV and the use of 'giving explanation' in first messages. The significant chi-square test showed a positive relationship between the use of 'giving explanation' in first messages and tree IV in IV-1 and IV-2 groups.
The relationships between participants’ use of language functions in first messages and tree IV were analyzed using chi-square tests. A cross tabulation was conducted with tree IV. Message trees were collapsed into 3 categories with a median and an upper-quartile split on IV. This procedure insured the expected frequencies large enough to perform the tests. Thus, “simple trees” were defined as those trees of IV below 12, “ordinary trees” were trees of IV between 12 and 18, and “complicated trees” were trees of IV greater than 19. These data are detailed in table 4.19-4.21.

Table 4.19 Frequency of “asking information” in first messages and IV

<table>
<thead>
<tr>
<th>Use “asking information”</th>
<th>Simple tree</th>
<th>Ordinary tree</th>
<th>Complicated tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>44</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>yes</td>
<td>23</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Chi-square (2, 134)= 0.252, p=0.882.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.20 Frequency of “giving explanation” in first messages and IV

<table>
<thead>
<tr>
<th>Use “giving explanation”</th>
<th>Simple tree</th>
<th>Ordinary tree</th>
<th>Complicated tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>62</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>yes</td>
<td>5</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Chi-square (2, 134)= 7.09*, p=0.029.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
*Significant at the .05 level

Table 4.21 Frequency of “presenting opinion” in first messages and IV

<table>
<thead>
<tr>
<th>Use “presenting opinion”</th>
<th>Simple tree</th>
<th>Ordinary tree</th>
<th>Complicated tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>55</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>yes</td>
<td>12</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Chi-square (2, 134)= 1.99, p=0.370</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pearson chi-square was used with an alpha of 0.05. Two of the three the chi-square tests of association that examined whether use of different language functions (i.e. “asking information”, “presenting opinion”) in first messages was associated with tree IV were not significant. The chi-square tests shown in table 4.20 indicated a significant result on “giving
explanation”. To examine how different tree groups are associated with one another, post hoc correlations were made. Each of these pair-wise correlations was conducted via a 2x2 chi-square test. Total three such 2x2 chi-square tests were conducted among the three tree types (i.e. “simple tree”, “ordinary tree”, and “complicated tree”). Two of these chi-square tests of association (simple and complicated tree groups, ordinary and complicated tree groups) were not significant. However, Chi-squares revealed that the type of trees (simple and ordinary trees) was positively associated with participants’ use of “giving explanation” in first messages (chi-square (1, 100)=7.207, p=0.007). This indicates that the “simple” trees were less likely to have specific explanations in first messages than “ordinary” trees.

4.5.2.4 Language functions in first messages related to T-units

Last, relationships between participants’ use of each of the language functions in first messages and T-units were analyzed. Pearson chi-square tests were administrated to examine the relationships between language functions used in first messages and the total number of T-units. A cross tabulation was conducted with T-units. Message trees were collapsed into 3 categories with a median and an upper-quartile split on T-units. This procedure insured the expected frequencies large enough to perform the tests. Thus, “terse trees” were defined as those trees with T-units less than 9, “succinct trees” were trees with T-units between 9 and 13, and “lengthy trees” were trees of IV greater than 13. These data are detailed in table 4.22-4.24.

Table 4.22 Frequency of “asking information” in first messages and T-units

<table>
<thead>
<tr>
<th>“asking information”</th>
<th>Terse tree</th>
<th>Succinct tree</th>
<th>Lengthy tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>42</td>
<td>28</td>
<td>20</td>
</tr>
<tr>
<td>yes</td>
<td>21</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

Chi-square (2, 134)=0.702, p=0.704.
Table 4.23  Frequency of “giving explanation” in first messages and T-units

<table>
<thead>
<tr>
<th>“giving explanation”</th>
<th>Terse tree</th>
<th>Succinct tree</th>
<th>Lengthy tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>60</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>yes</td>
<td>3</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Chi-square (2, 134) = 10.475*, p=0.005.
*Significant at the .05 level

Table 4.24  Frequency of “presenting opinion” in first messages and T-units

<table>
<thead>
<tr>
<th>“presenting opinion”</th>
<th>Terse tree</th>
<th>Succinct tree</th>
<th>Lengthy tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>48</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>yes</td>
<td>15</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

Chi-square (2, 134) = 1.78, p=0.411

Pearson chi-square was used with an alpha of 0.05. Two of the three chi-square tests of association that examined whether use of different language functions (i.e. “asking information”, “presenting opinion”) in first messages was associated with tree IV were not significant. The chi-square tests shown in table 4.23 indicated a significant result on “giving explanation”. To examine how different tree groups are associated with one another, post hoc correlations were made. Each of these pair-wise correlations was conducted via a 2x2 chi-square test. A total of three such 2x2 chi-square tests were conducted among the three tree types (i.e. “terse tree”, “succinct tree”, and “lengthy tree”). The chi-square test of association that examined whether different tree types (terse and lengthy trees) was associated with “giving explanation” in first messages was not significant. However, chi-squares revealed that for “terse” and “succinct” trees (chi-square (1, 102)=6.211, p=0.013), and for “terse” and “lengthy” trees (chi-square (1, 95)=10.496, p=0.01), the type of trees was positively associated with participants’ use of “giving explanation” in first messages. This indicates that both “succinct”
and "lengthy" trees were more likely to have specific explanations in first messages than "terse" trees.

To summarize, when using Pearson chi-square to examine relationships between language functions used in first messages and interactivity, a total of twelve tests were conducted. Among these twelve tests, nine tests were not statistically significant. However, there were significant relationships for three tests—those between 'giving explanation' in first messages and tree level, between 'giving explanation' in first messages and tree IV, and between 'giving explanation' in first messages and T-units. To gain insights of these relationships, nine post hoc tests were also administrated. Among these nine post hoc tests, five tests were not statistically significant. Nonetheless, there were significant relationships for four tests — those between 'giving explanation' in first messages and tree level in "stunt" and "short" tree groups, between 'giving explanation' in first messages and tree IV in "simple" and "ordinary" tree groups, and between 'giving explanation' in first messages and T-units in "terse"/"succinct" groups and "terse"/"lengthy" groups.

Comparing these four measures of interaction in relation to participants' use of language functions in first messages, some interesting patterns appear. Apparently, participants' use of 'giving explanation' in first messages is positively correlated to the last three measures of interaction (i.e. level, IV, and T-units of a message tree) but is not related to the first measure (i.e. tree size). This suggests that the more explanations were expressed in first messages, the more likely the message trees were taller, had a higher IV, and lengthier, but the tree size was not changed accordingly.
4.5.3 Scaffold consideration

The next issue being explored was whether different patterns shown in participants' use of language functions in relation to their interaction when scaffolds were used. In this section, scaffolds are taken into consideration and analyses of relationships between language functions used in messages and interaction are reported. These analyses are broken down into message trees containing scaffolds and message trees without scaffolds. For the remaining chapters, a scaffold tree refers to a tree containing at least one message using scaffolds, while a non-scaffold tree denotes a tree without using a scaffold. The section is divided into two parts. In section 4.5.3.1, results of analysis dealing with scaffold trees are reported, whereas explorations dealing with non-scaffold trees are detailed in second section 4.5.3.2.

4.5.3.1 Message trees with scaffold

In the following, relationships between the language functions used in scaffold trees and the first three measures of interaction are examined. Kendall rank order correlation coefficients were computed between language functions and interaction in terms of size, level, and IV score for scaffold trees.

Table 4.25  Rank-order correlations between language functions and size for scaffold trees

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>46</td>
<td>.254</td>
<td>.088</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>46</td>
<td>.071</td>
<td>.639</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>46</td>
<td>-.176</td>
<td>.243</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>46</td>
<td>-.138</td>
<td>.360</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>46</td>
<td>.232</td>
<td>.120</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

Kendall rank correlation coefficients (tau) between language functions associated with messages and tree size ranged from -0.176 to 0.232 for the different language functions. None of the five language functions showed statistically significant relationship with regard to size (see Table 4.25).
Table 4.26  Rank-order correlations between language functions and level for scaffold trees

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>46</td>
<td>.344</td>
<td>.019</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>46</td>
<td>.209</td>
<td>.163</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>46</td>
<td>-.148</td>
<td>.325</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>46</td>
<td>.122</td>
<td>.418</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>46</td>
<td>-.055</td>
<td>.121</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

Table 4.26 gives the results of statistical analyses of correlations between language functions used and tree level for scaffold trees. For scaffold trees, Kendall rank correlation coefficients (tau) between language functions and tree size ranged from -0.148 to 0.344 for the five different language functions. None of the five language functions showed statistically significant correlations with size (see Table 4.26).

Table 4.27  Rank-order correlations between language functions and IV for scaffold trees

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>46</td>
<td>-.287</td>
<td>.053</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>46</td>
<td>.084</td>
<td>.579</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>46</td>
<td>-.172</td>
<td>.253</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>46</td>
<td>-.167</td>
<td>.267</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>46</td>
<td>.147</td>
<td>.329</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

Table 4.27 gives the result of statistical analyses of correlation between language functions and IV scores for scaffold trees. Kendall rank correlation coefficients (tau) between language functions and tree size ranged from -0.287 to 0.147 for the different language functions. None of the five language functions under study showed a statistically significant relationship with IV scores (see Table 4.27).

In the process of coding language functions, it was noted that students were able to correctly use most of the system provided scaffolds, such as “I need to understand”, “New information”, “New learning”, and “Problem”. However, the use of scaffold idea of theory (i.e. ’my theory’ and ‘theory’) showed a rather broad range. There was a total of 72 messages used ‘my theory’. Qualitative analysis of these messages demonstrated that students used a lot of
synonyms of the concept of 'theory'. The majority of these messages were using 'my theory' to represent 'my guess', 'my understanding', 'my answer', 'I think', etc. However, there were also a couple of inappropriate uses of this concept.

To summarize, this section answered the question: “When scaffolding was used in at least one message, is there any relationship between language functions used in messages and interaction?” The statistics results showed that, in general, there was no relationship between participants’ use of language functions in their CMC generated messages and interaction if each message tree contains at least one message using scaffolds.

4.5.3.2 Message trees without scaffolds

Relationships between language functions used in non-scaffold trees and first three measures of interaction are examined in the following. Kendall rank order correlation coefficients were computed between language functions used in messages and interaction in terms of size, level, and IV score of non-scaffold message trees. Because of the lack of variability, no inferential statistics was conducted with respect to language functions used only in first messages.

Table 4.28 provides the statistical analyses of correlations between language functions and size for non-scaffold trees. For non-scaffold trees, Kendall rank correlation coefficients (tau) between the language functions and tree size ranged from -0.111 to 0.288. None of the three language functions ('asking information', 'presenting opinion', and 'making suggestion') showed statistically significant correlations with tree size (see Table 4.28).
Table 4.28  Rank-order correlations between language functions and size for non-scaffold trees.

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>88</td>
<td>-.111</td>
<td>.304</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>88</td>
<td>.288*</td>
<td>.007</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>88</td>
<td>-.000</td>
<td>.998</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>88</td>
<td>.127</td>
<td>.237</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>88</td>
<td>.255</td>
<td>.017</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

However, a significant relationship was discerned at the .01 level. The Kendall correlation coefficient of 0.288 (p=0.007) indicated a significant positive relationship between the use of 'giving explanation' and tree size. The larger the message trees, the more likely participants would provide explanations when scaffolds were not used.

Table 4.29  Rank-order correlations between language functions and level for non-scaffold trees.

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>85</td>
<td>-.049</td>
<td>.649</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>88</td>
<td>.261</td>
<td>.014</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>88</td>
<td>.087</td>
<td>.421</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>88</td>
<td>.042</td>
<td>.695</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>88</td>
<td>.378*</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

Table 4.29 gives the results of statistical analyses of correlation between language functions and tree level of non-scaffold trees. For non-scaffold trees, Kendall rank correlation coefficients (tau) between language functions and tree level ranged from -0.049 to 0.378. Only one significant relationship was discerned at the .01 level. The Kendall correlation coefficient is 0.261 (p=0.014), which is indicative of a significant relationship between using 'giving explanation' and level. For non-scaffold trees, more incidences of 'giving explanation' are associated with taller trees.
Table 4.30  Rank-order correlations between language functions and IV for non-scaffold trees.

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>88</td>
<td>-0.095</td>
<td>.378</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>88</td>
<td>0.296*</td>
<td>.005</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>88</td>
<td>-0.077</td>
<td>.478</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>88</td>
<td>0.173</td>
<td>.108</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>88</td>
<td>0.259</td>
<td>.015</td>
</tr>
</tbody>
</table>

*Significant at the .01 level.

Table 4.30 gives the result of statistical analyses of correlations between language functions and IV score for non-scaffold trees. The Kendall rank correlation coefficients (tau) between language functions and IV scores ranged from -0.049 to 0.378. Only one significant relationship was discerned at the .01 level. A tendency was observed for more 'giving explanation' to be associated with interactivity, as indexed by IV (p(0.296)= 0.005).

To summarize, fifteen tests were conducted to investigate relationships between interaction and language functions associated with CMC messages for non-scaffold trees. Among these fifteen tests, twelve tests showed no statistically significant relationship. Nevertheless, there were significant relationships for three tests — those between 'giving explanation' and size, between 'giving explanation' and IV score, and between 'expressing disbelief' and level.

4.6 Data Addressing Research Question 3

Research Question 3

Are there any changes in frequency patterns in participants’ use of language function in relation to the degree of interaction with adult (including teachers and helping adults) involvement?
The third research question directs attention to the effect of teacher involvement. To answer this third research question, again descriptive and inferential statistics were employed. Originally, correlating language functions and interaction were considered for both student-only message trees and teacher-student message trees. However, considering the small sample size of teacher-student message trees (n=32), correlation studies were conducted only for student message trees.

4.6.1 All message trees

All message trees with size greater than one were lumped into two status groups: student group (student-only message trees) with N equal to 102 and teacher group (teacher-student message trees, teacher group including researchers and scientists) with N equal to 32. For the remaining sections, “status” refers to teachers (including researchers and scientists) or students. Total number of T-units of using each language function in trees was computed for the two groups searching for patterns. These data are presented in figure 4.7.

Comparing teacher-student trees and student trees, probably the most striking finding is the difference shown in the use of ‘making suggestion’. Although the number of student message trees was more than triple the number of teacher-student message trees, the number of using ‘making suggestion’ messages in student-only trees is almost identical to that in teacher-student trees. This suggests that with adult involvement, participants were more likely to make specific suggestions.
Referential statistics were conducted for student-only trees. Correlation coefficients were calculated to further detect relationships. Table 4.3 gives the result of statistical analyses of correlations between language functions and size of student-only message trees.

Table 4.3  Correlation between language functions and student tree size

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>'asking information'</td>
<td>102</td>
<td>.000</td>
<td>.997</td>
</tr>
<tr>
<td>'giving explanation'</td>
<td>102</td>
<td>.314*</td>
<td>.001</td>
</tr>
<tr>
<td>'presenting opinion'</td>
<td>102</td>
<td>.012</td>
<td>.908</td>
</tr>
<tr>
<td>'making suggestion'</td>
<td>102</td>
<td>.063</td>
<td>.527</td>
</tr>
<tr>
<td>'expressing disbelief'</td>
<td>102</td>
<td>.226</td>
<td>.022</td>
</tr>
</tbody>
</table>

*Significant at the .01 level

Kendall rank correlation coefficients (tau) between language functions used in student-only trees and size ranged from 0.000 to 0.314 (see Table 4.3). A significant relationship was found at the .01 level. The Kendall correlation coefficient (tau) between the use of ‘giving explanation’ and size is 0.314 (p=0.001), which is indicative of a significant positive relationship between the two variables. When students interacted with each other and presented more explanations, the message trees tended to be bigger.
Table 4.32  Correlation between language functions and student tree level

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘asking information’</td>
<td>102</td>
<td>-.067</td>
<td>.500</td>
</tr>
<tr>
<td>‘giving explanation’</td>
<td>102</td>
<td>.340*</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>‘presenting opinion’</td>
<td>102</td>
<td>.039</td>
<td>.699</td>
</tr>
<tr>
<td>‘making suggestion’</td>
<td>102</td>
<td>.017</td>
<td>.868</td>
</tr>
<tr>
<td>‘expressing disbelief’</td>
<td>102</td>
<td>.194</td>
<td>.051</td>
</tr>
</tbody>
</table>

*Significant at the .01 level

Data in table 4.32 give the result of statistical analyses of correlations between language functions and level of student-only trees. Kendall rank correlation coefficients (tau) between language functions associated with student-only trees and level ranged from -0.067 to 0.340. None of the four language functions (‘asking information’, ‘presenting opinion’, ‘making suggestion’, and ‘expressing disbelief’) illustrated statistically significant correlations with level (see Table 4.32). However, a significant relationship between ‘giving explanation’ and level was discovered at the .05 level. The Kendall correlation coefficient is 0.340 (p < 0.000), which is indicative of a significant positive relationship between the two variables. When students interacted with each other and presented more explanations, the message trees tended to be taller.

Table 4.33  Correlation between language functions and student trees IV

<table>
<thead>
<tr>
<th>Language function</th>
<th>N</th>
<th>tau</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘asking information’</td>
<td>102</td>
<td>.006</td>
<td>.953</td>
</tr>
<tr>
<td>‘giving explanation’</td>
<td>102</td>
<td>.326*</td>
<td>.001</td>
</tr>
<tr>
<td>‘presenting opinion’</td>
<td>102</td>
<td>.027</td>
<td>.790</td>
</tr>
<tr>
<td>‘making suggestion’</td>
<td>102</td>
<td>.070</td>
<td>.483</td>
</tr>
<tr>
<td>‘expressing disbelief’</td>
<td>102</td>
<td>.213</td>
<td>.031</td>
</tr>
</tbody>
</table>

*Significant at the .01 level

Table 4.33 provides the result of statistical analyses of correlations between language functions and IV score in student-only trees. Kendall rank correlation coefficients (tau) between language functions associated with student messages and IV score ranged from 0.006 to 0.326 for the different language functions. Only one significant relationship was
discovered at the .01 level. The Kendall correlation coefficient of 0.326 (p=0.001) is indicative of a significant positive relationship between ‘giving explanation’ and IV. When students interacted with each other and provided more explanations, message trees had the tendency to have higher IV scores.

To summarize, a total of fifteen correlation coefficients were computed to test relationships between students’ use of language functions and interaction. Twelve of the fifteen coefficients were not significant. Nonetheless, there were significant relationships for three tests – those between ‘giving explanation’ and size, between ‘giving explanation’ and level, and between ‘giving explanation’ and IV.

4.6.2 Scaffolds consideration

Because this study was mainly exploratory, various analyses were conducted to discover patterns. The variables: “teacher” and “scaffold” were both taken into consideration. In other words, patterns of teacher-student scaffold trees and teacher-student non-scaffold trees, as well as patterns of student-only scaffold trees and student-only non-scaffold trees were all explored. Whenever appropriate, descriptive and inferential statistics were employed.

Table 4.34 Frequency distribution for teacher-student scaffold tree

<table>
<thead>
<tr>
<th># of teacher notes with scaffold</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>19</td>
<td>59.4</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>25.0</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.34 provides the distribution of scaffold used in teacher-student message trees. Nearly 60 percent of teacher-student message trees did not use scaffolds. One fourth of teacher-student message trees contained only one scaffold-message. Here, a scaffold-message
refers to a message using scaffolds. Teacher-student message trees rarely had more than two scaffold-messages.

Table 4.35  Frequency distribution for student trees

<table>
<thead>
<tr>
<th># of student notes with scaffold</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>69</td>
<td>67.6</td>
</tr>
<tr>
<td>1</td>
<td>23</td>
<td>22.5</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>7.8</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>102</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.35 reports the distribution of scaffold use in student-only trees. Over 68 percent of student-only trees did not contain any scaffold-message. Less than 10 percent of message trees had more than one scaffold-message. Comparing student interactions to teacher-student interactions, it appears that teacher-student message trees tended to have slightly more scaffold-messages.

4.6.3 First messages

The relationships between students’ use of language functions in first messages and interaction were examined. To explore patterns, preliminary examinations of frequencies of using different language functions in first messages both in student-only trees and teacher-student trees were administrated. The message trees were divided into two status groups: teacher-student group (n=32) and student group (n=102). Total number of T-units of each language function appeared in first messages was computed and is shown in table 4.36.
Table 4.36  Language functions in first message by status

<table>
<thead>
<tr>
<th></th>
<th>AI</th>
<th>GE</th>
<th>PO</th>
<th>MS</th>
<th>ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>10</td>
<td>5</td>
<td>21</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Student</td>
<td>55</td>
<td>32</td>
<td>25</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>


For teacher-student group, ‘presenting opinion’ is the language function that has the highest frequency. Among the five language functions studied, whenever teachers involved in a discussion, ‘presenting opinion’ is the language function that appeared most often in first messages. For student trees, ‘asking information’ is the language function that appeared most frequently. This shows that students were asking a lot of questions in first messages.

Next, chi-square tests were conducted to test relationships between language functions appeared in first messages of student trees and degree of interaction. Same as the statistical procedure used for first messages in all message trees as described in section 4.5.2, both variables: ‘language function’ and ‘degree of interaction’ were collapsed into categories and chi-square tests were conducted to examine relationships. Each of the five language functions was lumped into the two categories as delineated in section 4.5.2 (essentially “yes” and “no” group). Since the variables “making suggestion” and “expressing disbelief” in first messages did not show enough variances to make any inferential statistics, chi-square tests were not conducted for these two variables.

4.6.3.1 Language functions in first messages related to size

Relationships between students’ use of language functions in first messages and tree size were analyzed using chi-square tests. Because of a lack of variability, tree size was broken down into two categories, essentially making a binomial variable: those trees with size 3 or less
(small) versus those trees with size 4 and up (large). This procedure is used to reduce the number of low size cells. These data are detailed in table 4.37-4.39.

Table 4.37  Frequency of “asking information” in first messages and student tree size

<table>
<thead>
<tr>
<th>Use “asking information”</th>
<th>Small tree</th>
<th>Large tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>43</td>
<td>21</td>
</tr>
<tr>
<td>no</td>
<td>26</td>
<td>12</td>
</tr>
</tbody>
</table>

Chi-square (1,102)=0.017, p=0.898

Table 4.38  Frequency of “giving explanation” in first messages and student tree size

<table>
<thead>
<tr>
<th>Use “giving explanation”</th>
<th>Small tree</th>
<th>Large tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>61</td>
<td>25</td>
</tr>
<tr>
<td>no</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Chi-square (1,102)= 2.70, p=1.00.

Table 4.39  Frequency of “presenting opinion” in first messages and student tree size

<table>
<thead>
<tr>
<th>Use “presenting opinion”</th>
<th>Small tree</th>
<th>Large tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>56</td>
<td>27</td>
</tr>
<tr>
<td>no</td>
<td>13</td>
<td>6</td>
</tr>
</tbody>
</table>

Chi-square (1,102)= 0.006, p=0.936.

Pearson chi-square was used with an alpha of 0.05. Neither of the chi-square tests of association that examined whether use of different language functions (i.e. “asking information”, “giving explanation”, “presenting opinion”) in first messages was associated with tree size was significant.
4.6.3.2 Language functions in first messages related to level

Relationships between students' use of language functions in first messages and tree level were analyzed using chi-square tests. Because of a lack of variability, tree level was broken down into two categories, essentially making a binomial variable: those trees with level 3 or less (short) versus those trees with level 4 and up (tall). This procedure is used to reduce the number of low size cells. These data are detailed in table 4.40-4.42.

Table 4.40 Frequency of "asking information" in first messages and level of student trees

<table>
<thead>
<tr>
<th>Use “asking information”</th>
<th>Short tree</th>
<th>Tall tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>51</td>
<td>13</td>
</tr>
<tr>
<td>no</td>
<td>31</td>
<td>7</td>
</tr>
</tbody>
</table>

Chi-square (1,102)=0.054, p=0.816

Table 4.41 Frequency of "giving explanation" in first messages and level of student trees

<table>
<thead>
<tr>
<th>Use “giving explanation”</th>
<th>Short tree</th>
<th>Tall tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>71</td>
<td>15</td>
</tr>
<tr>
<td>no</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>

Chi-square (1,102)=1.632, p=0.201.

Table 4.42 Frequency of "presenting opinion" in first messages and level of student trees

<table>
<thead>
<tr>
<th>Use “presenting opinion”</th>
<th>Short tree</th>
<th>Tall tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>67</td>
<td>16</td>
</tr>
<tr>
<td>no</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

Chi-square (1,102)=0.031, p=0.860.

Pearson chi-square was used with an alpha of 0.05. Neither of the chi-square tests of association that examined whether use of different language functions (i.e. "asking
information”, “giving explanation”, “presenting opinion”) in first messages was associated with student tree level was significant.

4.6.3.3 Language functions in first messages related to IV

Relationships between students’ use of language functions in first messages and tree IV were analyzed using chi-square tests. Because of a lack of variability, IV was broken down into two categories, essentially making a binomial variable: those trees with IV 14 or less (simple) versus those trees with IV greater than 14 (complicated). This procedure is used to reduce the number of low size cells. These data are detailed in table 4.43-4.45.

Table 4.43  Frequency of “asking information” in first messages and IV of student trees

<table>
<thead>
<tr>
<th>Use “asking information”</th>
<th>Simple tree</th>
<th>Complicated tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>45</td>
<td>19</td>
</tr>
<tr>
<td>yes</td>
<td>26</td>
<td>12</td>
</tr>
</tbody>
</table>

Chi-square (1.102)=0.054. p=0.816

Table 4.44  Frequency of “giving explanation” in first messages and IV of student trees

<table>
<thead>
<tr>
<th>Use “giving explanation”</th>
<th>Simple tree</th>
<th>Complicated tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>64</td>
<td>22</td>
</tr>
<tr>
<td>yes</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Chi-square (1.102)= 5.998*, p=0.014.
* Significant at the 0.05 level.
Table 4.45  Frequency of “presenting opinion” in first messages and IV of message tree

<table>
<thead>
<tr>
<th>Use “presenting opinion”</th>
<th>Simple tree</th>
<th>Complicated tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>57</td>
<td>26</td>
</tr>
<tr>
<td>yes</td>
<td>14</td>
<td>5</td>
</tr>
</tbody>
</table>

Chi-square (1,102)= 0.183, p=0.668.

Pearson chi-square was used with an alpha of 0.05. Two of the three chi-square tests of association that examined whether use of different language functions (i.e. “asking information”, “presenting opinion”) in first messages was associated with student tree IV were significant. However, chi-square results showed in Table 4.44 revealed that the type of trees (simple and complicated trees) was positively associated with participants’ use of “giving explanation” in first messages (chi-square (1, 102)=5.998, p=0.014). This suggests that in complicated trees, students tended to give specific explanation in first messages.

In summary, a total of nine chi-squares were computed, accompanied by an equal number of significance tests for the examination of relationships between language functions used in first messages and degree of interaction for student trees. Among the nine tests, eight tests were not statistically significant. However, there was significant relationship between ‘giving explanation’ and IV.

4.7 Summary

This chapter has presented the data analyses for this research. Of the 716 messages collected, a total of 188 message trees were analyzed. Four measures (size, level, Interactivity Value, and total number of T-units) of interactivity were used to explore the relationships between participants’ communication pattern and interaction in CMC settings. In addition, the
extent of participants’ interaction using CMC was examined. The next chapter provides a summary of findings from this research and a discussion of the findings. Recommendations for future research are made and final thoughts about the study are also described.
CHAPTER V: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This study is intended to contribute to knowledge in the area of collaborative learning in the context of computer-mediated communication (CMC). Because collaboration is not operationally defined, and because interaction is the major learning factor in collaborative learning (O’Donnel & Dansereau, 1992), in the present study, therefore, collaborative learning was explored in terms of students’ interaction in their learning process. That is, in this study, interaction – not a synonym but a major indicator of collaboration – was measured and explored. The primary purpose of this study is to examine relationships between language functions associated with the messages generated in the context of CMC and participants’ interaction. Again, language function is defined as “ways we can use language to achieve a communicative purpose” (Olsen, 1992). The secondary purpose is to learn the extent that participants interact in the context of CMC. The third purpose is to explore the use of language functions in relation to teacher-student interactions.

This final chapter presents a summary of the current study, comparing the present results to those of earlier researchers. The conclusions, recommendations to interested parties, and suggestions for further research resulting from this study are also presented. In section 5.2, basic points of this study are reviewed. Section 5.3 provides a summary of the study. In section 5.4 and 5.5, results of the data analyses of the study are addressed using the IV in conjunction with the other three measures of interaction, namely, the size, level, and total number of T-units of a message tree.
5.2 Review of Basic Points

This study first investigated to what extent participants collaborate in a classroom using CMC. It also examined patterns of participants’ use of language functions in mathematics and science learning in relation to their interaction. It then explored changes of frequency patterns of language functions in relation to interaction with adult involvement in the context of CMC. Data were gathered from a fifth- and sixth-grade classroom in an inner city elementary school in Toronto. The Knowledge Forum Knowledge Building Community Project team at the OISE of University of Toronto supplied the data for the study.

Of the 716 messages collected, 506 messages, which were considered as being dialogical, were chosen to analyze. These non-dialogical messages constituted notes merely “quotation” or “rise-above” without offering any comments. The 506 analyzed messages generated a total of 188 message trees. These 188 message trees constituted the sample of this study.

Four measures of degree of interaction were defined and employed. The size, level, interactivity value (IV), and total number of T-units of a message tree each constituted “interaction” for this study. Both descriptive and correlational statistics were performed to reveal patterns of participants’ use of language functions in relation to their interaction in the context of CMC. To obtain the extent of participants’ interaction, the four measures of interaction defined in this study were also analyzed.

Several terms were used frequently in this study and are reviewed here to help set the context. One of these terms is the “message tree”. A message tree is characterized as a group of messages that interact with one another. The size of a message tree is the number of interactive messages in the tree. A message tree with a greater size value than other trees is
interpreted as a "bigger" or "larger" tree. Depending upon the position of a message in a tree, the message was assigned a generation value. The level of a message tree was defined as the highest message generation value. A "taller" tree referred to a tree with a greater level value than other trees.

5.3 Summary of the Study

This study adds to the literature base in the following ways:

- Development of an informal measure of degree of interaction;
- Determination of the extent that participants interact in the context of CMC;
- Examination of patterns of participants' interaction in relation to the use of language functions; and
- Exploration of patterns of teacher/student interaction in relation to the use of language function.

Numerous studies have been conducted to explore collaboration and interaction. In CMC environments, researchers have investigated ways of identifying interactive messages (Henri, 1995). Studies also measured participation in terms of number of messages generated, time spent on task, and length of messages. However, according to Henri (1995), to measure participation is not to measure interaction. In addition, few, if any, studies have developed instrument directly assessing degree of interaction which takes both "reading" and "writing" acts into consideration. Since both "reading" and "writing" acts are essential factors of interaction in the context of CMC, it is important for the measures of interaction to incorporate these two factors. Therefore, in this study, one of the measures—namely the "interactivity value" (IV)—is developed to quantify interaction in CMC settings. Again, "Interactivity Value" is defined as a function of the number of interactions that occurred and the depth of these interactions
considering both ‘reading act’ and ‘writing act’ to be interactions. Chapter three provides the detailed description of this measure.

In this study, the IV appears to be a useful measure of degree of interaction. It goes beyond the number of messages participants generate, how much they write, or even how many layers the correspondence includes. Collaboration is a very complicated process. As Internet becomes more entrenched in our society, people read, write, and interact/collaborate more and more using CMC. IV scores provide a different measure of this interaction from merely amount of time participants spent on computers or number of messages generated. Taken as a whole, the four measures (i.e. size, level, T-units, and IV) provide a more complete picture of interaction in CMC settings.

Rarely have any recent studies of collaborative learning using CMC used any measure of degree of interaction. Due to the lack of description, it has been difficult to interpret the findings of these studies, and to describe the nature of collaboration in CMC setting. The absence of an adequate measure of degree of interaction can be viewed as a primary cause in the prevention of educational researchers of more fully portraying collaborative learning processes. With the development of the Interactivity Value in conjunction with other indexes such as size, level of message trees, it is hoped that researchers can begin to better understand and describe the nature of interaction in classrooms using CMC. This, in turn, may strengthen the studies that examine the effectiveness of CMC.

5.4 Conclusions

Several conclusions are highlighted by the results of the present study. This section provides conclusions drawn from the analysis of data in line with the research questions posed in chapter 1. Whenever appropriate, the use of IV along with other measures of interaction are presented. Particularly, the results related to message trees in general, is followed by a description of the effects of scaffolds, and finally, the conclusions that refer to teacher-student
interaction. Taken together these sections provide a summary of the conclusions drawn from the study.

5.4.1 Message trees in general

The first task of the study was to examine the extent of collaboration (in terms of interactivity) in the classroom that uses CMC. The conclusion was that in this study, participants (including teachers, students, researchers and scientists) were actively participating in collaborative learning in the context of CMC. Nonetheless, most of the message trees analyzed contain only two to three messages and appear to be very short (with 2 levels only). This indicates that degrees of participants' interaction are relatively low in this computer-mediated environment.

The primary goal of the study, which was the second task of the data analysis, was to identify frequency patterns of participants' use of language functions in relation to their interaction in an elementary classroom that uses CMC. Out of five language functions examined, three language functions used by participants in the context of CMC showed no relationship with participants' interaction. However, significant relationships were evident in participants' use of 'giving explanation' and all measures of interaction. This could be because providing more explanations cause the message trees to flourish and be more intricate. Another possibility is that taller and more intricate trees may have proportionally more explanations than short and smaller trees, because this maybe the natural way discussions evolve. Participants generally do not start discussions with explanations; they are more likely to start with questions, and explanations tend to appear one or two messages later. However, the analysis of first messages also indicates that when tree size is bigger than 2, the total number of explanation given in first messages increased drastically. Even though no affirmative conclusion can be drawn from these results, it is reasonable to argue that 'giving explanation' may have positive effects on interaction, and this in turn, may impact collaboration. Similarly, significant relationships also exist between participants' use of 'expressing disbelief' and their
interaction (size, level, and IV). Participants' expressing disbelief is positively associated with their interaction. However, the fourth measure of degree of interaction -- total number of T-units is not associated with the use of "expressing disbelief". That is, although the total number of utterances might remain relatively constant, the more frequently disbelief is expressed, the more likely participants will read, respond, and exchange ideas.

Patterns identified from the previous experiences in face-to-face discourses indicate that the initiative talk often largely affects the development of whole conversation. Thinking that initiative talk might be similar in the context of CMC, the relationships between the language functions used in first messages and measures of interaction were also explored. Generally speaking, most of the language functions analyzed in first messages do not relate to size, level, interactivity value, or total number of T-units of message trees. Nonetheless, 'giving explanation' appeared in first messages is positively related to level, interactivity value, and the total number of T-units of message trees. In other words, 'giving explanation's at the beginning of discussions set the stage for a relatively taller and more intricate tree.

Since learning is a social, therefore communicative activity, flourish message trees seem to suggest more collaboration and interaction. The implication of these conclusions is that when we teach young students in CMC settings, we need to encourage them to give more explanations since it seems to help the message tree flourish.

5.4.2 Use of scaffold

To help young students learn mathematics and science, the Knowledge Forum Knowledge Building Community Project team designed the software that specifically incorporated various scaffolds. This design is intended to promote student collaborative knowledge building (Scardamalia & Bereiter, 1999). It also affords students' engagement in hypothesis-testing activities in mathematics and science disciplines. Essentially, hypothesis testing is an important technique that mathematicians and scientists use continuously to
advance our knowledge. To test whether the use of scaffolds affects relationships between the use of language functions and interaction, analyses were then broken down to two parts: those message trees with at least one message using scaffolds (scaffold trees), and those message trees without using scaffolds (non-scaffold trees). Again, scaffolds refer to a built-in software structure include both the “scaffold (i.e. “theory building”, etc) and the “thinking type labels” (i.e. “my theory”, “I need to understand”, “new learning”, etc.), designed to enhance student collaborative learning.

For non-scaffold message trees, the relationship between the language functions employed and collaboration is consistent with results of the analysis of all message trees (i.e. both scaffold trees and non-scaffold trees). That is, when explanations and/or disbeliefs are presented more in messages, the message trees tend to become bigger, taller, and more intricate. In other words, when scaffolds were not used, presenting more explanation and/or disbelief tend to engage more respondents in terms of breadth and depth. Nevertheless, size, level, or Interactivity Value of the message trees is not related to the other three language functions, i.e. the use of ‘asking information’, ‘presenting opinion’, and ‘making suggestion’.

For scaffold message trees, the analysis result is different. The five language functions analyzed demonstrated no relationship with interaction. It should be noted that only forty-six message trees in this study contained scaffolds; thus, this finding must be interpreted with caution.

5.4.3 Teacher-student interaction

The patterns of teacher-student use of language functions in relation to their interaction were examined. The data set was broken into two sets: student only message trees and message trees containing teacher-contributed messages. The message trees containing only student
messages will be referred to as student message trees, while message trees containing teacher-generated messages will be noted as teacher message trees unless otherwise stated. The majority of the message trees were student-message trees. This demonstrates that in this elementary classroom, students were actively engaged in discussion and interactions. This is in contradiction to the research results in face-to-face settings that indicate the teachers’ dominant role in class discussion and conversation. As indicated by Cazden (1986), knowledge related communication in schools almost unavoidably dominated by the teacher, who acts as the communication center. The results of this study suggest that these elementary students were more actively involved in their collaborative learning in this classroom uses CMC.

One interesting finding is that with adult involvement, participants are more likely than students alone to make suggestions. When scrutinizing the pattern of the use of language functions in first messages, it appears that students’ strategy was to ask a lot of information, while with teachers’ and helping adults’ engagement, participants used ‘presenting opinion’ most frequently. This is not surprising since students are learners and they naturally have more questions; whereas teachers and helping adults tend to direct and train their students. therefore when teachers and helping adults are participated, participants are more likely to present opinions. This finding is consistent with the research result of Harris and Jones (2000). Their result shows when students interact without the participation of their teachers and helping adults, they used language functions differently than they did when they generate messages with their teachers and helping adults.

Comparing the students to all participants (including students, teachers, and helping adults), the patterns of their use of language functions in relation to interaction are similar. Once again, providing explanations in messages (including the first messages) tends to encourage students to read, write, and correspond in an iterative fashion. In addition, the more disbelief expressed in the messages, the more likely the students will read and respond to the messages.
5.5 Discussion

This discussion is based upon the review of literature and the analyses of the data. There were a number of interesting findings in this study of computer-mediated communication. First, with 716 messages, it is reasonable to argue that students were actively involved in collaborative learning using CMC. This conclusion concurs with research by Bonk et al (1998) and Tao & Reinking (1996), and points to a trend that learning using CMC tend to have rich student participation and dialogue. This result also in agreement with the conclusion of Piburn and Middleton’s (1998) study that students, more than teachers, tended to initiating conversations in CMC environments as opposed to face-to-face settings. It is, however, in contrast with Aviv and Golan’s (1998) research results, which indicated passive learners’ participation using CMC.

Previous research suggests that CMC fosters a collaborative approach to learning (Anderson, 1994; Burge, 1994; Waggoner, 1992). This is consistent with the results of the current study. It indicates that, in this elementary classroom using CMC, interactions within the student group and between teachers (including other helping adults) and students occurred. It concurs with the research conclusion (Ahern & El-Hindi, 2000; Bonk et al, 1998) that “diverse educational stakeholders” (Bonk et al, 1998) -- students, teachers, scientist, researchers -- were all involved in collaborative learning and communicating with each other through CMC. However, the data analyses of this study also show that, in this classroom, interaction often occurred in a less iterative fashion.

Similar to previous research results (Bonk et al. 1998), teachers’ (helping adults’ including scientists’ and researchers’) direct instruction was drastically decreased in classrooms using CMC. Contrary to general teacher-student interaction patterns identified in traditional face-to-face settings where teachers dominate classroom discussion, peer interactions constituted a high percent of the interactions in this classroom using CMC. According to Harel (1992), “teacher talks little” is a major characteristic indication of collaborative learning.
Therefore, the results of this study illustrate that students were engaged in collaborative learning in this elementary classroom using CMC. This is enticing as it suggests educational merits of CMC—the medium provides an environment for student collaboration and authentic learning. These, in turn, promote student knowledge acquisition and construction. However, this result is in contradiction to Rueda (1992) and Harris & Jones’ (2000) finding that adults dominated communication and teachers wrote more, asked more questions than students did in CMC settings.

With respect to relationship between the use of language functions in messages and participant’s interaction, the result is somewhat mixed. First, similar to previous research (Olsen, 1992) conducted in traditional face-to-face settings, two language functions—‘giving explanation’ and ‘expressing disbelief’—are used in messages that were positively associated with interaction. This implies that in the CMC environment, participants’ use of some language functions such as ‘giving explanation’ and ‘expressing disbelief’ is associated with collaborative learning.

Secondly, out of five language functions analyzed, two language functions (i.e. ‘asking information’ and ‘presenting opinion’) did not demonstrate any relationship with interaction. These results do not support the conclusions of prior studies suggesting that the use of these language functions promotes collaborative learning (Coelho, 1992). The explanation for this difference is difficult to determine. Maybe the fact that using computer-mediated communication is different than ordinary face-to-face communication provides a partial explanation. No definite conclusions can be draw from this study that the use of these language functions in CMC settings no longer supports collaborative learning. However, to a certain extent, this result may illustrate participants’ different communication patterns in relation to their collaborative learning in this new learning environment.

Thirdly, a new area was explored in this study. No previous research explored the affects of initial talk in relation to collaborative learning. Some intriguing patterns are revealed in this study. It is found that ‘giving explanation’ appearing in the first messages is related to
participants' interaction. In relatively short (i.e. level-2 and 3) and simple trees (i.e. ‘simple’ and ‘ordinary’) trees, initiating an exchange with ‘giving explanation’ has positive affects on interaction. It is interesting that this significant relationship did not show with taller trees (i.e. level-4 and up trees). Due to the nature of data set, it is impossible to provide insights of this phenomenon.

Fourth, the use of scaffolds revealed some interesting patterns. Teachers tend to use scaffolds more often than their students do. This supports earlier research done by Bonk et al (1998): “while some authoritative instructor dialogue was noted, teachers most often electronically scaffolded or apprenticed student learning without giving away answers.” This may be due to the fact that these teachers and helping adults had a more profound understanding of the rationale behind the design of this feature. Further research on this issue is needed.

Last, the successful use of the measures (particularly the Interactivity Value) of interaction in this study proved that they are valuable measures. Although it was not the primary focus of this study, this study does represent an effort to develop measures of interaction in order to assess collaborative learning. Based on the few related studies, four indexes were proposed as a measure of interaction and were employed for the analyses of this study. The different conclusions drawn from the use of the different indexes of interaction confirmed that each of these distinct indexes provides a valuable means of quantifying interaction which “lead to a evaluation of the level of collaborative learning” (Henri, 1992). The IV results are comparable to those from the ‘size’ and ‘level’ measures. This suggests that the IV developed in this study has promise. However, further investigations are needed to test the validity and reliability of the IV measure.

5.6 Limitations and Suggestions for Further Research

The results of this study have shed lights on student collaborative learning in the context of CMC. In addition, the study has provided information about the relationship between
participants' communication using CMC and their interaction. However, there are also limitations. First, the data set contains only a small amount of large message trees. This limits the data analyses. Secondly, because of the uniqueness of the setting (private school and the highly committed instructor), the generalization of the conclusions to regular CMC classrooms should be conducted with caution.

This work also suggests a variety of additional questions, which require further research. In spite of the interesting and inspiring findings, there are, nevertheless, a number of concerns. First of all, as the majority of the message trees under study are fairly small trees, this may indicate that students in this elementary classroom generally lack of continuing effort of investigation in their responding. Since CMC is "one of the most appropriate online environments for learning collaborations" (Harasim, 1990), it will be helpful to find out how to promote students' in-depth collaboration in CMC. More research is needed in this area.

The focus of this study is specifically on relationships between participants' use of language functions and their collaborative learning in CMC settings. Although two language functions have shown some relationship with interaction, more language functions under study ('asking information', 'presenting opinion', 'making suggestion') do not indicate any relationship with interaction as opposed to the general research results dealing with collaboration and communication in traditional face-to-face settings. Future research is needed to ascertain whether the findings of the present study can be replicated in other samples.

Important and interesting patterns emerged for the analyses of effects of variations in initial discourses. As detailed in previous sections, use of 'giving explanation' in first messages has some positive associations with interaction. But this relationship did not show in large trees. It is possible that some kind of evolution of conversation is emergent. Further investigation of the language patterns in this tall tree group may offer strategies to promote interaction and thus enhance collaboration.

Another interesting finding is that the pattern of student only and teacher-student interaction was similar in the use of language functions and interaction. Constrained by the
size of the database, no affirmative conclusion can be drawn with respect to the pattern of teacher-student interaction. A research study, which has larger sample size in teacher-student interaction, may broaden the framework of collaborative learning in CMC regarding affective factors. In addition, qualitative studies are needed to analyze the quality and depth of collaborative learning that occurs in the CMC environment.

Finally, although the results of this study presented here support the validity of the IV, it is only through its use in educational research that its value can be judged. Therefore, further examination on the validity of the measures seems warranted. For instance, studies that examine the correlations between IV and the other three measures proposed in this study may provide important insights into the validity and reliability of the measure.

5.7 Final Thoughts and Implications

This study demonstrated that collaborative learning in CMC settings fosters different interaction and communication patterns. Perhaps these findings will help us in the design of educational technologies that nourish better collaborative learning, thereby helping advance the research on computer-mediated communication. It is conceivable that, through this type of research, computer-mediated communication in mathematics and science education will be enhanced when we have better understanding of students’ collaborative learning in the context of CMC.

The most important merit of this educational study lies in the application in educational settings. The current findings suggest that the way we teach social skills for collaborative learning addressing as language functions may promote collaboration in CMC settings. To support elementary students’ collaborative mathematics and science learning in an environment using CMC, we need to encourage them to provide explanations and express disbelief if appropriate.

In the end, I want to echo the statement that further research and development on the application of CMC to teaching and learning is needed (Bonk et al. 1998). We are just starting
to understand how students learn collaboratively using CMC. However, based on these initial works, CMC is likely to soon become used in a myriad of learning activities.
BIBLIOGRAPHY


*Where references are to Internet articles, page numbering is difficult or impossible. Instead I attach paragraph numbers where possible or in some cases the year only.
## APPENDIX 1

Coding rules and gambits for the selected language functions (adapted from Cookson, 1995 & Olsen, 1992)

<table>
<thead>
<tr>
<th>Language Functions</th>
<th>Rules</th>
<th>Gambits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking information (AI)</td>
<td>Elicits facts about the content subject, or procedures being considered with the intent that another should respond. Questions can be answered by &quot;yes&quot; or &quot;no&quot; are included in this category. Statements of requesting explanation, clarification and confirmation should also be coded under this category. Using scaffold &quot;I need to understand&quot; is also coded under this category.</td>
<td>I’d like to know... I’m interested in... Would you tell me...? Do you know...? Could you find out...? What is...? Could/may I ask...? What do you mean...? I need to understand...? Why...? How come...?</td>
</tr>
<tr>
<td>Giving explanation (GE)</td>
<td>Giving reasons to statements or questions about content subjects.</td>
<td>The reason is ... This is because... Because of ... Because For this reason...</td>
</tr>
<tr>
<td>Presenting opinion (PO)</td>
<td>Expression of feeling, or personal opinion or feelings about some topic. Guessing about content subject is also coded in this category. In addition, statement using scaffold &quot;my theory&quot; is coded under this category.</td>
<td>I think that. I’m convinced that Without a doubt I’m positive In my opinion I personally believe In my experience From what I’ve read</td>
</tr>
<tr>
<td>Making suggestions (MS)</td>
<td>Offers alternative ideas/actions, directions and encourages others to explore them, implying autonomy for others.</td>
<td>What don’t you...? Why not...? Perhaps you could... Have you thought about...? Here’s an idea... Let’s... Please do ...</td>
</tr>
</tbody>
</table>
| Expressing disbelief (ED) | Shows rejection, formality, withholds help with regard to the content subject. | I’m afraid…  
I don’t see how…  
But the problem is…  
But don’t forget  
That’s good, but  
I doubt  
What bothers me is |
Coding rules of T-units and language functions

The basic unit for coding language functions is the T-unit, which is defined as "one main clause plus whatever subordinate clauses happen to be attached or embedded within it" (Crookes, 1990). A clause is defined as "one subject or one set of coordinate subjects with one finite verb or one finite set of coordinated verbs." (Crookes, 1990) Thus "I went home" is one clause, and so is "Jim and I went home and rode our bikes" (Hunt, 1966, p.735). A phrase containing no verb but representing complete meanings is also coded as one T-unit. For example, "No way!" is one T-unit.

For this study, following conjunction words are considered to adjunct subordinate clauses:

"after, before, as, while, since, until, till although, though, if, even if, lest, unless, than, because, that, whether, so that, as soon as, as long as, in order that, as if, as though, suppose (that), provided that, in case that, on condition (that), now that, seeing (that), so...that, as...as, so...as"

Following conjunction words are considered to adjunct non-subordinate (or parallel) clauses:

"so, nor, therefore, yet, however, nevertheless, for, hence, as well as, both...and... only only... but also... or... neither... nor... then..., anyhow, consequently, therefore, besides, moreover, also, too, still, then, thus, nonetheless"

T-units are separated by "//" and whenever applicable followed by brackets indicating the language functions. Thus "my theory is that clouds freeze and start to crumble and fall // [PO] that[sic] why when you touch snow flakes they vanish// [GE]" means that there are 2 T-units in this one sentence. The first T-unit is PO and the second GE.

It is found from pilot studies that it is highly possible that a T-unit can be coded for more than one language functions. For the purpose of this study, a T-unit can only be coded at most one the five language functions. The ascendant order of the five language functions is: Asking information, Giving explanation, Presenting opinion, Making suggestions, Expressing disbelief. That is, whenever possible, a T-unit should be coded as the language function that has the highest priority. For example, if a T-unit can be coded as both "expressing disbelief" and "making suggestion", it is only coded as "expressing disbelief".

If a T-unit does not fall into any of the five language functions, it will not be coded as any language function under current study. For instance, the T-unit "I did all the changes" is not coded as any language functions.

Following are the abbreviations for the five language functions:

APPENDIX 2

<table>
<thead>
<tr>
<th>Language Function</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking information</td>
<td>PO</td>
</tr>
<tr>
<td>Giving explanation</td>
<td>GE</td>
</tr>
<tr>
<td>Presenting opinion</td>
<td>PR</td>
</tr>
<tr>
<td>Making suggestions</td>
<td>MS</td>
</tr>
<tr>
<td>Expressing disbelief</td>
<td>EB</td>
</tr>
</tbody>
</table>
Asking information == AI
Giving explanation == GE
Presenting opinion == PO
Making suggestions == MS
Expressing disbelief == ED
## APPENDIX 3

Samples of coded message trees

(KF=Knowledge Forum)

### Example 1

<table>
<thead>
<tr>
<th>TEXT</th>
<th>CODING</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dividing Fractions</strong> (Note #1799) &lt;br&gt; Author: M &lt;br&gt; I need to understand how to divide fractions ///[AI].</td>
<td><strong>Generation</strong> -----1  &lt;br&gt; <strong>Interactivity rank</strong>: I=2</td>
<td>This message is the 1st message of the message tree.  &lt;br&gt; <strong>Language functions:</strong>  &lt;br&gt; Asking information -----1  &lt;br&gt; Giving explanation  &lt;br&gt; Presenting opinion  &lt;br&gt; Making suggestions  &lt;br&gt; Expressing disbelief  &lt;br&gt; <strong>T-unit</strong> ---------------1</td>
</tr>
</tbody>
</table>

| **dividing fractions** (Note #1815) <br> Author: MA  <br> “M” this is how I believe you divide fractions ///[PO] 2*3/4= First you have to reverse the fraction like this 4/3 // then you take the whole number and times it by the new fraction 2 times 4/3=8/3 // but three can go into 8 two times // so it goes from 8/3 to 2 2/3 /// | **Generation** -----2  <br> **Interactivity rank**: I = 4 | This message clearly responds to the 1st one (i.e. #1799).  <br> **Language functions:**  <br> Asking information  <br> Giving explanation  <br> Presenting opinion -----1  <br> Making suggestions  <br> Expressing disbelief  <br> **T-units** -------5 |
Example 2

<table>
<thead>
<tr>
<th>TEXT</th>
<th>CODING</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>who? (Note #118)</td>
<td>Generation ---- 1</td>
<td>This message is the 1st message of the message tree.</td>
</tr>
<tr>
<td>Author: D</td>
<td>Interactivity rank: 1=2</td>
<td></td>
</tr>
<tr>
<td>Who invented the 747 jet? // [AI]</td>
<td>Language functions:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asking information---- 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Presenting opinion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expressing disbelief</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-unit----------------- 1</td>
<td></td>
</tr>
<tr>
<td>dividing fractions (Note #1815)</td>
<td>Generation ---- 2</td>
<td>This message clearly responds to the 1st one.</td>
</tr>
<tr>
<td>Author: B</td>
<td>Interactivity rank: 1=4</td>
<td></td>
</tr>
<tr>
<td>My theory</td>
<td>Language functions:</td>
<td>&quot;My theory&quot; is a standard beginning of a sentence in KF.</td>
</tr>
<tr>
<td>I'm almost sure it's Boeing. // [PO]</td>
<td>Asking information</td>
<td>The sentence serves as PO.</td>
</tr>
<tr>
<td></td>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Presenting opinion---- 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expressing disbelief</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-unit----------------- 1</td>
<td></td>
</tr>
</tbody>
</table>

Example 3:

```
#1719H
  #1745M
  #1874H
```
<table>
<thead>
<tr>
<th>TEXT</th>
<th>CODING</th>
<th>OBSERVATION</th>
</tr>
</thead>
</table>
| **Wing Shape** (Note #1719)  
Author: H  
Considering the fact that for lift air must go under the wing, would a wing like this fly?//[AI]  

| Generation ----1  
Interactivity rank: I=2  
|  
| Language functions:  
Asking information----1  
Giving explanation  
Presenting opinion  
Making suggestions  
Expressing disbelief  
T-unit-------------1  

This message is the 1st message of the message tree by "H". |
| **No** (Note #1745)  
Author: C  
"H" a wing shaped as you said would not fly because it does not have a leading edge or a curved top surface//[GE] there for it is not a wing/.[ED] Does that answer your question?//[AI]  

| Generation ----2  
Interactivity rank: I = 4  
|  
| Language functions:  
Asking information-----1  
Giving explanation-----1  
Presenting opinion  
Making suggestions  
Expressing disbelief-----1  

This message clearly responds to the message #1719 by M. |
| **Simpler** (Note #1874)  
Author: H.  
"C", what you have said is all well and good. //[PO] but I am not an aerodynamics expert.// Could you explain in simpler terms?//[MS]  
"H".  

| Generation ----3  
Interactivity rank: I = 5  
|  
| Language functions:  
Asking information  
Giving explanation  
Presenting opinion----1  
Making suggestions----1  
Expressing disbelief  
T-unit-------------3  

This message is responding message #1745 by "H" again. The author of this note is the same as the one at generation 1. |
| **OBSERVATION**  
This is AI according to the rule.  
"A wing shaped as ...because..." is GE.  
"therefore..." is rejecting the statement made in #1719. Therefore it is coded as a ED  
"Could you explain..." is a MS.  
"what you said..." is PO.  
"...I am not..." is not any of the five language functions. |
Example 4:
Flight

<table>
<thead>
<tr>
<th>TEXT</th>
<th>CODING</th>
<th>OBSERVATION</th>
</tr>
</thead>
</table>
| How do you land? (Note #897) Author: H | Generation ----1  
Interactivity rank:  I=2 | This message is the 1<sup>st</sup> message of the message tree. |
| | Language functions:  
Asking information----2  
Giving explanation  
Presenting opinion  
Making suggestions  
Expressing disbelief | "How do you land…" is AI. |
| | T-unit-------------4 | |
| How do you land in the MS Flight simulator?/[AI] I've tried braking, bringing down the throttle and turning down the altitude.// but I keep skimming over the ground.// What should I do?/[AI] | | |
| landing-FS (Note #939) Author: MA | Generation ----2  
Interactivity rank:  I = 4 | This message clearly responds to the message #897. |
| | Language functions:  
Asking information  
Giving explanation  
Presenting opinion  
Making suggestions------2  
Expressing disbelief | "Maybe you haven't…" is MS. |
<p>| | T-unit-------------2 | |</p>
<table>
<thead>
<tr>
<th>Message</th>
<th>Generation</th>
<th>Interactivity rank</th>
<th>Language functions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;H&quot;; I just got the Flight Simulator for my computer at home.// I haven't mastered landing yet// but I know that Mac had showed me how to land last term // (unfortunately I don't remember how)//. Maybe you could ask him?// [MS] Sorry, I just realized that Mac has responded to your question.//</td>
<td>1 = 4</td>
<td>2</td>
<td>Asking information, Giving explanation, Making suggestions, Expressing disbelief</td>
<td>This message clearly responds to the message #897. &quot;maybe you could ask…&quot; is MS. No other language functions in this message.</td>
</tr>
<tr>
<td>This is also a factor(Note #1499) Author: Howard</td>
<td>1 = 6</td>
<td>3</td>
<td>Asking information, Giving explanation, Presenting opinion, Making suggestions, Expressing disbelief</td>
<td>This message clearly responds to the message #1499 and the author had read #897.</td>
</tr>
</tbody>
</table>
Example 4

<table>
<thead>
<tr>
<th>TEXT</th>
<th>CODING</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decimals vs. fractions</td>
<td>Generation ------1</td>
<td>This message is the 1st message of the message tree.</td>
</tr>
<tr>
<td>(Note #1582)</td>
<td>Interactivity rank: I=2</td>
<td>&quot;Opinion&quot; is another scaffold in KF.</td>
</tr>
<tr>
<td>Author: R</td>
<td></td>
<td>1. I think that...</td>
</tr>
<tr>
<td>Opinion I think that fractions are so</td>
<td>Language functions:</td>
<td>2. ..which is not that hard are PO.</td>
</tr>
<tr>
<td>much easier than decimals. // [PO]</td>
<td>Asking information</td>
<td></td>
</tr>
<tr>
<td>(Remember, this is my opinion/) because</td>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td>for decimals in division, you have to</td>
<td>Presenting opinion---3</td>
<td></td>
</tr>
<tr>
<td>move the decimals and everything which is</td>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td>so annoying to me. // [PO] but in</td>
<td>Expressing disbelief</td>
<td></td>
</tr>
<tr>
<td>fractions you only have to make the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>denominator the same // and you also</td>
<td></td>
<td></td>
</tr>
<tr>
<td>have to make it into simplest[sic] form</td>
<td></td>
<td></td>
</tr>
<tr>
<td>which is not that hard. // [PO]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"because for.... which is so annoying.." is both GE and PO. According to the rules, PO has higher priority than GE, therefore, the 3rd T-unit in this message is coded as PO instead of GE.
<table>
<thead>
<tr>
<th>Decimals all the way</th>
<th>Generation —— 2</th>
<th>This message is a response message the message #1582</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note #1584</td>
<td>Interactivity rank: 1=4</td>
<td>“I feel…” is a PO. It also is an ED. Since ED has higher priority than PO, this T-unit is coded as ED.</td>
</tr>
<tr>
<td>Author: S</td>
<td>Language functions:</td>
<td>“Because although you have to move…round off the answer” is a long sentence. It only has one main clause which is “you just have to …”. Therefore it is coded as one T-unit.</td>
</tr>
<tr>
<td>I feel the opposite way than you.</td>
<td>Asking information</td>
<td>“I feel…” is a PO. It also is an ED. Since ED has higher priority than PO, this T-unit is coded as ED.</td>
</tr>
<tr>
<td>Because although you have to move the decimal in decimals</td>
<td>Giving explanation———1</td>
<td>“Because although you have to move…round off the answer” is a long sentence. It only has one main clause which is “you just have to …”. Therefore it is coded as one T-unit.</td>
</tr>
<tr>
<td>Because for Ex.</td>
<td>Presenting opinion</td>
<td>“Because although you have to move…round off the answer” is a long sentence. It only has one main clause which is “you just have to …”. Therefore it is coded as one T-unit.</td>
</tr>
<tr>
<td>3.9</td>
<td>Making suggestions</td>
<td>“Because although you have to move…round off the answer” is a long sentence. It only has one main clause which is “you just have to …”. Therefore it is coded as one T-unit.</td>
</tr>
<tr>
<td>x 0.4</td>
<td>Expressing disbelief——1</td>
<td>“Because although you have to move…round off the answer” is a long sentence. It only has one main clause which is “you just have to …”. Therefore it is coded as one T-unit.</td>
</tr>
<tr>
<td>without having to think how many spot holders to the left the decimal has to go you just have to round off the answer.</td>
<td>T-unit---------------------</td>
<td>“Because although you have to move…round off the answer” is a long sentence. It only has one main clause which is “you just have to …”. Therefore it is coded as one T-unit.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Go Fractions!</th>
<th>Generation —— 3</th>
<th>This is responding to #1584 and obviously the author had read #1582 message at generation 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note #1794</td>
<td>Interactivity rank: 1=6</td>
<td></td>
</tr>
<tr>
<td>Author: HS</td>
<td>Language functions:</td>
<td></td>
</tr>
<tr>
<td>Opinion</td>
<td>Asking information</td>
<td>“I am with R” indicate a disbelief of the statement made in the previous message #1584. So it is a ED.</td>
</tr>
<tr>
<td>I am with “R”</td>
<td>Giving explanation</td>
<td>“Fractions just seem…” is &quot;presenting opinion&quot;</td>
</tr>
<tr>
<td>Fractions just seem easier.</td>
<td>Presenting opinion———2</td>
<td>“Maybe decimals questions…” is PO.</td>
</tr>
<tr>
<td>//PO “J” said that with fractions it is easier to see your mistake (that is if you made one)\</td>
<td>Making suggestions</td>
<td>“but then…” can both be PO and ED. Again, ED is used because it has higher priority than PO.</td>
</tr>
<tr>
<td>Maybe decimals questions don't take as long to figure out. //PO but then you are more likely to make a mistake.//</td>
<td>Expressing disbelief———2</td>
<td></td>
</tr>
</tbody>
</table>

| T-unit--------------------- | | |

<table>
<thead>
<tr>
<th>Shouldn't there be a better way to do this?</th>
<th>Generation —— 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Note #1583</td>
<td>Interactivity rank: 1=4</td>
<td></td>
</tr>
<tr>
<td>Author: S</td>
<td>Language functions:</td>
<td></td>
</tr>
<tr>
<td>Shouldn't there be a better way to do this?</td>
<td>Asking information</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>Presenting opinion———2</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>Expressing disbelief———2</td>
<td></td>
</tr>
</tbody>
</table>

| T-unit--------------------- | | |
I agree totally (Note #1800)
Author: H.

I'm gonna be the one to say:
I AGREE
TOTALLY!!!/[PO]
Mistakes are sooo easy to
do in decimals!!/[PO] In
fractions, you might have to
work a bit longer. ///[PO]but
it's worth it!!/[PO]

<table>
<thead>
<tr>
<th>Generation</th>
<th>Interactivity rank: I=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language functions:</td>
<td></td>
</tr>
<tr>
<td>Asking information</td>
<td></td>
</tr>
<tr>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td>Presenting opinion-----4</td>
<td></td>
</tr>
<tr>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td>Expressing disbelief</td>
<td></td>
</tr>
<tr>
<td>T-unit-------------4</td>
<td></td>
</tr>
</tbody>
</table>

This is responding to #1794
and the author had read
previous messages in the
thread.

"Mistakes are sooo easy…" is PO

<table>
<thead>
<tr>
<th>Generation</th>
<th>Interactivity rank: I=6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language functions:</td>
<td></td>
</tr>
<tr>
<td>Asking information</td>
<td></td>
</tr>
<tr>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td>Presenting opinion---2</td>
<td></td>
</tr>
<tr>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td>Expressing disbelief----1</td>
<td></td>
</tr>
<tr>
<td>T-unit-------------5</td>
<td></td>
</tr>
</tbody>
</table>

This message clearly
responds to #1584.

“Down with decimals!!!” is
obviously a PO and an ED
since the author responds to
the previous message and
expresses a disbelief about
the statement made in the
previous message
(i.e.#1584). Again, it is
coded as ED since PO has
lower priority than ED.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Interactivity rank: I=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language functions:</td>
<td></td>
</tr>
<tr>
<td>Asking information</td>
<td></td>
</tr>
<tr>
<td>Giving explanation</td>
<td></td>
</tr>
<tr>
<td>Presenting opinion-----3</td>
<td></td>
</tr>
<tr>
<td>Making suggestions</td>
<td></td>
</tr>
<tr>
<td>Expressing disbelief</td>
<td></td>
</tr>
<tr>
<td>T-unit-------------3</td>
<td></td>
</tr>
</tbody>
</table>

This is respond to #1841 and
the author had read all
earlier messages in the
thread.

"Decimals are better…" is PO.
<table>
<thead>
<tr>
<th>Decimals</th>
<th>Generation ----4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note #1816</td>
<td>Interactivity rank: 1=8</td>
</tr>
<tr>
<td>Author: E</td>
<td>Language functions:</td>
</tr>
<tr>
<td>Do you smell what the rock is cooking?// any way the rock says that decimals[sic] are better because it takes a shorter amount[sic] of time to do. //GE Fractions my friend has more opportunitys[sic] to make mistakes[sic].//</td>
<td>Asking information</td>
</tr>
<tr>
<td></td>
<td>Giving explanation--------1</td>
</tr>
<tr>
<td></td>
<td>Presenting opinion</td>
</tr>
<tr>
<td></td>
<td>Making suggestions</td>
</tr>
<tr>
<td></td>
<td>Expressing disbelief</td>
</tr>
<tr>
<td>T-unit--------------------------------3</td>
<td>The 1st sentence is not related to the content, so it doesn't count.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FRACTIONS ARE BEST</th>
<th>Generation ----5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Note #1867)</td>
<td>Interactivity rank: 1=10</td>
</tr>
<tr>
<td>Author: H</td>
<td>Language functions:</td>
</tr>
<tr>
<td>NO WAY!/[ED] DEIMALS RULE!// THEY LOOK BETTER, SHOW YOUR WORK BETTER, AND ARE EASIER TO USE.//PO</td>
<td>Asking information</td>
</tr>
<tr>
<td></td>
<td>Giving explanation</td>
</tr>
<tr>
<td></td>
<td>Presenting opinion--------1</td>
</tr>
<tr>
<td></td>
<td>Making suggestions</td>
</tr>
<tr>
<td></td>
<td>Expressing disbelief--------1</td>
</tr>
<tr>
<td>T-unit--------------------------------3</td>
<td>“No way!” is ED and PO. So it is coded as ED</td>
</tr>
<tr>
<td></td>
<td>“They look...” is PO.</td>
</tr>
<tr>
<td></td>
<td>Although the sentences “No way!” and “Decimals rule” contain no verb, they present complete meanings here. Therefore, they coded as 2 T-units.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fractions rule, decimals drool</th>
<th>Generation ----2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note #1797</td>
<td>Interactivity rank: 1=4</td>
</tr>
<tr>
<td>Author: H.</td>
<td>Language functions:</td>
</tr>
<tr>
<td>Fractions are the best, because you don't have to fiddle with halves, or that sort of stuff all the time.//PO</td>
<td>Asking information</td>
</tr>
<tr>
<td></td>
<td>Giving information</td>
</tr>
<tr>
<td></td>
<td>Presenting opinion--------1</td>
</tr>
<tr>
<td></td>
<td>Making suggestions</td>
</tr>
<tr>
<td></td>
<td>Expressing disbelief</td>
</tr>
<tr>
<td>T-unit--------------------------------1</td>
<td>This message responds to #1582 at generation 1.</td>
</tr>
<tr>
<td></td>
<td>The whole sentence is PO and GE. But it coded as PO since PO has higher priority.</td>
</tr>
</tbody>
</table>