Student Participation, Interaction, and Regulation in a Computer-Mediated Communication Environment

by

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(ABSTRACT)

This study provides an in-depth description and interpretation of student participation and interaction that occurred in computer-mediated interactive writing activities in two different classroom settings: a freshman writing class and a plant biology lab. Both classes were equipped with a network of Macintosh computers and the Daedalus Integrated Writing Environment software which was used to conduct in-class, synchronous computer-based discussions.

Electronic transcripts of interactive writing activities created in both classes were archived from the beginning to the end of one semester for analysis of student participation and interaction in the computer-mediated environment. A focal point of the participant observation research in both classes occurred in a capstone event which took place halfway through the semester and involved a peer review as well as interactive discussion activity conducted in the computer-mediated environment. The capstone was designed to provide multiple data points for analysis while also serving specific content objectives for each class.

The analysis of electronic interchanges revealed that student participation and interaction in the computer-mediated environment differed from the traditional, face-to-face setting in both cases by exhibiting increased participation and increased student-to-student interactions. Students responded to the CMC environment with variable timing in their responses and varied styles for using CMC as a medium for communication. The social

conventions for participation and interaction in the CMC interactive writing activities were influenced by the computer interface, the behavior exhibited by the teacher and fellow students in the CMC discussions, and the nature of the topic being discussed. All students reported increased understanding of the material by being able to read responses of their peers in the on-line discussions.

Three areas for improving future applications of this technology emerged from this study: (1) several students complained about having to type their messages; (2) several students reported that they felt overwhelmed by the number of messages and multiple, consecutive tangents in the CMC discussion; and (3) teachers would benefit by having more specific guidelines for designing appropriate activities for this technology which can be integrated into existing instruction and assessment activities.

Acknowledgments

Things which appear to be out of reach can be grasped from a supportive foundation, and that is what my committee, colleagues, and family have given me--a foundation for reaching something seeming so far away. Getting to know each of my committee members and their way of thinking and strategies of analysis has provided guidelines and high standards which have given me direction throughout this process. I am also lucky to have had such knowledgeable, creative, and enthusiastic educators to work with in both settings. I am sincerely grateful for the support and cooperation I received from Steve Scheckler, Associate Professor in both Biology and Geology Departments, Jeshua Pacifici, computing consultant and English teacher, and Stewart Hill, a graduate teaching assistant also working with the plant science lab project. The students who participated in this study were extremely cooperative. Their insights and thoughtful responses greatly enriched this research effort.

John Moore, Director of Educational Technologies, and Tom Head, Director of Media Services, have provided support, guidance, access to equipment and software and a workspace which have been extremely helpful. David Taylor has been my supervisor for my graduate research project from which this research first emerged; he has helped me on many occasions talk through ideas, resolve problems with equipment or scheduling, as well as research-related concerns. Committee members Norm Dodl and John Burton have provided encouragement, good advice, and valuable contact with others who are interested in this same area of research. Tom Sherman gave his time listening and talking through the early literature surveys on this and related topics and helped confirm what issues would be worth further investigation.

Having two major professors serve as my advisers has given this study more depth and perspective than it would probably have had otherwise. I am fortunate to have had two advisers who have worked well together to make this research study richer and stronger

because of their complementary expertise and interests. I am especially grateful to Jan Nespor for agreeing to serve in the capacity of co-advisor when the study was already underway. I have greatly benefited from the advice, time, and guidance Mike Moore has given me since the day I started this program and continuing up through the final step.

Throughout the process of pursuing this degree my family and friends have been willing to help in a variety of ways. On numerous occasions my parents and my husband's parents have taken care of our children so that I could concentrate on my work. My friends who are also in this program have provided thoughtful comments and moral support. My mother passed away during the time span of this study, but I continue to be inspired by her memory. My husband, George, and sons, William and John, have provided tremendous support, patience, and love throughout this process.

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Chapter 1

Research Questions and Methodology

Research Questions

This study provides detailed descriptions, analyses, and interpretations of student interactions and participation that occurred in computer-mediated interactive writing activities in two different classroom settings: a freshman writing class and a plant science lab. The freshman composition class focused on the teaching of writing through assigned reading and writing exercises and incorporated the electronic discussions into every other class. The plant science lab used the computer-based discussions to put students in a position in which they had to verbalize what they observed and learned in the interactive computer-based tutorials, simulations, and analysis of live plant specimens. Both courses incorporated the use of computer mediated communication (CMC) activities via a software application program called *Daedalus*.

This study documents verbal communications and social interactions which occurred in the CMC environment in both settings. It also includes naturalistic observations of other activities in both cases since the computer-based writing activities were one among several different kinds of communications activities occurring within each class. Both cases include a capstone event which occurred about half-way through the semester. The capstone event was a carefully designed series of in-class activities adapted to each setting which provided multiple data points for analysis.

Prior observation-based research of classrooms reports that traditional classroom interactions typically consist of two thirds to three quarters teacher talk and one third student talk (Flanders, 1970; Levin, Kim, & Riel, 1990). Preliminary research on instructional uses of CMC indicates that teacher-led discussions in this environment

dramatically change the teacher-student interaction ratio. Student interactions dominate the electronic discussion environment with student-initiated comments occurring 70 to 80 percent of the time and teacher comments becoming much less dominating (Faigley, 1992). This shift to a student-centered discourse in the CMC environment raises many questions about participation and interaction. If the teacher isn't dominating the discussion who is? What kind of conventions regulate the interactions that occur in the CMC social environment? This research examined the computer-based classroom environment to provide detailed, descriptive information regarding the nature and quality of the electronic discourse created by students and their teacher through CMC interchanges conducted within the classroom setting. The specific questions focused on in this study are:

1. What are the characteristics of student interactions and participation in the computer-mediated environment?
2. What kind of impact do CMC interactions have on student learning?
3. How are CMC interactions the same and different in the two settings observed in this study?

All three of these research questions focus on documenting how student participation, interaction, and regulation are expressed in computer-based communication conducted synchronously within a given class period. Literature regarding CMC contains many projections, predictions, and opinions regarding the magnitude of impact this technology will have on education. A recent quote by Press (1993) is one example of the high expectations associated with computer-based communications. "Electronic mail is an example of low-tech innovation which can eventually have a radical impact on curriculum, commuting patterns, work patterns, frequency of class meeting, campus lab budgets, student-teacher and student-mentor roles, the campus service area, and the student's perception of the world" (p. 21). While some or all pieces of this prediction may be valid,

we need more specific context-based information to really understand how CMC can improve the delivery of instruction.

Harasim (1993) proposes that instructional use of CMC "opens unprecedented opportunities for educational interactivity" (p. 42) because of its ability to support interactive group communication. This study responds to Harasim's assertion with observations of on-line instructional activities designed to meet subject-specific cognitive goals as well as goals for a desired level of interactivity. This study provides detailed descriptive information regarding: (1) particular instances in which CMC was used to accomplish predetermined instructional goals; (2) the degree to which the technology interface facilitated and/or inhibited student participation, interaction, and regulation in accomplishing the on-line instructional activity posed for both settings; and (3) student and teacher attitudes towards this method of in-class discussion. Student attitudes toward and responses to CMC activities were compared with their attitudes toward other computing activities and toward other non-computing activities. The data for this study was gathered from field notes based on participant observation of both classes, informal interviews with instructors and students, archives of student on-line discussions, student responses to questionnaires, and analysis of relevant documents and reports.

This study describes student and teacher interactions in the CMC environment in terms of the instructional goals being addressed. What kind of student-to-student and student-to-teacher and teacher-to-student interactions are sought as a part of the instructional objectives? What role does student participation and interaction play in the objectives for each class? On another level, how does the use of CMC technology as applied in these two settings facilitate and/or inhibit achieving the objectives for learning.

Looking at the questions posed for this study on these two levels is useful for avoiding a major problem with instructional systems development research noted by Clark (1983) and Clark and Sugrue (1991). Too often according to Jih and Reeves (1992) and

Clark (1983), researchers rush into experimental or quasi-experimental designs before the variables to be studied and compared are clearly understood. Eisner (1985) points to a similar problem with conventional approaches to evaluation which "focus almost exclusively on the products of the enterprise (a narrow slice at that) while they neglect the conditions, context, and interactions that led to these consequences" (p. 148). Eisner (1985; 1992) also agrees with Reeves (1993) and Jih and Reeves (1992) that evaluation studies concerned with measurement of performance are typically of such a narrow focus that they provide little practical information to indicate what should be altered and what should be maintained to improve student performance. Therefore, this study provides descriptions of these contextual factors for both classes in order to lay the groundwork for the detailed illustrations, analyses, and interpretations of student on-line participation and interaction.

The Daedalus Human-Computer Interface

Both settings used the Daedalus Integrated Writing Environment (Daedalus) application program for the in-class CMC activities. The Daedalus program is designed to use the "power of collaboration between writer, editors, and instructors" (The Daedalus Group, 1992, p. 1). In keeping with this process of collaboration, the Daedalus developers group at the University of Texas also distribute and moderate an Internet discussion list, electronic newsletter, and maintain FTP, Gopher, and World Wide Web electronic resources which provide software upgrades, product information, newsletters, articles, bibliographies, and sample course materials. These resources are available to anyone interested in classroom applications of the Daedalus software. The local Daedalus discussion list among faculty on this campus and the international discussion list distributed by the software developers group is a forum for both technical and pedagogical issues.

This and other topics related to making the transition from the traditional classroom to using Daedalus are discussed in the context of specific classroom issues in chapters three and four. This section summarizes features of this program's capabilities that were used, identifies aspects of this program used in this study, and describes the nature of the Daedalus human-computer interface.

Daedalus is a collection of computer programs which is designed to operate on a computer network. Components of this program which were used in the freshman composition class and in the plant biology lab:

Class Assignment

Class Assignment was used to post announcements and instructions to students and was usually viewed by students at the beginning of each class. The "assignment" text file is automatically displayed on the screen when students log into their class. Figure 1 provides an illustration of the default Assignment window which comes with this program. This file can be viewed at any time. The assignment can be copied and pasted into other files, but cannot be modified once posted. Only the instructor can create and post a file to be placed in the assignment window. Both the freshman writing class and the plant science lab classes used the assignment window routinely to give students an overview of class activities for that day and/or an introduction to the interchange topic.

Daedalus Mail

Daedalus Mail is an electronic mail system which was used as part of the capstone activity to send the rating scale form to students. Students returned their completed rating forms also using the Mail program. The Daedalus mail system is designed for sending and receiving mail messages within the local area network on which Daedalus is installed. This is not the same as electronic mail which sends mail messages across campus or to any Internet address. Figure 2 provides a screen picture of the Daedalus Mail interface.

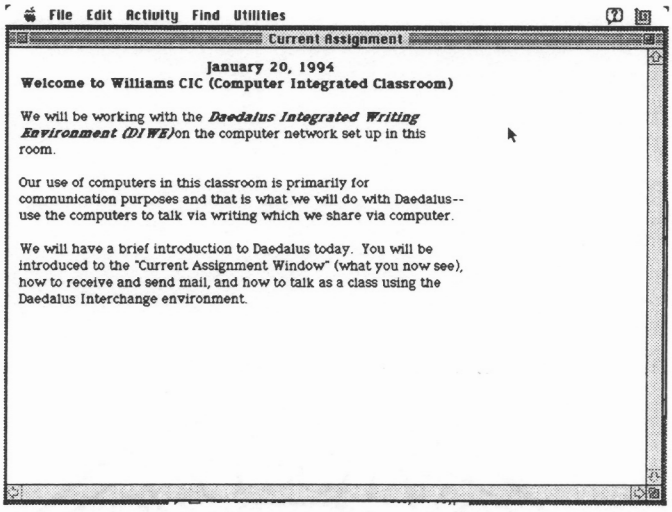


Figure 1

This figure contains a screen picture of the Daedalus Assignment window which is automatically displayed after the user has logged into the program.

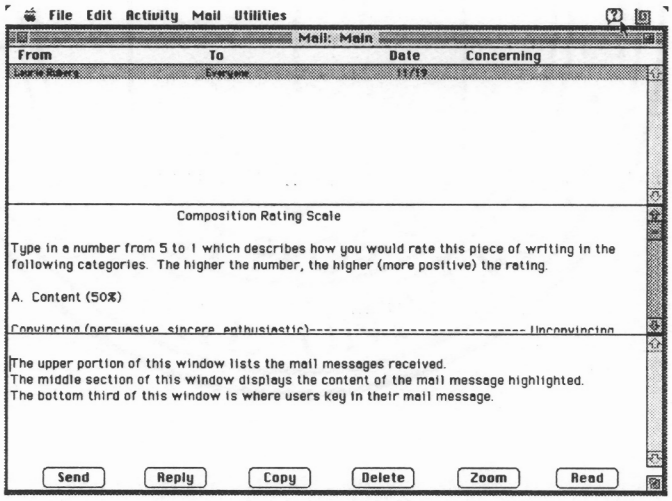


Figure 2

This figure contains a screen picture of the Daedalus Mail window. The mail system shown here has three activity windows. A listing of mail messages received is displayed in the top section of this window. Specific mail messages can be viewed in the middle section. Mail messages are keyed in and sent from the bottom section. Mail messages to be sent and messages viewed can be copied into Daedalus word processing files.

Messages are composed in the lower window and the listing of mail messages is displayed in the top window. Mail messages are read in the middle window. All three of these windows can be enlarged by using the mouse to click the box in the upper right corner of each window. Clicking the same box again will reduce the window to the default size and orientation.

Daedalus Interchange

Daedalus Interchange is used to facilitate on-line class discussions which occur simultaneously within a class period. Appendices A and B contain sample text archives of two interchange discussions held in the freshman composition class during the fall semester. The Daedalus Interchange program "lets any number of people 'talk' at once and still be 'heard,' [and] produces a transcript of all the comments made during the discussion. This dialogue takes place in an electronic classroom" (The Daedalus Group, 1992, p. 13). All students can participate at the same time working individually on their own computer or sending in a group message from one computer. The text-based interchanges communicated via computer are each tagged with the name of the sender and displayed as a sequential list of messages in the top section of the interchange window (see Figure 3). Once the interchange is completed, it can be saved as a text file that can be printed, copied onto a disk, or electronically distributed.

Figure 3 shows what the Interchange window in Daedalus looks like and displays the message viewing and sending tools available to the user. The user can scroll through the messages received in the upper section of this window to receive messages. Scroll bars are also provided to enable the user being able to scroll through messages composed in the lower half of this window. The send button is immediately below the message composing area and must be clicked once with the mouse to be activated. Pressing the return bar will only add blank lines to the message composing window. The display of messages received cannot be edited in any way. The Interface window is similar to the Mail interface except

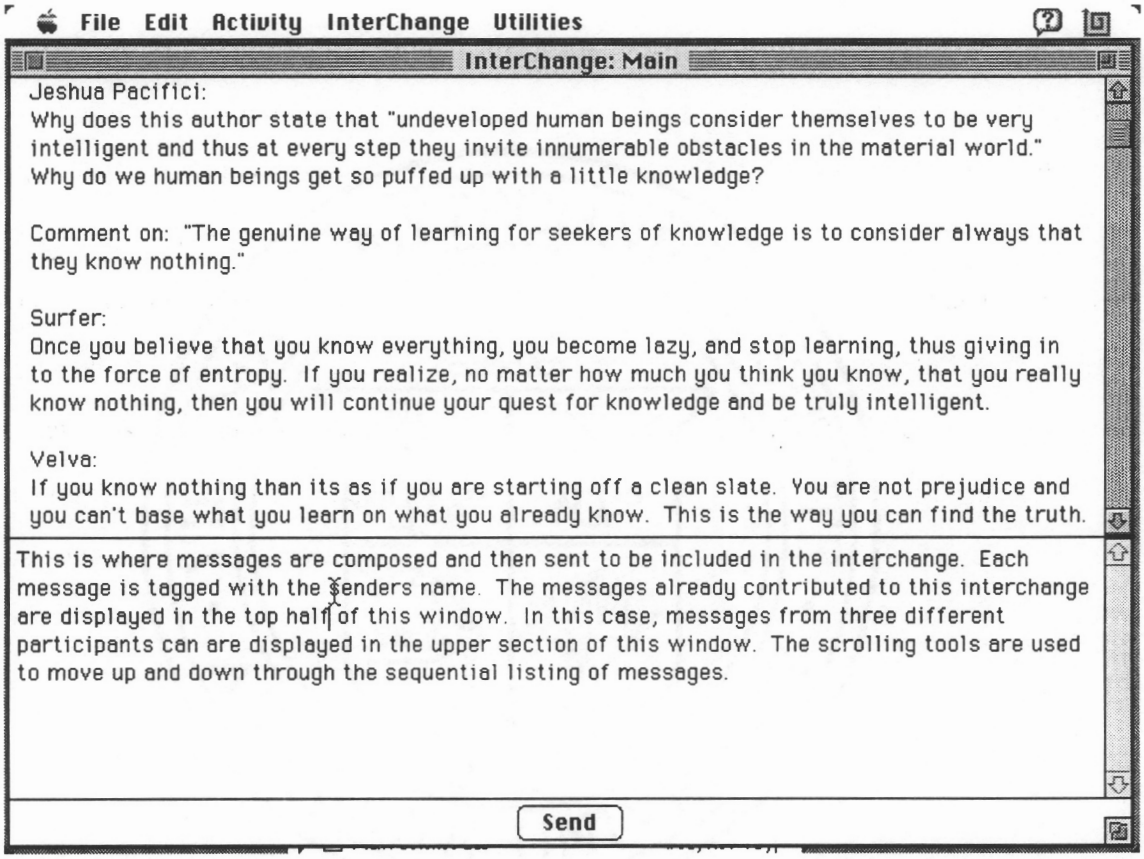


Figure 3

This figure represents a screen picture of what the Daedalus Interchange looks like. The Daedalus environment is designed to display text messages and, therefore, does not include any color or graphics features in current versions.

there are two windows, not three. The top window allows the user to view and scroll through messages that have been sent and distributed to all members of the Interchange. The lower window (in which the cursor is automatically placed when this window is active) is where the user keys in a message. When the message is complete, users can edit it, use the Daedalus electronic spell checker if they choose, and then use the mouse to click the send button and the message will be distributed to all participants in that interchange discussion.

More than one interchange discussion can occur at the same time within a class. Each interchange is given a distinct name and participants can move across the multiple discussions at their own discretion. Interchange discussions can also be made accessible to more than one class and over extended periods of time.

The electronic archives of the on-line discussions in the two classroom settings was the primary data source for this study. All of the interchanges were created in the Daedalus Interchange environment and have been saved in linear format as text files which have then been coded and analyzed. Excerpts from the capstone interchange text files are presented in the analyses of participation and interaction within each setting presented in chapters three and four.

Analysis of Data

A variety of data collection procedures and tools were used to address the questions which are the focus of this study. Table 1 describes the linear sequence of events in which data has been gathered either electronically or by participant observation methods, including field notes, analyzing relevant documents and reports, and initiating informal interviews with key informants.

Table 1

Rationale for Data Collection Procedures and Tools

Data source	*Rationale*
January	
Entry survey (conducted partially on-line, partly on paper)	provides background information about students such as gender, prior experience with and attitude toward CMC which is useful in providing detailed answers to questions identified as the focus of this study
Interviews with class instructors at each site	provides information regarding the instructors' intentions and expectations for the CMC activities
Participant observation of classes (as often as possible) at both sites	provides access to face-to-face verbal communication related to observing how class adjusts to use of CMC and design considerations for capstone task
Electronic archives of on-line discussion and questionnaires conducted prior to capstone tasks	provides baseline information and guidelines used to refine the design and presentation of the capstone task and also used in the analysis of data obtained from the capstone task
March	
Capstone Task (1) archive of discussion	provides an electronic file of all comments made to contribute to the Interchange discussion--each comment is tagged with the senders' name
(2)Initial and (3)Post (discussion) rating scale questionnaires completed on-line by students	a descriptive analysis of this data reveal the range of variation in student assessments of the selected writing put on-line for review
(4) Archives and observation of follow-up activities to capstone task	provides information regarding student interpretations of selected pieces of the Interchange and data regarding how students view their own learning experiences from the on-line interactions
May	
Exit survey (conducted partly on-line and partly on paper)	provides a follow-up to the initial background survey and indicates any shifting in self-reporting of attitudes towards CMC. The on-line portion of this survey provides a way to get students to respond to some questions about CMC within an on-line discussion environment.

Description of Data

The analysis of social interactions in the CMC environment was primarily based on the electronic transcripts. However, since the computer-based discussions in both of these settings were conducted within the classroom, field notes from observations of the CMC and other classroom interactions have been used to describe the context in which the interactive writing discussions occurred. The quantitative analysis of the electronic transcripts was based on techniques described by Butler (1992, p. 70). Descriptions of the ways in which the electronic transcript data was organized and coded follows.

Raw data. Archives of on-line interchanges are preserved as generic text files and are considered raw data in this format. Before coding and manipulating the interchange, I preserved a copy of each transcript as a linear sequence of a string of messages each of which includes a name-tag from its sender. I also coded the raw data in the interchange transcripts with a number beside the name header to each message which would document the sequence in which a given message was displayed in the interchange discussion. Numeric descriptions of the electronic transcript data included averages, percentages, and ratios of interactions on-line. The Daedalus program has a concordance utility program which provides a word count and frequency listing as well as statistical analysis of an interchange in regard to the number of: characters; characters per word; words per sentence; unique words; sentences; questions; paragraphs; words per paragraph; sentences per paragraph; and ratio of unique words to word total. I have used this program to count the number of words per message, words per participant per interchange, number of sentences and number of questions initiated within a given interchange.

Quantitative Measures of Participation and Social Integration. The distribution of participation refers to quantitative comparisons of the messages sent and received. This analysis also considers who messages are directed to and received by within a specific interchange. The results of increasing student participation and providing interesting topics

for students to discuss in electronic discussions are long reams of chronological text messages. The message flow analyses and social psychological coding systems described above do not provide a systematic way to measure the impact of individual participant's message(s). Butler (1992) describes three quantifiable measures of individual participation--the participation ratio, participation frequency, and integration ratio. These measures are described below along with an additional measure which I call the volume ratio. These three figures provide quantitative information about participant interaction and participation. Tables 3 provides the formula for calculating each of these figures. When compared with the participation ratio the volume ratio shows not just how often, but also what percent of the discourse volume is generated by a given participant. Identifying the proportional length of a message is important because in this study as in Butler's (1992) research as well, students indicate that they sometimes skip over long messages and mention that they dislike reading long "essay-length" messages in the interchanges. Longer messages may receive fewer responses for this reason.

Table 2

Quantitative Descriptions of Participant Participation and Interaction

Participation Ratio	# messages sent/# total messages
Volume Ratio	# words sent/# words total
Participation Frequency	# total messages/# messages sent
Integration Ratio	# messages received/# messages sent

Content description and classification. Several different types of coding systems have been used to interpret and describe the nature of the interactions and content of the electronic transcripts. Analyzing the transcripts in terms of these coding system required enormous amounts of time--even to complete the analysis of a single interchange transcript. The three different methods of analysis discussed here illustrate the kind of variations in how electronic texts can be interpreted and how each method pulls out some qualitative aspect of the text which the others cannot detect. However, even the best method of analysis cannot be exhaustive. The issue that emerges from this process becomes not which method of analysis is best, but which method can pull out the qualitative features of greatest relevance to this study and what features does this method overlook.

Description of Coding Systems

(1) Message Act Analysis. The "message act analysis" developed by Levin, Kim, and Riel (1990) is based on the system for classifying instructional speech acts developed by Mehan (1978) to document a common classroom interaction pattern called "IRE sequences"--Initiation by teacher; Reply by student; Evaluation by teacher. When they applied Mehan's analysis system to "message acts" in electronic instructional teacher-student interactions, Levin et al. (1990) found that "...There are substantial differences between face-to-face instruction and instruction conducted using electronic networks. However, there are also important similarities" (p. 206). The key difference between globally distributed electronic group interactions and face-to-face interactions is related to the nature of time. Using electronic networks to link people who are geographically distributed allows the discussion to become time-independent. However, stretching interactions over this "nonreal time medium" (Levin et al., 1990, p. 210) changes the course of interactions in ways not fully understood. While the interactions are stretched out over new, unpredictable time bands, the participants are partly compensated by the multiple threads of discussions occurring simultaneously.

This study looks at in-class use of electronic discussions and avoids some of the timing problems associated with distributed electronic groups because the interchanges stopped at the end of the class period most of the time. The message act analysis is useful for describing the pattern of teacher-student interactions in the electronic community. This method of analysis was used to interpret the capstone transcripts of student peer and student-teacher interactions in both settings. Levin et al. (1990) indicate that the typical IRE sequence is spread out in the electronic communication environment--particularly when participants in distributed geographic locations are linked via electronic mail. Even in the two classes observed in this study where all communications occurred within a class period, responses are spread out and are sent at different time intervals. Distinct and separate simultaneous strands within the discussion are identified in the message flow analysis showing that students continued to send their responses to the teacher's initial question while other subsequent topics for discussion have been initiated.

The electronic message flow analysis demonstrates student responses to teacher initiations dominate the discourse. The message act analysis developed and described by Levin et al. (1990) is a useful model for describing the sequence of interactions which can then be diagrammed to visualize the IRE sequence, but this kind of analysis does not describe the emotional quality of the messages as part of its coding system. Since this study focuses on describing how students interact and regulate each other on-line, another analysis tool is employed which is designed to track the social emotional quality of the messages.

(2) Rhetorical Analysis. The rhetorical content coding system used by Butler (1992) was modified from a twelve to ten group system by combining the last four categories into two as follows: (1) Question; (2) Reply; (3) Consensus Building; (4) Evaluation; (5) Topic Initiation; (6) Assertion; (7) Acknowledgment; (8) Off-Task; (9) Qualification/Definition; and (10) Clarification/Elaboration. This analysis showed that most

of the comments by students were assertions and clarifications, but some "consensus building" comments were also exchanged which are of particular interest in this study. This system describes the nature of the content of the interchange. The rhetorical analysis was less satisfactory because it does not help the researcher classify the social-emotional quality of each message. I used this system on several interchanges, but found that this coding system was not directly answering the research questions addressed in this study.

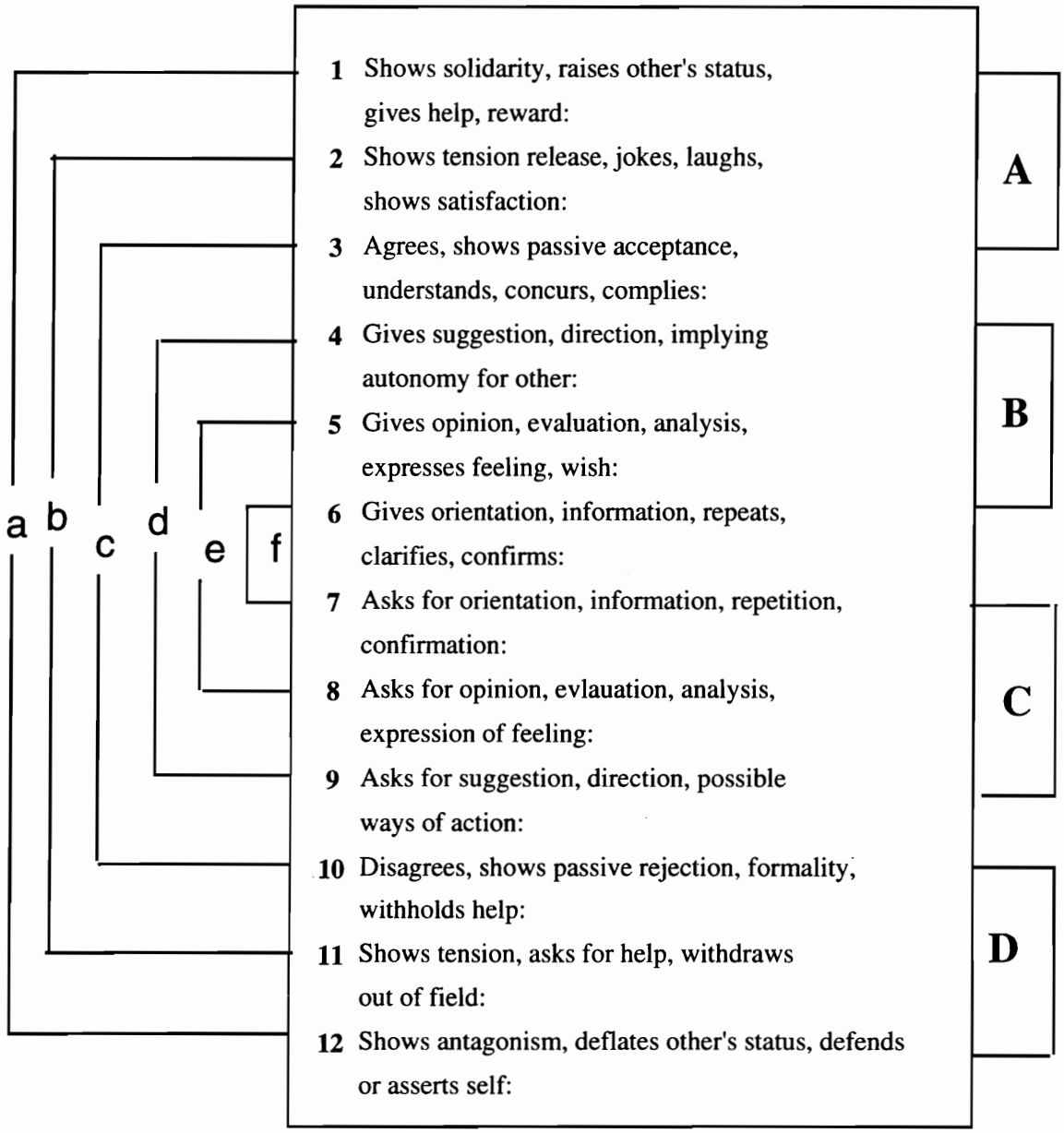
(3) Bales Interaction Analyses Scale. The Bales Interaction Analyses Scale (Bales, 1976) provided a coding system which was used to identify and compare the positive, negative, or neutral quality of social mediations evidenced in the text transcript. In analysis of the interchange transcripts, the Bales system for categorizing interchange transcripts provided fairly adaptable categories for coding the text messages which accounted for the social-emotional quality of the message. Table 2 describes the theoretical framework for the Bales Analysis Scale. This scale was primarily used to distinguish positive reactions, attempted answers, questions/new topic initiations, and negative reactions. Based on their more than ten years of research addressing the social psychological aspects of CMC, Sproull and Kiesler (1991) report that individuals are more likely to share negative and more emotionally charged comments in the CMC environment. I needed to use a coding system that would address these variables, and the Bales Interaction Analysis Scale did this.

Instruments

This study included several instruments which were adapted to fit the two classes selected for this study. An entry survey was distributed at the beginning of each class to measure students' initial attitudes and experience with computers and CMC. An exit survey was distributed at the end of each class to find out how students responded to the Daedalus activities offered throughout the course. Student reactions to the interchange

Table 3

Bales Interaction Analysis Scale



KEY:

a Problems of Communication
b Problems of Evaluation
c Problems of Control
d Problems of Decision
e Problems of Tension Reduction
f Problems of Reintegration

A Positive Reactions
B Attempted Answers
C Questions
D Negative Reactions

discussions were obtained through these surveys as well as through classroom observation and informal interviews with students..

The Capstone Activity

The "capstone activity" represents a somewhat artificial event which fits into the normal curriculum and activities of the class, but which also provides a way for getting a matrix of measurable comparable data within one class period. The "capstone activity" can be described as a Daedalus activity with the following characteristics:

- Occurs far enough into the semester that the students and their teacher have become familiar with the Daedalus interface and can open, use, and manipulate this program with minimal assistance.
- Consists of a pre- and post-discussion individual rating activity with numeric data to compare how students are influenced by the on-line discussion.
- Includes a Daedalus interchange discussion in which all students participate.
- Addresses one or more of the content objectives of the course .
- Asks students to comment on their experiences with the Daedalus interchange activities in a written questionnaire.
- Gives back information to students regarding their participation in the "capstone activity" from which students are again asked to share their reactions to the capstone discussions and the rating scores.

Preparation for Capstone Task

The following list describes levels of familiarity with Daedalus and preliminary testing of the capstone task which needed to be accomplished before the target activity could begin.

(1) The first step was to establish a routine and level of comfort with the technology. This means that students can initiate the Daedalus program, log in, highlight and select the instructor's name, the class name, their own name from the class list, and key in their personal password. After completing the log-in routine, the Daedalus

"Assignment" appears in a resizable window on the screen. The procedures for getting to the class assignment became routine for students in both settings. The capstone activity was scheduled to occur when all students had reached this level of familiarity with the classroom technology. In the pilot testing for the study the instructor noticed that, "Students are relaxed when they come into this room, and are much more comfortable participating on computer than they are in the class discussions [held in the traditional classroom]" (Fieldnotes).

(2) The next step was to establish a familiarity with the Daedalus program interface. The freshman writing and plant science lab classes used only two of the Daedalus environments: mail and interchange. The computing tasks involved in the capstone activity required no more than basic word processing skills. Students did need to be familiar with using a mouse to select items from a menu bar. The main editing procedures used consisted of copying, cutting, and pasting.

(3) In both settings, the instructors were involved in formative testing of different Daedalus activities in preparation for the capstone task. Since the capstone activity involves student construction of meaning and student-to-student interactions, the computer-based task used had to be one in which the questions discussed on-line required more than simple answers and instead stimulated the sharing of ideas and opinions. The development of the capstone follows the iterative task development procedure described by Jih and Reeves (1992). Students in both settings had practice with various aspects of the capstone activity before this event took place. The concept of the capstone event from which the researcher can gather multiple data sources for detailed analysis is based on Butler's (1992) study of student interactions on the Daedalus interchange program.

Capstone Procedures

The following section provides a brief description of the step-by-step procedures involved in the capstone activities.

1. Students read a meditation in the freshman writing class and a newspaper article in the plant science lab which included topical material which was used to address the cognitive goals which the instructor had identified and wanted the students to learn in this CMC activity.

2. After reading the article, students responded to a series of questions which asked them to quantitatively rate the material they read according to categories of analysis appropriate to each discipline. The plant biology lab used a categorical rating instrument which emulated the process of scientific inquiry and analysis. The freshman composition class used a "Composition Rating Scale" which has been used to evaluate student writing in national, standardized tests (Tuttle, 1986).

3. After completing the rating scale, students went into the Daedalus Interchange environment and discussed their critical analysis of the selection with their peers.

4. At the end of class, all interchanges were "compacted" and saved in text file format. These text files of all the capstone interchanges from both settings were then labeled and coded for detailed analysis. The electronic transcripts were analyzed and coded in a similar manner as traditional face-to-face discussions have been recorded, compiled, and analyzed (Butler, 1992).

Overview of Document

This report is presented in five chapters. Chapter one provides an introduction to the study and educational setting as well as a description of the methodology for data collection and analysis. Chapter two presents a review of the literature addressing instructional uses of CMC. Chapters three and four describe student interactions, participation, and regulation in the freshman writing and plant science lab settings. Chapter five provides a summary and interpretation of the findings described in chapters three and four in the context of the research questions posed for this study.

Chapter 2

Characteristics of Computer-Mediated Communications (CMC)

Introduction

Since this study focuses on real-time, in-class use of CMC, a brief summary of key characteristics of student participation and interaction in the face-to-face classroom precedes the discussion of CMC research. The description of classroom interaction analysis by Morine-Dershimer (1985) and Stubbs (1976) provides a theoretical and descriptive framework from which to compare the social psychological characteristics of computer-mediated interactions reported in previous research. Finally, this chapter concludes by providing a summary of the behavior and outcomes that would be expected to occur in the CMC environment employed in this study based on prior research.

Computer-mediated communications (CMC) refers to computers and computer networks which are used to perform telecommunications functions (Berge & Collins, 1994). CMC technologies are used to transfer, store, and retrieve information, but this study emphasizes the communication aspect of CMC. The observations of classroom use of computer systems and networks view the computer as a mediator for human communication rather than a processor of information.

The tools for conducting computer-mediated communications (webmaker@bev.net, 1994) include:

- electronic mail
- gopher servers
- World Wide Web servers
- bulletin boards (Usenet)
- electronic conferences (mailing lists)

- virtual terminal access
- switched video.

Each of these different modes of CMC relies on different media and communication characteristics and human-computer interaction. Individuals selectively use one or all of these computer-based communication vehicles depending on the work station tools available and the nature of the communication task.

A large portion of the research investigating appropriate applications of computer-based communication has come from studies of "well-established electronic communities in high-technology organizations, universities, and the financial industry" (Sproull & Kiesler, 1991, p. x). Electronic communication networks are common tools for technologically sophisticated professionals, but are just now gaining in popularity among significant numbers of educators (Honey & Henriquez, 1993). Successful communication networks have been established within elementary and secondary schools, and research assessing the value of these networks is beginning to emerge (Hunter, 1993). This study looks at a particular kind of electronic messaging system which involves real-time, synchronous text-based interactions which Ferrara, Brunner, and Whittemore (1991) refer to as a new kind of register called interactive written discourse. Although the computer networks described in both settings of this study have wide area networking capabilities, the research focused on computer-based communications within the classroom in both settings.

Key Findings from Traditional Classroom Observation

Sociolinguistic studies of the classroom are primarily "exploratory work on a relatively narrow range of classrooms" (Stubbs, 1976). Varied types of classroom observation research have all determined that classroom dialogue is asymmetrical:

teachers contribute about two thirds of the language expressed in the classroom (Flanders, 1970). This finding is also supported by Sproull and Kiesler (1991) who report that face-to-face communication outside the classroom is also generally unequal. Typically one person or a minority clique in control dominate face-to-face transactions. Dominance in face-to-face groups is typically based on social status or professional rank. For example, managers speak more than subordinates, men speak more than women (Sproull & Kiesler, 1991), and teachers more than students (Flanders, 1970).

Other characteristics of face-to-face interactions documented by social psychologists (Forsyth, 1983; McGrath, 1984) who have studied decision-making in small groups are expressed in classroom situations to varying degrees. The person in the front of the room speaks more than those in the back. People tend to be polite and considerate in face-to-face groups. People avoid controversy. People prefer to select options that have obvious popularity. The outcomes and decisions of small face-to-face groups can be predicted based on knowledge of who dominates the discussion. Members of face-to-face groups tend to form more social bonds of cohesiveness. Groups tend to adopt more extreme positions than individual members would on their own.

The question and answer sequence is the most basic pattern of classroom dialogue (Bellack, Hyman, Smith, & Kliebard, 1966; Sinclair & Coulthard, 1974). This teaching strategy has been found to be stable over fifty years (Hoetker & Ahlbrandt, 1969) and across different countries (Bellack, 1973). The question and answer sequence of interaction is one of the recitation patterns of direct instruction and there is some evidence regarding the effectiveness of this strategy (Berliner & Rosenshine, 1976; Rosenshine, 1977). A variation of this sequence has been documented by Mehan (1978) as a way of classifying a common classroom interaction pattern which Mehan refers to as IRE sequences--Initiation by teacher; Reply by student; Evaluation by teacher. A variation of this sequence is used to analyze the transcripts created by computer-based interactive

writing conducted in real-time within the classroom settings. This analysis of IRE sequences (referred to as Message Act Analysis) provides another way to document how CMC interactions are both similar and different from face-to-face classroom interactions.

The rules of classroom dialogue are quite distinct from those of conversation between social equals (Stubbs, 1976). Such rules may inhibit children's use of language by setting up a social situation in which they play a passive role, give short answers to discrete questions, and seldom initiate discussion (Flanders, 1970). There is evidence that teacher absence can lead to productive and complex discussion among children (Barnes & Todd, 1975; Labov, 1970, 1972; Wight, 1975), and that children follow different rules of discourse in social situations other than the classroom (Boggs, 1972; Dumont, 1972; Philips, 1972). This evidence from classroom interaction analysis supports the sociolinguistic thesis that the social situation is the strongest determinant of verbal behavior. If CMC changes the social environment, this, therefore, suggests that verbal behavior will be affected by this change. This study documents some of the changes in verbal behavior which were observed in both settings.

Language serves several distinct functions in the classroom which can primarily be categorized as performing status definition and socialization functions. Effects of pupil language on teacher judgments can be critical. Informal assessments that teachers make as a result of face-to-face encounters with pupils can lead to decisions that greatly influence the school lives of children. According to Stubbs (1976):

> The demands which one has to make for work on language in education are therefore as follows. The work should be based primarily on naturalistic observations and recording of language in real social situations: Mainly in the classroom itself, but also in the home, and in the peer group, which is the most powerful linguistic influence on children (p. 112).

This study observed natural language expressed in the face-to-face classroom and language usage in the computer-mediated environment within that same group. In both the freshman

writing and plant science lab settings addressed in this research, the computer-mediated language was restricted to classroom time and space. As a result of these restrictions, the CMC discourse was closely related to the face-to-face language behavior of each class.

Sociolinguists examine the relationships among social status, participation in discourse (conversation), and interpretation of the meaning of that discourse. How we interpret what we hear and what we consider appropriate to say will depend on who is speaking to whom (Morine-Dershimer, 1985). However, CMC changes the traditional classroom model of one-to-one or one-to-many interactions and facilitates the creation of a discourse which is based on many-to-many interactions. The sections that follow describe the characteristics of CMC associated with the computer-based interface and diminished social environment that lead to the changes in student participation, interaction, and social conventions addressed in this study.

Constructing a Profile of CMC Based on Prior Research

CMC Reflects a Rapidly Changing Technology

The synchronous CMC studied here consists of linked workstations which have multimedia display capabilities. Although people with access to sophisticated network environments can easily send and receive video and audio packets of data as well as text messages, in the settings studied here, as in most situations today, CMC still primarily means sending simple text messages and files. Reinking (1992) indicates in research comparing print and electronic texts that the real potential of viewing information electronically is two-fold: 1) to be able to search and sort through material via semantic association; and 2) to be able to truly integrate graphic elements into the presentation of information. CMC will be a much more powerful, much more useful, and much more

enjoyable medium to use when the communications functions reflect the true capabilities of the computer interface.

Yet even in text-based only format, CMC offers communications access and capabilities which were previously either impossible or too expensive to consider (Mackay, 1989). Great effort and resources have been put into the development of CMC to provide computer supported cooperative work (CSCW) functions (Olson & Bly, 1991). CSCW research is currently underway to address issues regarding how to make the CMC interface more like face-to-face interaction. Some researchers suggest that the text-based restriction of CMC offers some positive features which may be lost when the interface more closely resembles traditional conversation. By removing reminders of a possibly critical audience, e-mail induces people to be more open (Sproull & Kiesler, 1986).

Characteristics of CMC Identified in Prior Research

The existing research regarding CMC ranges from enthusiastic predictions to quasi experimental studies to controlled experiments. Until new technologies are in place and used routinely, the impact of these new communication systems will be difficult to predict, for as Sproull and Kiesler (1991) suggest, "The most important effects of a new technology may be not to let people do old things more efficiently but instead to do new things that were not possible or feasible with the old technology" (p. 4). The self-report testimonials and case studies from those who have used CMC in instructional settings are helpful in motivating others to consider using CMC for instructional purposes, and provide descriptive information regarding all dependent and independent variables (e.g., Beals, 1991; Feenberg, 1987; Kaye, 1989; Quinn, Mehan, Levin, & Black, 1983; Romiszowski, 1990).

The empirical investigations conducted by Kiesler, Siegel, and McGuire (1984), Siegel, Dubrovsky, Kiesler, and McGuire (1986) and McGuire, Kiesler, and Siegel (1987) provide information obtained from controlled, experimental settings which can provide

useful comparisons with the case study reports. While the controlled experiments provide data from a well designed empirical situation, the activities, time invested, and social situation were artificially created and may not represent what really happens in real-world environments.

Recent studies in the area of computer supported cooperative work (CSCW) such as the distributed design team described by Olson and Bly (1991) and the study of "effective group work" by Johnson-Lenz and Johnson-Lenz (1991) demonstrate how field studies incorporating participant observation of emerging multimedia technology can provide helpful insights into future uses of CMC. The questions posed in several recent media research reports (Reinking, 1992; Jih & Reeves, 1992) suggest that there is a great need for investigations which address how electronic media characteristics interact with learner characteristics to affect comprehension and learning.

Harasim (1990; 1992) suggests five key characteristics which nearly all types of CMC share: (1) many-to-many communication; (2) place independence; (3) time independence (time flexible, not atemporal); (4) text-based (limited bandwidth--text only); and (5) computer-mediated. CMC research has shown that each of these characteristics has an impact on the social psychological conditions influencing human communications which will be discussed in this section. The variety of types of CMC differ and may not contain all five of the characteristics described by Harasim (1990; 1992). Two of the five variables associated with CMC are not addressed in this study: place independence and time flexibility. Both settings observed in this study conducted CMC activities within the class period, in real time (synchronous), and in one place.

CMC studies addressing communication characteristics categorize issues in terms of: procedural constraints; ability to convey affective cues; flexibility in interactions; and network characteristics affecting time and physical space associated with interaction (Rice,

1987; Rice & Case, 1983). These categories distinguish features of CMC identified in previous research and are used to organize this summary of prior research findings.

Procedural Requirements

Most current CMC systems require users who have some prior experience with using a computer for at least word processing. Those who are frequent computer users readily adapt to using their computer for electronic mail and other communications functions (Lea, 1991). In research assessing attitudes and behavior shifts associated with CMC, Lea found that most users described their use of CMC to be most like informal note messages which could frequently be used in place of phone calls and did not require problem solving or resolving interpersonal issues. Users perceive electronic communications as having a spontaneous quality which differs from other forms of communication and which can facilitate more equally distributed interactions.

The synchronous interactive writing conducted via CMC described in this study "may be the first type of language use to be studied that is both edited and interactive" (Ferrara, Brunner, & Whittemore, 1991, p. 25). The conventions of interactive writing environments will vary depending on the setting and purpose of the interchange, but generally, according to Ferrara et al. (1991), there is an acceptance of first draft quality in which misspellings and grammatical errors are overlooked in order to maintain the pace and informality of interactions. Observations from videotapes of individuals participating in interactive writing dialogues indicate that people briefly scan or reread their message before transmitting it; however, as expected there are vast individual differences in behavior among participants (Ferrara et al., 1991). Interactive writing discourse may be a language variation that never existed before because of its simultaneous oral and written characteristics.

Research by Rice and Case (1983) comes to nearly this same conclusion: A CMC system may serve as an additional communication form rather than as a substitute for an

existing one. Rice and Case (1983) further found that "using such a system is a different style than is writing (or personal contact) and that heavy telephoners are not as likely to use the [CMC system]" (p. 142). Rice and Case (1983) concluded from their study that people tend to prefer different media depending upon the task, their organizational status, attributes of the medium, and their own personalities.

Because CMC is primarily limited to text-based interchanges, participants must adapt to a limited social context in their CMC interactions. Problems with "information overload" as described by Mackay (1989, p. 381) have also been observed and studied--particularly in regard to electronic mail and electronic distribution lists. Usually, problems with information overload are voiced by recipients rather than senders of information. Typically this problem involves issues of information control--participants receiving unwanted information. Information overload is more likely to occur, according to Mackay (1989), when recipients of large quantities of e-mail have a problem dealing with one or more of the following management issues in regard to: allocation of time; evaluation of information; and/or prioritization of tasks. Information overload was occasionally a concern with the CMC discussions that occurred in this study. Several students commented that there were so many topics initiated at once, that they weren't sure which one to follow. (See chapter four, "Student responses to Daedalus.")

Another potential problem with CMC information exchanges is the risk of misinformation: "Simply increasing the rate and scope of information sharing might only increase the number of misleading and discounted communications" (Sproull & Kiesler, 1991, p. 117). The risk of misinformation was an issue discussed with the teachers involved in this study as well. In the CMC environment, student responses can flood the discourse, and the teacher cannot evaluate each response as is done in the traditional classroom where responses occur one at a time, sequentially. Some students may move onto another interchange before reading the teacher's response or correction to previous

statements. Misinformation and the diminished cues regarding the correctness of information are topics addressed in the analysis of electronic transcripts created at both settings and are discussed further in chapters three and four.

Interactions via computer exchanges may be immediate or delayed regardless of the geographic distance between participants. For example, computer mediated groupware can allow two or more individuals to view the same document simultaneously on their own respective systems and make editorial changes which are displayed on local and remote work stations. This is different from electronic mail which allows simultaneous "chat" among those on the same system, but does not allow simultaneous editing of the same document. The kind of interaction described here provides technical procedures which offer increased social regulation and which may successfully counterbalance the problems with information overload described earlier.

Ability to Convey Affective Cues

In a study comparing CMC with letter writing, telephoning, and face-to-face interactions, Lea (1991) found that, "Users tended to view letter-writing as emotionally rich communication whereas note-writing was considered to be emotionally poor. E-mailing occupied the middle rank between these two written activities: it was rated slightly towards the poor end of the dimension" (p. 168). Face-to-face communications or meetings were preferred when resolving disagreements, providing criticism, discussing alternatives, and building consensus. Lea (1991) concludes that users would choose to use CMC when they desired spontaneous and informal communications which lack a sense of immediacy or personal involvement.

Research by Sproull and Kiesler(1986), Sproull, Kiesler, and Zubrow (1984), Lea (1991), and Rice (1987) suggests that group decisions are influenced by the use of CMC media when compared with outcomes of face-to-face groups. For example, Dubrovsky, Kiesler, and Sethna (1991) report that groups which use electronic networks as a medium

for communicating and making decisions have a tendency to shift toward more extreme positions than face-to-face groups, and electronic groups also have enormous difficulty in reaching consensus. Such shifts in group consensus are believed to be caused by the decreased influence of social context cues in CMC exchanges. Additional research assessing group decisions and consensus-making via CMC (McGuire et al. 1987; Siegel et al. 1986) indicates that computer mediated groups are less likely to come to the expected choice and are more likely to go along with less predictable, more extreme recommendations.

As Dubrovsky et al. (1991) suggest, analysis of the learning task itself should indicate whether communication of social context information is relevant, and thus, whether use of CMC is appropriate. Preliminary research suggests that performance outcomes of some tasks may change significantly when presented to learners via CMC (Sproull & Kiesler, 1991). CMC may be particularly effective for facilitating communications between students and teacher for tasks such as sharing feedback regarding homework assignments (Finholt, Kiesler, & Sproull, 1990). People tend to have longer comments on-line than in face-to-face discussions--partially because the on-line comment is prepared and sent from within a socially deregulated environment. The look of boredom, a negative reaction, or being passed over by other CMC participants is not seen by the sender of an electronic text message.

In the text-based CMC environment communicators feel a greater sense of anonymity and detect less individuality in others. Communications in these text messages inspire less empathy, less guilt, less concern over how one compares with others in the electronic group, and messages sent are less influenced by social conventions (Short, Williams, & Christie, 1976). Text exchanges contain little static information that relates to place, persona, and social position. From the receiver's end, all e-mail looks pretty much the same and e-mail headers convey little about the sender's social rank. Because a person

composing an electronic message lacks tangible reminders of audience, the writer can easily forget norms of appropriate behavior with that audience. This is an issue addressed in this study because students in both settings had to be reminded that the CMC discourse was a public discussion being archived and analyzed (in accordance with each participants prior informed consent agreement).

Because of its limited capacity to convey social cues, text-based CMC offers some advantages as a way to collect information (Sproull & Kiesler, 1991). The computer always treats everyone the same and never gets tired. Electronic questionnaires can ask follow-up questions in a branching design based on respondents answers. Computer interviews, like e-mail, create a feeling of privacy. This sense of privacy makes interviewees somewhat more willing to disclose information than they would in face-to-face interviews or on paper-and-pencil questionnaires. As a result of these factors and based on some empirical comparisons between CMC surveys and pencil-and-paper surveys, Sproull and Kiesler (1991) suggest that the self-disclosure induced in computer interviews has more honesty than that in other methods.

Other studies suggest that the CMC environment may contain less honesty and may, in fact, construct its own reality where participants can suspend their day-to-day persona and become someone else in the CMC ethereal world. Existing research indicates that CMC discussion and conference groups can develop their own social climate and milieu (Myers, 1987; Sproull & Kiesler, 1991). This alternative world may provide a positive outlet for some counseling and behavior rehabilitation interactions. In this regard CMC services have been used to support existing crisis phone lines which offer a greater variety of interactive help and group support services. CMC on-line counseling services are used to offer more peer support and longitudinal interaction to encourage self-maintenance behaviors. This kind of on-going dialogue with one's peers has also proven to be an effective tool for professionals who seek on-line interaction with colleagues having

similar areas of interest. Myers (1987) discusses his observations of the unique social context which was created and sustained by frequent participants in a CMC social discussion group. Over the next few years increasing use and experimentation with more "conversational" modes of CMC will lead to better understanding of this medium and that each individual will learn to use CMC selectively as suits one's personal style, preferences, and requirements.

Organizations, businesses, schools, and groups have developed their own set of protocols and standards for CMC transactions among their members. The development of these protocols has provided a way to respond to the process of deindividuation which occurs when people feel that they have anonymity or when situations lack reminders of societal mores and values. CMC decisions and behavior may be more extreme and impulsive resulting from users feelings of deindividuation. As CMC becomes adopted into the formal patterns of communications within an organization, strong social norms eventually become attached to all common communication technologies and situations (Sproull & Kiesler, 1991).

The fact that the social cues evidenced in a face-to-face group are not evidenced in on-line interactions can have an unpredictable impact on student groups as well. Students respond to assignments in different ways and on different levels. In a traditional class an instructor makes compromises in his or her presentation to maximize the value of the pacing for all students. An on-line discussion has a different sense of timing and can, in some cases and within reason, allow for multiple levels of the pacing and interpretation of the assignment. However, the group participants and the instructor need to agree upon some guidelines for the pacing, or late responses can cause confusion and will be too far out of context to receive replies or be considered relevant to the discussion. Several different kind of examples of the issue of timing in student group work are listed below.

Butler (1992) looks at the forces, dynamics, and characteristics of student on-line interactions to describe how members of an academic, electronic discourse community socially construct knowledge of literary texts. Butler reports that, "The goal in inviting students into the meaning-making discourse could be undermined if students are unable to participate for any of the following reasons: because their personalities and learning styles are in conflict with active learning; because they are not as literate as their peers; because they do not possess the typing skills necessary to keep up with the conversations; and because they do not have equal access to the technology" (p. 286).

In his final interpretations Butler (1992) suggests that participants were aware that the status in the electronic community was influenced by the quantity as well as the quality of participation. Butler (1992) concludes that, "Despite combined efforts of pedagogy, theory, and technology to restructure classroom discourse with the goal of rectifying traditional discourse conventions that conspire to marginalize some members of society, the pervasive influence of our male-dominated culture continued to shape the social construction of knowledge in the electronic discourse community" (Butler, 1992, p. vi).

On the other hand, research regarding participation in the CMC environment reported by Hiltz (1990) suggests that more motivated, more mature students will benefit more from instructional applications of CMC because they are better able to manage their own pacing through the material and have the confidence to initiate more questions and interactions with other students and with the instructor. Selfe (1990) reports that women tend to participate and interact more in CMC activities than in the traditional classroom setting because they are less inhibited voicing their opinions and ideas in the computer-based environment. Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, and Zubrow (1991) found that less able, poorer performing students or those with writing anxiety, will be more comfortable participating in the CMC environment because of the diminished social context of this environment.

These findings regarding participation suggest that what Stubbs (1976) found in the traditional classroom may also be true for the CMC context, and that is that the social situation, not the medium of communication, is the strongest determinant of verbal behavior. This further suggests that the social conventions established in a given CMC environment will determine the nature and characteristics of participation. This study describes the distribution of participation and interaction as well as the social conventions adopted in both classroom settings in order to portray how participation relates to the social situation in the freshman writing and plant science lab applications of CMC.

Supporting Multiple Interactions Simultaneously

Because CMC can support variable response rates and can manage multi-leveled topical themes simultaneously, electronic mail can improve the communication efficiency and productivity of collaborative work groups (Johnson-Lenz & Johnson-Lenz, 1991). CMC can provide very large groups of physically separated people with a convenient, inexpensive communication link more versatile than the telephone.

Long-term effects from implementing CMC technologies come about primarily because new communication technology leads people to pay attention to different things. Patterns of information exchange are changed, and thus, social and organizational structure is changed, as are perceptions of who is important, what is legitimate, and what is prestigious. New communications technology also leads people to have contact with different people and to depend on one another differently (Sproull & Kiesler, 1991).

The asynchronous quality of computer-based interactions make the pattern of discussion in CMC exchanges different from face-to-face exchanges. Face-to-face interactions tend to be linear so that remarks and replies build from one another. In contrast, on-line discussions characteristically have "multiple threads" and a non-linear pattern. With these characteristics, and the fact that participants typically cannot see each other and cannot exchange many tacit signs that facilitate resolving ambiguities and

establishing social control, computer-based communications must compensate for the limited social context of this medium. Research regarding on-line scientific collaboration has found that face-to-face meetings are particularly important for getting a group started, negotiating issues, and addressing problem solving tasks (Kraut, Egido, & Galegher, 1990). Students enrolled in a technical writing class taught completely on-line have suggested that the class meet with their instructor in person at the first session to make the class seem less impersonal (Ruberg, Holmes, & Nespor, 1994).

"Social control is intimately connected with participation" (Sproull & Kiesler, 1991, p. 113). The more people participate in organizational affairs, the happier they seem to be, and the more confidence people have that they can influence others (Feenberg, 1987). Computer networks allow broader access to information and a decrease in the power of traditional gatekeepers. This process can lead to conflict as people who had positions with power view distributed access to information as threatening their position of control (Sproull & Kiesler, 1991). "When hierarchical control of information is strong and information exchange follows strict channels, computer networks and widespread electronic communication have the potential to undermine long-established patterns of management control" (Sproull & Kiesler, 1991, p. 109). In addition, increased, lateral access to information also leads to unsupervised information sharing. This process, which has been well documented in organizations, can lead to conflict within the classroom as teachers and students find themselves adjusting to new roles. In some cases, student-to-student on-line discussion groups may be given the responsibility of regulating themselves (Newman, 1993).

Extensive CSCW research is currently underway to address issues regarding how to make the CMC interface more like face-to-face interaction. Scientists participating in the Portland experiment group were purposefully separated geographically in order to test the effectiveness of a "conversational" CMC network to support interactions among a

collaborative design team. Interestingly, members of this design team reported that even with all the visual and audio cues available through their network system, being able to talk by telephone while using the other CMC technology provided a limited bandwidth for interaction which in some cases helped focus group members and decreased confusion (Olson & Bly, 1991). Members of the Portland development team found from their participant-observation and task-based use of the "conversational" CMC system that the technology allowed team members to collaborate in new ways, and that perhaps the greatest potential of this technology will be found in what it enables us to do that we cannot do well face-to-face. From situated, real world research projects like the Portland experience (Olson & Bly, 1991) we will learn a great deal about face-to-face interactions as well as about CMC.

Network Characteristics

CMC discussion groups function optimally with a larger number of participants than analogous face-to-face situations (Sproull & Kiesler, 1991). Based on this and other unique characteristics of CMC networks, educational researchers suggest the kind of future direction instructional applications of CMC could take. Student-to-student CMC interchange could facilitate increased productivity in collaborative projects in which students are distributed across campus. Newman (1993) suggests that one of the keys to making school network projects successful is the transfer of responsibility for learning onto students. Hunter (1993) and Scardamalia and Bereiter (1993) support this view as well and suggest that successful applications of CMC link school-based learning activities to real world work-related tasks, and in the process of participating and interacting in these CMC lessons, learners become contributors to a collaborative knowledge base which they create themselves and share with others.

Implications for Effective Instructional Applications of CMC

As Kiesler and Sproull (1991) point out, it is important to examine the impact of using CMC in the instructional setting in order to learn how students and teachers will negotiate new patterns of working together on this new communications platform. The patterns of social interaction and hierarchical control of information flow typical of the traditional classroom may not transfer over to the CMC environment. CMC offers communications access and capabilities which were previously either impossible or too expensive to consider (Mackay, 1989). Computer communications technology enables students and teachers to exchange, store, edit, broadcast, copy, and send written documents instantly, conveniently, and relatively cheaply over short or long distances (Kiesler et al., 1984).

Much has been written about the revolutionary changes in the social organization of the classroom, but still little is known about the impact that digital communication technologies will have on the organization of schools and systems for learning. Current views of learning suggest that computer-based communications media are powerful tools to encourage progressive work on a problem wherein "ideas remaining active over extended periods of time [can be] revisited in new and unexpected contexts" (Scardamalia & Bereiter, 1993, p. 38).

In an evaluation of the use of an enhanced CMC system which was used for learning and communicating, Hiltz (1990) investigates whether it is possible to use CMC to improve the access to and the effectiveness of post secondary educational delivery" (p. 133). Based on pre- and post-course survey questionnaires, grades, analysis of on-line activity, and qualitative observation and interviews with some 232 students, Hiltz reports that CMC is a viable option for post secondary educational delivery under certain conditions: (1) adequate access to equipment; (2) faculty participants who are comfortable,

skilled, and willing to put in the time to adjust to teaching with the technology; and (3) students who are motivated to explore CMC technology, have some self discipline/maturity, and have average or better quantitative and verbal skills (as indicated by at least average scores on standard tests such as the SATs). Students who lack internal motivation or basic college-level skills, or who must travel to use a computer for accessing CMC material are likely to drop out, participate more irregularly, and perform poorly than they would in a traditional course.

Students who participate in traditional classroom-based instruction programs can use CMC to get access to course lecture notes and bibliographical information and to participate in course-related dialogue with fellow students (in which student participation will be reviewed by the class instructor). Traditional classroom-based instruction programs will also make use of CMC as a tool to facilitate cooperative learning projects done within and outside of class. Courses using computer networks can also make use of CMC as a medium for students to share their writing and ideas for research projects with each other--either to seek comments and suggestions on early versions of a paper, or for a teacher or student to share their good work with others who are interested in that topic. Once students and teachers begin sharing their work on-line, the need for having better search, store, and retrieval tools available to support extensive CMC interaction is paramount. A hypermedia interface which is powerful enough to perform complicated searches would be appropriate. From this tool, students could build "semantic trails" of their searches and constructive interactions with the course material.

Ultimately, as our understanding of appropriate instructional applications of CMC increases, our understanding of how media can be used to facilitate learning will likewise increase. As we broaden our understanding in these areas, we also improve the likelihood that we can help more children and adults by offering additional constructive learning

environments which can be brought into the home, place of work, and other locations where people gather together, as well as into the schools.

Expectations Regarding the Social Psychological Impact of CMC in Both Settings

This review of prior research regarding social psychological characteristics of CMC, in comparison to the traditional face-to-face classroom, suggests a profile of social behavior we would expect to occur in both settings of this study. Appendix D provides a list of these characteristics and shows how each of these traits is reflected in the research questions addressed in this study. The presentation of data provided in the subsequent two chapters shows how many of these characteristics were expressed in one, or the other, or both settings. Chapter five provides a summary of how many of these expected characteristics were expressed and responds to the research questions associated with each characteristic.

Thompson (1989) suggests that communication behavior expressed in small sized electronic groups may follow similar distribution patterns as that of face-to-face small group discussions. Brown, Palincsar, & Armbruster (1984) view CMC educational environments as a part of the shift from using technology as a cognitive delivery system to using it as a means to support collaborative conversation about a topic and the ensuing construction of understanding. This position reflects what Hawkins, Frederiksen, Collins, Bennett, and Collins (1993) refer to as the performance assessment of learning, which suggests that competence in a discipline includes verbal presentation and explanation skills, the ability to answer questions and challenges in exchange with others, and the ability to try out different conjectures and subsequently revise one's own. This is the kind of curricular use of CMC that teachers in both settings observed in this study strove to achieve.

Chapter 3

Interaction and Regulation in the Freshman Writing Electronic Community

Introduction

Why This Case Was Worth Studying

Traditional writing classes have involved students completing writing assignments which are turned in and reviewed by the instructor, who then gives feedback in one-to-one written or verbal dialogues between the instructor and student. This suggests the novice-expert or pupil-tutor model of teaching and learning. With the advent of word processors and networked computer labs, the one-to-one model for teaching writing has been challenged for several reasons. Studies (Faigley, 1992; Hillocks, 1986; Ochsner, 1990; Sitko, 1993) conducted in the 1980's have shown that students write better when they are writing for each other than when they are writing to the teacher. The two situations of writing greatly differ. In peer writing situations, students become more conscious of their audience and put more effort into considering how they present what they have to say as well as what they say. In assignments written for the teacher, students direct their writing to fulfilling the assignment and in some cases try to write what they think the teacher will want them to say.

Writing for one's peers puts the act of writing into a broader social context for students and provides a way to impress upon students that writing is a process of communication. The final judgment regarding whether a piece of writing is effective or not is based on responses from the targeted audience and context. By writing for one's class, a student gets practice with this aspect of writing. Whether a piece of writing is correct or not (which is the typical focus for grading purposes by a composition instructor) is a

different question than whether a piece works or not--this is a contextual question and cannot be answered without an audience. Learning the technical aspects of writing is crucial to good writing, and the direction and guidance needed to learn the technical skills must come from a knowledgeable expert in writing. Learning how to make a piece of writing serve its rhetorical purpose requires a context and an audience of more than one, and using computers to communicate via writing has been an effective way to give students experience with writing to an audience of peers within a contextual setting.

The Daedalus Interactive Writing Environment software provides several different tools for facilitating student writing for each other, their teacher, and for a geographically distributed audience if desired. However, little is known about how to design interactive writing assignments which will facilitate the kind of interactions and participation and learning desired. This study provides specific, classroom-based descriptions of how student interaction and participation were expressed in a freshman writing class.

Background

Introduction to Setting

I got to know Jeshua Pacifici through my participation in the evaluation of the Technical Writing course taught exclusively via electronic mail. Pacifici works for Academic Computing Services where he performs a variety of computer consulting activities on behalf of the Information Systems Division (ISD) of the university. One of Pacifici's assignments has been to serve as technical consultant for the computer-based sections of technical writing. Pacifici was also given the opportunity to teach one section of the Freshman writing course as part of his ISD work. Pacifici was enthusiastic about doing this classroom teaching because: (1) his academic background is English (he has bachelors and masters degrees in English from this university); (2) he enjoyed his previous

experience as an instructor in the English Department; and (3) teaching freshman writing would allow him to have direct experience with the Daedalus software and would provide valuable, first-hand feedback to computing services. Even though Pacifici is affiliated with the university computing division, he was somewhat skeptical and simultaneously curious about how the Daedalus software could improve his teaching.

Pacifici was one among several freshman composition instructors to have classes scheduled in the newly finished computer-equipped classroom situated in Williams Hall, where the English Department is housed and where most English classes are taught. The Computer Integrated Classroom (CIC) in Williams is a modern-looking oasis within this building which contains about 120 traditional-style classrooms. The typical classroom in Williams Hall consists of several rows of chairs with partial writing tablet tops which all face forward. A blackboard and in some cases a large wooden teacher-desk define the front of the classroom. The CIC, however, represents a contrasting classroom layout with the focal point for both the instructor and the student being the computer screen.

Figure 4 shows how the student workstations are positioned facing opposite sides of the room. The instructor's workstation is positioned to set in the front corner of the classroom at an angle that allows fairly good visual contact with students as they work on-line. The instructor workstation can also be used to project a visual presentation program on a large screen situated in the front of the classroom. As Figure 4 shows, the CIC can accommodate up to 25 students with a computer workstation for each student.
All of the computers in this classroom are linked together via an ethernet network and software used on these machines, including Daedalus, is accessed through the CIC Apple server which is housed in a restricted access location outside the CIC. All the Macintosh Centris 650 computer workstations for students in the CIC have the At Ease™ interface which provides an icon-based menu of the utilities, software, and applications available on each individual computer. The focal point of this classroom was the computer screen.

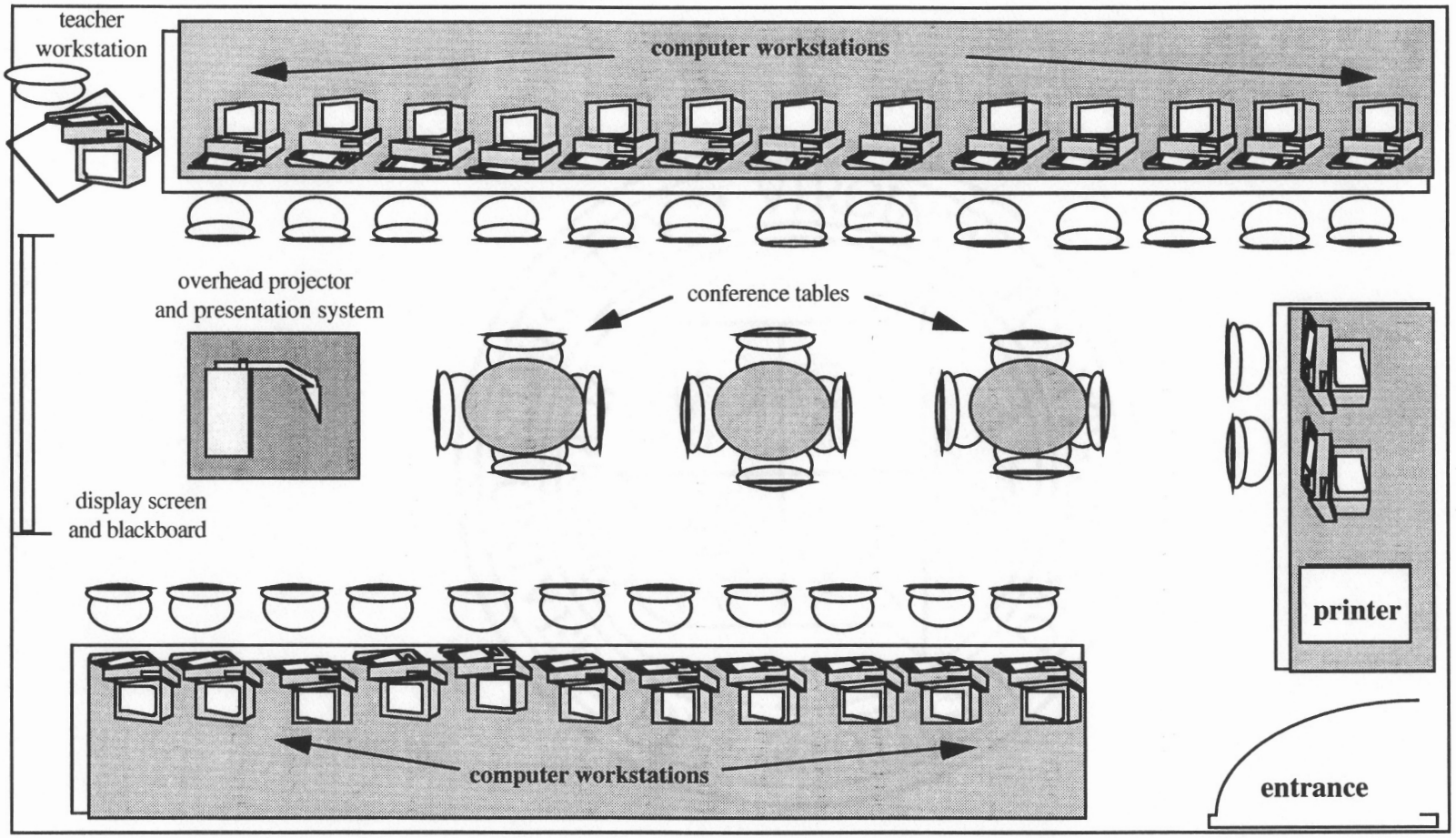


Figure 4
Layout of Computer
Integrated Classroom (CIC)

Students faced away from each other and away from the front of the room. The room was set up for the electronic display to be the central vehicle of communication.

The Instructor Gets the Class Started.

At the beginning of his talk to the class, Pacifici encouraged students who were not interested in the reading material for this class, nor interested in working in the CIC one class per week, or did not want to participate in this research study, to switch to another section of this course better suited to their interests. Many sections of freshman writing are offered each semester, and the instructor for each section uses their own discretion in selecting the reading materials and writing assignments for their specific classes. The reading materials for this class included expository, narrative, philosophical, and poetic/meditative writing from authors of diverse backgrounds and nationalities.

All students were given a class syllabus to follow along with while Pacifici led the class through a verbal description of each topic. Pacifici read aloud the course objectives from the course syllabus which are summarized below:

- Students will develop skills in close reading of texts and sharpen their verbal and listening skills through discussion, collaborative work, and oral presentation.
- Analysis and critical thinking will be improved as students come to better understand how to locate a position from which they can write with authority and insight.
- Students will refine their notions of "evidence" and "argument" and move beyond the five paragraph theme and the agree/disagree formula.
- Finally, students will learn through revision to modify their original assumptions and open out their work in new ways.

Pacifici emphasized the following three points as being his goals for this class as the instructor:

1) to get students to write more clearly, and more effectively

2) since good writing is preceded by good thinking, to encourage students to improve their critical thinking skills

3) to use the course activities and assignments to place students in the position of really wanting to say something.

Evaluation of Participation

Pacifici gave the students a few guidelines regarding the computer-based discussions that would be a regular part of this class. Students were encouraged to participate in the on-line discussions at their own pace as they chose. "Speaking" on-line can provide students with a different platform to express their views without feeling like they're in the spotlight. Pacifici mentioned that he used the Daedalus program in the CIC with students in his class last semester and was very pleased with the results. Based on his personal observations and on individual comments, students found that they could talk on-line comfortably.

Pacifici explained that student participation in the on-line discussion would be a part of their grade. Normally students would receive a "check" for their participation. Students who showed extra effort at facilitating the discussion with encouraging and constructive comments would receive a "check plus." Students who obstructed or inhibited the class discussion would receive a "check minus." The syllabus for this course described all aspects of the course grading and included the computer-based discussion exercises as part of each student's evaluation. This activity was included because Pacifici considers class discussion and on-line participation to be a valuable part of the learning experience.

Introducing Daedalus and Gathering Initial Data

After a brief introduction in which I explained that I was working on a dissertation research project which involved the use of the Daedalus software. I presented a "hands-on" introductory exercise to the class. I gave students a brief summary of what I would be researching throughout this course with their permission. I distributed the consent forms,

computer attitude index, and background survey which I asked students to read, complete and turn in before leaving the classroom. Pacifici and I then worked together to give the students a quick overview of Daedalus which would lead them into their first interchange in which they would answer some introductory questions about: (1) their goals for this course, and what kind of writing skills and experiences they want to get from this class; (2) what kind of writing they most enjoy--e.g., letter writing, writing in their personal area of interest, fact-based writing or personal essays; and (3) what kind of writing they least enjoy. (See Table 6.)

After completing their introductions, students were asked to move into a second Daedalus Interchange in which a selection from the Scott Peck book was already entered along with a question about this selection to initiate student discussion. A few students who weren't familiar with using a mouse had some difficulty getting Daedalus started because they accidentally clicked outside the document and went into the Finder mode. Students seemed to find the Daedalus activities easy, because the program responds like a simple word processing program--except when moving in and out of different environments and manipulating the multiple window screens. Since most of the students were more familiar with DOS- or Windows-based systems, part of understanding Daedalus was getting used to the Macintosh system.

By the end of class the students had created two separate discourses using the Daedalus Interchange system. The first interchange was an informal introduction activity which was designed to get students to share a little about themselves and their views about writing. In the second interchange students were asked to read and respond to a selection from the first of the assigned reading materials. These interchanges will be discussed further in the description of students and analysis sections of this chapter.

The ratio of males to females was three to one in Pacifici's fall semester class, and men out numbered women two to one in this section also, with 16 males and 8 females at

the first class. Three of the male students present at this first class meeting had also taken Pacifici's class in the fall semester and had made special arrangements to take his section for the second sequence of the freshman writing requirement.

All together students spent about forty-five minutes working on the two computer-based interactive writing exercises. Combining these transcripts, students created and sent some 47 messages which is equivalent to fewer than two messages per person. Students responded well to the introductory Daedalus assignments and for the most part were comfortable participating. Four of the students at the first class completed the printed survey materials and consent forms, but didn't contribute a message to either interchange.

Students were asked to complete and return the entry survey, computer attitude index, and consent forms before leaving the classroom. Those who were considering switching to another section could ignore these materials. I stood near the doorway and reminded each student as they left to turn in the survey and other materials for my research study. Students were given the opportunity to select their own pseudonym on the bottom of the consent form, and a number of students did so.

Characteristics of Alternate Classroom Setting (Face-to-Face)

On Tuesdays, Pacifici's freshman writing class met in a traditional classroom setting with no computers--simply six rows of desks facing the blackboard in the front of the room. Based on my observation of the class in this setting I constructed the following description of student participation and interaction in the face-to-face setting of this class.

> Pacifici speaks to the class in an informal, conversational manner and students listen attentively in relaxed postures of lounging and comfortable slouching over the desktops. Even though Pacifici's manner in and out of class is relaxed and calm, he leads the class discussion in a disciplined manner. While the atmosphere is relaxed, the social interactions are clearly structured. The teacher regulates the pacing and sequence of the discussion, and students who participate are recognized and invited to participate in the discussion with a nod, vocal recognition, or other informal gesture. Students show respect to Pacifici and appear to be comfortable with him in the position of authority as their teacher. They are quiet, attentive, and seem to concentrate on what he has to say (Fieldnotes).

In this traditional class setting only five to six students participated in the teacher-led discussion, and usually it was the same five or six who participated in each class. Based on a discussion with Pacifici and on observations from sitting in on the traditional class on at least six occasions I can describe the students as: (F) those who always or very frequently participate in class; (M) those who sometimes, but not consistently participate in class; and (R) those who rarely to never participate in face-to-face class discussions. Table 4 describes each student as being in one of these three categories. As Table 4 shows, the majority of students--11 out of 22-- fall into the category of those who rarely participate. Seven fall into the middle group, and four are considered consistent, frequent participants.

Description of Data Sources

Data describing student attitudes towards and prior experience with technology were obtained primarily from surveys distributed to students during the initial class meeting, capstone event, and final class session. Additional data describing student responses to the electronic interchanges used in this study were obtained from observations of students as they were using this technology, and from informal interviews with students during, before, or after class sessions. A profile description of the students participating in this study follows.

Student Initial Self Reports. This class included twenty-two students who were all in the second semester of their freshman year at Virginia Tech. A one-page introductory survey distributed to the students during the first class asked for information regarding: 1) computer experience; 2) experience with collaborative learning activities; 3) background information; and 4) computer attitude scores. In addition to the printed survey, students used the Daedalus Interchange for the first time to share their views about their goals for this class and what kind of writing they liked the most and the least.

Table 4

Description of Student Participation in Traditional Classroom Setting

Describes the level of participation of each student in the traditional classroom:
F = Frequent to always
M = Moderate to occasionally
R = Rare to never

Student Pseudonym	Level of participation in class
Steve	R
Demi	R
Stephany	R
Bryan	R
Candy	F
Kahil	M
Marcus	M
Kevin	F
Dave	M
Beth	M
Abby	R
Surfer	M
Nathan	R
JR	R
Matt	F
Velva	F
John	M
Josh	R
Max	R
Houston	R
Ray	M
Ian	R

From the pool of information gleaned from the initial surveys, which are summarized in Table 5, the group of students who chose to take this class were experienced computer users who viewed collaborative activities as increasing learning. Every student in this class had prior experience using a computer to do at least word processing. Only three students had prior experience with Hypercard, but 17 out of 22 students had a course in high school which required using a computer and many of these courses introduced the students to programming activities. Thirteen students in this class reported to have had prior experience using electronic mail, which means that at least half of the class had used the computer as a communication device. Nearly all the students who owned a computer had a DOS or Windows-based system, and students overall were less familiar with the Macintosh systems used in the English CIC lab. Nearly half (10 out of 22) of the students reported that they began their writing directly on computer; half reported that they began their composing on paper; while one student reported beginning either on computer or paper. The majority of students in this class (17 out of 22) owned their own personal computer. Surprisingly two of the five students who did not own a computer reported that they began their composing process on computer, not on paper. Thus, even those who didn't own a computer relied heavily on having access to a computer to do their writing.

Discussion of Introductory Interchange. Five of the students who attended the first class switched to another section. As in all other references to individuals who are quoted in this study, the names of these students have been changed to protect their anonymity. The spelling, grammatical, and typographical errors in this as in all other selections from the electronic transcripts have not been corrected in order to display the exact content of the original electronic messages.

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Rodney:
My main goal for this course is to become a better thinker and
```

Table 5

Summary of Computing Experience

Own their own computer	Yes (17) No (5)
Compose their writing first (a) on computer (b) on paper	on computer (10) on paper (11) on both (1)
Use computer: Daily Every other day Only as needed	Daily (7) Every other day (9) Only as needed (6)
Program he/she is familiar with: Word Processing Hypercard Electronic Mail Other	all have used word processing programs (19) are not familiar with Hypercard; (3) are (9) have not used e-mail; (13) have
Had at least one course in high school which required using a computer	Yes (17) No (5)
Summary of kind of high school courses required using a computer:	Engineering Programming in Basic, DOS, & Turbo Pascal Computer Drafting English/Writing Center/Word Processing "Programming Old Apples" Business Computer and Programming Computer Science Applications of Computers Information Systems Computer Graphics Math Applications
Previous exposure to collaborative activities: in high school at Virginia Tech	(17) had hs collaborative exp.; (5) have not (9) had VT collaborative exp.; (13) have not
Student attitudes towards collaboration: Frustrating	(13) said collaboration was not frustrating, (2) reported it was frustrating
Productive	(18) said collaboration was productive; (1) said it was not
Increases learning	(18) said collaboration increased learning; (none) said it did not
Student academic majors:	Electrical, Civil, & General Engineering (8), University Studies (2), Forestry and Wildlife (2), Math (1), Early Childhood Education (1), Psychology (1), Architecture (1), Biology (1), Computer Science (1), Business (1), & Undecided (1)

consequently a better writer.
I most enjoy writing personal essays.
I least enjoy writing when dorks like you are reading it.

Daryl:
1. From this class I plan to gain writing experionce that will help me succeed in the college atmosphere as opposed to the type of writing that would have been considered acceptable in High School. My goal for this class is to pass with a B or better.
2. I most enjoy writing essays that pertain to my areas of interest.
3. I least enjoy writing essays that reflect upon and analyze a novel that we were forced to read.

Manny:
1. Honestly I do not have any particular goals for this class. Perhaps the only one would be to get through it without learning to totally dislike this subject.
2. I do not enjoy one form of writing over any of the others.
3. I do not like writing long boring essays on an authors work or works.

Julian:
1. I would like to gain a better understanding of different readings and to become a better writer.
2. I enjoy fact-based writing rather than creative writing.
3. I don't enjoy real deep and drawn-out writing.

Tammy:
My goals for this course are to become a better writer and try to enjoy reading more. I do not know.
2. I like to write nothing, however I prefer to write research papers.
3. I least enjoy creative writing.

As Table 6 illustrates, the students who self-selected to stay with this class expressed a strong preference for writing about subjects that were of a personal interest to them. The process of writing research papers was commonly cited as their least favorite kind of writing. To this group of freshmen, the process of writing was most enjoyable when it was in an informal, open format in which they could express their personal interests, opinions and feelings. The students' desire to write about things that were personally meaningful matched well with Pacifici's view that students write better when they are presented with a provocative topic which provokes them to think.

The students generally had compatible goals and interests in what they hoped to get out of this course. Nearly all of the students mentioned that they wanted to improve their writing skills, and some students had more specific objectives for improving their writing, sentence structure, and grammar. All the students mentioned that they preferred to write about things that they were interested in and knew something about, and that they especially enjoyed writing personal essays. All the students seemed to agree that they did not like writing research papers or essays on topics in which they had no interest.

Daedalus Interchange Transcripts

The Daedalus assignments presented in the freshman writing class were designed to help the novice writer learn to read critically and have access to a non-threatening, constructive forum in which they could express their critical thinking with their peers. The Daedalus Interchange function was used as a way to facilitate complex discussions of reading assignments or of additional selections of writing. Student discussions were typically given some initial points by way of several questions posted at the inception of the interchange by the instructor. Faigley (1992) provides a useful description of his experience with Daedalus Interchange:

> ....Interchange has drawn the most attention because of the copiousness and intensity of discussions. Students see an ongoing list of messages sent by everyone in the class, scrolling upward on their screens as they are posted. When students decide to contribute to the discussion, the software permits them to introduce with one key stroke a "message" window on which they can compose. Another key stroke allows them to "send' that message, which then appears at [the] end of the list of messages on the screens of all the student in the class. The result is a hybrid form of discourse, something between oral and written, where the conventions of turn-taking and topical coherence are altered. Another difference from oral discussion is that students can move back and forth in the emerging transcript to check what was "said" earlier. (p. 168).

Faigley (1992), Kemp (1993), and many others (Butler, 1992) have used electronic discussions to fundamentally restructure their instructional methods and greatly

Table 6

Student descriptions of the kind of writing they like verses what they dislike
(from first Daedalus Interchange)

WRITING STUDENTS SAY THEY PREFER	WRITING STUDENTS SAY THEY DISLIKE
Steve: I enjoy writing about topics that are up-to date in the news. I really like to write about a topic where my opinion is important.	I cannot write on the spur of the moment. I have to have time to think about the topic before I do any kind of affective writing.
Demi: I most enjoy personal essays.	I least enjoy writing about subjects that I am not interested in.
Stephanie: I love to write letters and personal essays. Writing about personal experiences is always interesting.	...writing about a piece of literature or a subject matter that did not interest me.
Bryan: I enjoy writing about my areas of interest	Writing about literature and other peoples writings.
Candy: I enjoy personal writing about different novels or creatively.	Writing about a subject that didn't interest me.
Kahil: I mostly enjoy writing essays regarding my view on things, and poetry.	I would probably [dislike] research-related writings.
Marcus: Personally, I am not comfortable with writing, so I need to write about something that I am interested in or something I am familiar with.	I don't enjoy writing on things that I am unfamiliar with.
MacMurphy: I like to write about my personal feelings on a certain point of view or reading	Fact based writing
Beth: I like fact-based writing and letter writing.	I don't really like to write poems and argumentative papers.
Abby: I enjoy writing informal letters to my friends.	I hate to research topics and write papers about them.
Surfer: I most enjoy writing persuasive or opinionated essays, along with some poetry and short stories.	I really do not like research papers.
JR: Personal essays and creative writing	Technical or fact-restricted writing
Matt: I love to right about subjects that I have a knowledge about and I also like to write poetry.	I hate to write term papers and reports on subjects that are boring or have no substantial meaning to life.
Velva: I like to write letters and personal essays.	I hate writing research papers.
Josh: I usually don't like to write much of anything unless I have something to say that I'm am feeling.	I really hate doing research and having to write a technical paper about some event or occurrence. I would prefer to do more original work.
Ray: I enjoy writing in my area of interest because if I am not interested in my work, it will be done poorly, if at all	I do not enjoy writing papers on subjects which seem trivial or unimportant.
Ian: I enjoy writing on topics that are down to earth and straight forward. I also like writing about how I feel about different topics.	I hate writing when there are a lot of restrictions and guidelines. I also hate writing about topics that do not interest me.

increase and change the dynamics of student participation. Increasing student participation in class discussions was one of the goals for using Daedalus in Pacifici's freshman composition course as well. In the preliminary study of Daedalus in Pacifici's fall semester class we found that the electronic discussions consisted of 85 percent student-created comments, which was nearly the mirror opposite of the class discussions in the traditional setting, in which the discussion was 75 to 85 percent teacher-created comments. In his individual interviews with students in his fall semester class, Pacifici was told by several female students in his class that Daedalus offered them a comfortable way to participate in class discussions. Speaking in the traditional face-to-face class continued to be uncomfortable, but participating in Daedalus never made them feel "in the spotlight" and was preferable for this main reason. Selfe (1990) and Bump (1990) also report increased participation by women in classes using electronic written discussions.

These findings portray events which conflict with other studies of participant behavior in on-line communities which suggest that traditional cultural stereotypes are transferred to the electronic environment (Butler, 1992). In his study of an advanced writing class using Daedalus Interchange for class discussions, Butler (1992) found that the teacher's loss of power in the electronic discussion environment created a power vacuum which was filled by the power structure of the surrounding culture, which in his case meant that academically oriented males dominated the discourse and women and minorities were less integrated into the discussion. The analysis of interchanges from the freshman writing class described later in this chapter will address these issues.

Description and Interpretation of Capstone Data

Theoretical framework

The teaching of writing has been greatly influenced by changes in how we view the process of writing. Graves (1981) defines the writing process as "a series of operations

leading to the solution of a problem. The process begins when the writer consciously or unconsciously starts a topic and is finished when the written piece is published" (p. 4). According to Hillocks (1986) this definition is useful because it points out that some aspects of composing take place long before the physical act of writing begins, and it suggests the kind of thinking that goes on as a writer encounters, contemplates, and evaluates experience. This view of writing matches well with the constructivist position in which this research study is grounded. Describing writing as fundamentally a problem-solving process means that the process of writing is like any other kind of cognitive learning and involves the construction of new knowledge which is represented in the student's writing (Resnick, 1984).

As a problem solving activity, writing involves a series of pre-writing, composing, and revising tasks which freshman writers may have a vague or knowledgeable sense of depending on their prior writing experiences. By conducting the capstone peer review exercise in the electronic learning environment students could share their thoughts, questions, and critical views regarding the writing selection and their assessment of it. This process of sharing and interacting with others speaks to a fundamental tenet of the constructivist view of learning. Cognitive growth involves internalizations and transformations which come about in social events in which participants with different understandings or analyses of the situation negotiate solutions (Newman, Griffin, & Cole, 1989). Exposing students to the process of evaluation in a peer review provides them with much-needed practice in applying critical standards (Tuttle, 1986). The process by which they critically assess the writing of a stranger can be applied to peer reviews of writing by classmates and most importantly, to their own work.

The descriptions of on-line behavior are less valuable if merely used for a comparison with traditional classroom interactions. The computer-based interactions are more interesting when described and interpreted within their own context and in regard to

whether they are facilitating the purpose and/or goals for which they are being used. This was a major point which came up in my interactions with the instructor in this setting. Designing class activities to occur in the Interchange environment meant thinking about different kinds of things to do within a class period and were not about moving what was already being done to this medium. This was extremely difficult and required some willingness to experiment and take some risks and to sometimes be wrong, which happened when we had students working in groups of four to five to answer questions on-line, then come to consensus, and then share their consensus summaries with the class. The students quickly picked (or delegated) someone to be their spokesperson and usually all but two dropped out. The group was too small and the task was better suited to face-to-face interaction for reaching consensus. The capstone task was positioned to occur in the later half of the semester when students, their teacher, and the researcher had adjusted to the technology and ways to use it to facilitate student participation and interaction.

Description of Capstone Procedures

Throughout the capstone process students were encouraged to speak up if they needed any technical assistance or had any other questions about the assignment. Students were told that this activity was part of my research study, but that it was designed to have value for this class and for them personally. Since grades received on essays and other writing assignments may seem subjective and not always consistent from class to class or from teacher to teacher, the rating scale used in the capstone was the same scale used to evaluate student writing in formal testing programs. Use of this form was intended to give students a clearer concept of how to evaluate their own writing as well as that of their peers.

(1) Students logged onto Daedalus and read the assignment for this class. A selection by Rumi was displayed in the assignment window. Students were asked to read the writing selection carefully because this was the piece of writing that they were asked to

rate and discuss for the capstone activity. Students were reminded that they could refer back to the assignment window as often as they wanted to throughout the class.

(2) After reading the Rumi piece students were asked to go to the Daedalus Mail environment and open the mail message from Pacifici sent to them earlier that day. In this mail message was a copy of the Composition Rating Scale which each student was asked to complete and mail back to Pacifici. A copy of the Composition Rating Scale is contained in Appendix A.

(3) Students were not given a time limit on how long they could take to complete the review and rating of the Rumi selection. However, in the verbal introductions to the class activities, students were advised not to take more than a few minutes to complete the rating activity.

(4) After sending their initial rating scores, students posted their comments about the piece in three different interchanges which were set up to coincide with the three levels of analysis in the rating scale: content, style, and writing conventions.

(5) Once all of the students had read through the interchange comments and posted their own message(s), students were notified verbally to send their final comments, leave the interchange discussion, and go back into Daedalus mail and open the second mail message they received from Pacifici. Students were asked to rate the Rumi piece for a second time using their new, clean copy of the rating scale. Once they had completed their second rating, students were asked to send this rating to Pacifici.

(6) Once all the second rating scales were mailed, students were asked to complete an open-ended questionnaire which asked students to describe their reactions, attitudes, and thoughts about the use of Daedalus thus far in this course. Once students completed this questionnaire, the capstone was completed.

Interchange Discussions

Description of Interchange Data

A summary of the coding of each of the three capstone interchanges plus the post capstone interchange is provided in Table 7. As this table shows, the Content interchange had a total of 63 messages which is more than three times longer than any of the other interchanges. In addition to being longer, the Content interchange also has a greater variety of interactions than the other three interchanges, and for these reasons will be discussed in more detail than the other interchanges.

Content Interchange

This was the first of the three simultaneous interchanges which students participated in as part of the capstone event. In the composition rating scale, the content issues account for 50 percent of the assessment criteria. The questions already posted for students and which they would see as the first message in this interchange posted under the instructor's name is shown below. These questions were developed and put in under Pacifici's name the day before this class. The Daedalus program is structured so that there can be only one instructor per class, and Pacifici was comfortable with my using his Daedalus password for this class to set up Daedalus activities and having access to interchange transcripts for my research.

I have inserted the first 11 messages of this interchange (which represent the initial quarter of the messages) which includes a total of 63 messages in the complete transcript. I will use this selection from the interchange to illustrate some key features of the electronic "conversation." The first eleven messages posted in the Content interchange follow.

```
C1/63    Jeshua Pacifici:
Did you feel that this piece was:
(1) convincing; (2) organized; (3) thoughtful; (4)
expansive; and (5) specific?   Please explain your
evaluation of this piece in these areas.
```

C2/63 Kahil:
This piece used powerful descriptions to re-enforce the author's views. It was organized enough to hjelp moake the piece more convincing. The idea of this malevolent God he describes is very creative and eye-opening. Very expansive.

C3/63 Matt:
I felt that this piece was very convincing. The author must be a very spiritual and imaginative person. It could have been more organized, but it had an enormous effect as it was. It was extremely thoughtful, especially the similes and the way the author expresses that that things are not always what they seem to be. The author could have been more specific. This is a very powerful piece.

C4/63 Jeshua Pacifici:
Kahil: why do you refer to a "malevolent God?" The image is one of a magician.

C5/63 MacMurphy:
rumi used powerful descriptions to convay his messages. His piece was organized very well which also reinforced his views. Te messages in his work make you stop and think about what he was saying.

C6/63 Demi:
It was obvious that the author put a lot of thought into this piece and the descriptions he used were were very good. His choice of words and and the way he presents his view done in a very conviencing manner. Although I thought the piece was very powerful I feel that he could have been more specific.

C7/63 Marcus:
I feel that this piece could have been more convincing. The meaning or theme of the piece was vague. I guess that I am used to Scott Peck's style of writing. Peck states exactly what he wants you to learn, while Rumi hides the meaning and makes you search for a theme.

C8/63 Jeshua Pacifici:
Although there is magic and perhaps "trickery" in reality the voice of the fire is the voice of "truth" saying "I am not fire. I am fountainhead. Come into me and don't mind the sparks." Does this sound malevolent? Is this cruel? Later the writer states "If you are a friend of God, fire is your water."

Table 7

Description of Capstone Interchange Data

Interchange	Total # Messages & (# Directed Messages)	Total # Positive Reactions	Total # Attempted Answers	Total # Questions	Total # Negative Reactions
Content	63 (14)	22 student: 14 teacher: 8	140 student: 124 teacher: 16	17 student: 2 teacher: 15	3 student: 3 teacher: 0
Style	21 (0)	0	61 student: 59 teacher: 2	2 student: 0 teacher: 2	1 student: 1 teacher: 0
Writing Conventions	19 (2)	6 student: 6 teacher: 0	36 student: 31 teacher: 5	3 student: 0 teacher: 3	1 student: 1 teacher: 0
Capstone Total	103 (16)	28 student: 20 teacher: 8	237 student: 214 teacher: 23	22 student: 2 teacher: 20	5 student: 5 teacher: 0
Post Capstone	18 (0)	14 student: 14 teacher: 0	36 student: 36 teacher: 0	4 student: 0 teacher: 4	13 student: 13 teacher: 0
All Total	121 (16)	42 student: 34 teacher: 8	273 student: 250 teacher: 23	26 student: 2 teacher: 24	18 studen t: 18 teacher: 0

C9/63 Josh:
This work was thoughtful and the author expressed his views very well. He sometimes lost my interest and seemed to wander. It was also somewhat difficult to understand at times but it had a good point and was very well put. You could feel and taste what he was saying.

C10/63 Jean Blake:
I also enjoyed the piece and felt it was very powerful, but I was a little confused by it. The imagery is somewhat confusing. I associate the fire with acts of passion--perhaps violence. How can this lead to the cool waters? Can anyone explain this for me? (55)

C11/63 Jeshua Pacifici:
good assesment Matt!

Instructor's influence on-line. In this excerpt of the first 11 messages, the instructor has contributed four messages and has a strong impact on the early part of this discussion. His first message, placed hours ahead of time, is designed to lead the discussion and give a direction to student comments. His second comment is a directed response to Kahil who is frequently the first or nearly the first to participate in the on-line discussions. Kahil is one of the several students who had Pacifici last semester and made an effort to get in his section of the second semester offering of this course. In Pacifici's third message on-line he answers the follow-up questions he directed to Kahil and quotes several specific passages from the poem to clarify his interpretation with specific references to the text. Although this message was stimulated by Kahil's comment, it is directed to the whole class. Pacifici's fourth comment (C11) in the linear sequence of the transcript) calls attention to Matt's comment (C2) as a "good assessment."

The exchange between Pacifici and Kahil is somewhat similar to the IRE sequence in the traditional classroom. The follow-up directed questions to Kahil and later clarification for Kahil and the whole class is observed by the whole class and influences subsequent interactions. Pacifici's praising comment to Matt represents a positive social-emotional act and at least temporarily raises Matt's status in the class. Pacifici's interaction

with Kahil was not disagreeable or antagonistic, but was corrective and obviously meant to be instructive. Kahil does not send any additional comments to this interchange. Matt, boosted by the positive recognition by Pacifici, posts four additional comments in this discussion--one which is directed to Pacifici and follows up on Pacifici's clarification (C8) for the whole class posted in response to Kahil's comment (C2).

The message flow analysis in Figure 5 also illustrates how the instructor has a great influence on the direction, tone, and outcomes of the discussion. The first initiation, two subsequent reply-initiations and two final initiations by Pacifici move the discussion from one topic to another. Figure 5 shows that students move from one topic to another in response to the initiating messages from their teacher. The evaluation comments by Pacifici also have an influence on the discussion. The student who received two directed positive evaluation comments from the instructor was also the participant with the highest volume ratio (.11), highest participation ratio (.08), lowest (most frequent) participation frequency (12.6), and highest integration ratio (1). As the message flow analysis in Figure 5 shows, the initiations, replies, and evaluations by the instructor guide and direct student participation and interactions.

A closer look at student participation. Reviewing the Bales Interaction Analysis coding for each participant shows that by far the majority of messages posted in this interchange were statements of opinion and ideas and clarifications of these thoughts. These kind of comments are expected and have been requested by the initial questions. What is of interest in this study are the comments which fall outside what Bales calls the "task neutral" area and reflect either a positive or negative social-emotional message.

One of the positive comments posted to the discussion by the instructor has already been mentioned. All together the instructor initiated five additional short, enthusiastic, personally directed comments posted to the discussion which are as follows:

C26/63 Jeshua Pacifici:
good assessment Nathan!.

C31/63 Jeshua Pacifici:
good answer Velva - Maya means illusion in sanskrit .

C32/63 Jeshua Pacifici:
To Raymond: good evaluation.

C33/63 Jeshua Pacifici:
Good point Surfer.

C50/63 Jeshua Pacifici:
good reply Matt -- doesn't Peck talk about fear in growing? Aren't we afraid to move close to God because we fear a "burning" as in the alchemical transformation of flesh (materiality) into spirit?

Three directed "pat-on-the-back" comments were initiated by students to other students. These student-to-student special recognition comments appear to be modeled after the instructor's style as illustrated in the first five comments listed above. Here are the student-to-student positive feedback messages:

C40/63 Candy:
Really good points Matt!!!

C42/63 Matt:
Thanks Candy!!! I agree with yours also.

C62/63 Matt:
Good points, Velva! I never thought of that.

There were no antagonistic messages in this interchange, but there were several student comments which expressed some tension or confusion and disagreement with the with the prevailing views. To give an example of this and its context, I have included the posed question, which the student responded to, and in the response expressed the point of tension:

C30/63 Jeshua Pacifici:
How does this relate to Peck -- the water which is pleasurable looks so attractive and feels so good to the touch, while the fire is frightening and burns us on first

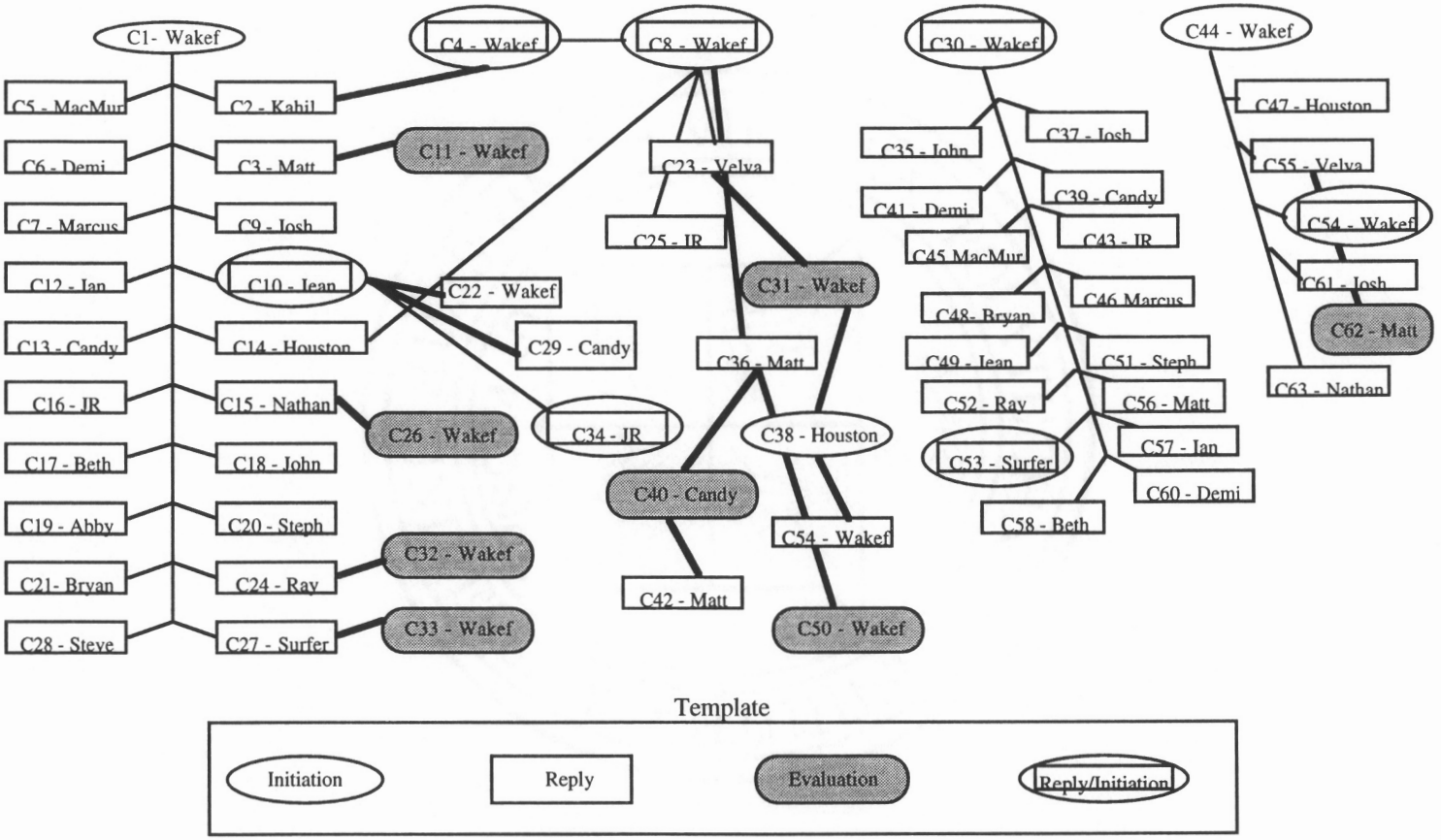


Figure 5

Message flow analysis and diagram for capstone "Content" interchange.

touch but then if you enter the water you end up in the fire burning and if you enter the fire you find relief. Please discuss.

C46/63 Marcus:
Peck believes that you must put effort into everything you do. Walking into a fire certainly takes more effort and discipline than walking to a stream, but I do not understand why Rumi thinks we should aim for something that might hurt us.

One of the difficulties for an instructor leading an interchange discussion is that with a class of 22 students all "talking" at once it is impossible to respond to all the messages. For that matter even to keep up and read all the comments is difficult. Another example of a student comment left hanging is this one by JR which is positioned about halfway in the interchange:

C34/63 JR:
I find this piece particularly interesting becouse of the contrast to contemporary Christian symbolism that relies so heavily on water. The baptism in water, the fountain of eternity within us and so forth. But I can't decide if this is a contradiction, is Rumi saying that fire, unlike its physical characteristics holds the same spirtual properties given to water in the aforementioned situations, or is he saying something else? Now I'm confused?

In an active interchange like this one in which the mean number of message postings was three, some participant comments were left unanswered. The posting like the one from JR shown above is like hearing someone thinking out loud and hearing someone's inner thoughts which would normally never be voiced. JR, for example, posted four messages in this interchange, one higher than the class average. None of her messages were responded to or commented on in the interchange with any directed replies. None of her comments were directed to anyone--this is typically how participants in this class became more integrated into the central group. JR is described by Pacifici as by far the best writer in the class. She never participated in the traditional class setting, but was

consistently an active participate in the on-line discussions. While her participation ratio and participation frequency for every interchange are at least average or better, her integration quotient for every interchange is zero.

Style Interchange

The style interchange had a total of 21 messages. There are no directed messages in this interchange and little interaction in the discussion. The question posed in the beginning of the interchange was answered by the students, and no one refered to anyone else's comment. Some of the students were not sure how to respond, but made efforts to contribute something to post an answer to the question. This interchange reflects the students' limited experience with doing this kind of analysis of a piece of writing. Here are messages from two students who were more confident than most of their responses to the initial question from Pacifici.

```
S1/21   Jeshua Pacifici:
Did you feel that this piece was fluent (expressive,
colorful); cultivated (varied, descriptive, smooth), and
strong (effective, striking, forceful, fresh)?  Please
describe your assessment of these qualitities in this
piece.

S12/21  Beth:
I think the piece was fluent and had a comfortable pattern
of rhythem to it.  Rumi's ideas were extremely effective
and powerful, although they did not contain a clear
message.  He definitely has a forceful style with words
which force his readers to think.

S13/21  Steve:
I believe that the piece was very fluent,  each idea led to
the next and it all came together at the end.  Rumi used
very descriptive words to describe the fire and water and
it made me feel as if I was there.  This was a very
powerful, forceful passage,  Rumi used understandable
examples to describe something that is not so
understandable
```

Writing Conventions Interchange

This interchange is similar to the one on style--it is rather short and only one person

posted more than one message. There are two directed messages which stimulated some discussion about how writers can strategically break rules of grammar to emphasize a point. This interaction is discussed in detail in the student rating scores section.

The participants seemed to lighten up a little in this interchange and a few tension-relieving comments were scattered in with students' responses to the question posed for this discussion. Here are a few samples of these.

```
WC1/19   Jeshua Pacifici:
Do you feel that this writing represents correct form
(paragraphing, punctuation, spelling) and conventional
grammar (sentence structure)?  Explain

WC7/19   Houston:
well, figuring that this came from a book, which came from
a publisher, that  was given to the  editor  by a very
intellegent author

WC15/19  Nathan:
This piece is not your typical A paper when it comes to
grammar.  But sometimes you have to break the "rules," to
get your point across.  That is what Rumi did.....
```

Post-Capstone Interchange

The post capstone interchange occurred at the beginning of class one week after the capstone. Every student was given a copy of four different bar graphs which depicted each student's average rating score for the Rumi piece in each of the three categories and included an overall mean rating score from each student. (Refer to Appendix A to see a copy of these bar graphs.) Superimposed on the bar graphs was a line which indicated each student's mean score in all three categories plus the overall mean for the post-discussion rating. Students were asked to notice on these graphs how much their pre- and post-discussion rating scores changed. If they had any trouble reading these graphs, they were encouraged to speak up or raise their hands.

Before entering the interchange students had a few minutes to look over the graphs and listen briefly to my explanation about what I would be asking them to do. I explained

to the class that part of my research methodology involves getting input from the participants regarding the data I gather from the on-line discussions. I explained that I wanted to hear their own interpretations regarding what influenced their ratings to change or to stay the same during the capstone rating of the Rumi selection.

The students responded well to this additional task for my research. The post-capstone interchange didn't last more than twenty minutes. All students who were present at the capstone and were present on this day shared their views. There was no real interaction on-line, but the way the question was posed didn't encourage interaction. As the transcript quoted illustrates, quite a few students explained that they were initially confused when they read the Rumi piece, but reading the reactions of others helped them form their own opinion and understand the poem better.

The initial question was posed under my name this time, not the instructor's, since this interchange was really for my benefit.

> PC1/18 Laurie Ruberg:
> Do you think the Daedalus discussion about the piece by Rumi influenced your rating of this piece? If yes, identify some of the discussion that influenced you. If no, please explain

Examples of some of the on-line joking around. Some students responded to these questions more seriously than others as illustrated in the following messages.

> PC2 John::
> The reason that I didn't change my mind is very simple. I was confused after reading the piece and I was still confused after the discussion. I therefore saw no reason to change my mind.
>
> PC11 Ray:
> The reason why I did not change my ratings was because after the discussion with the class confirmed my first ratings because I understood the material completely.

Feeling confused. Some students described a sense of confusion they felt during the initial rating which was relieved by reading peer responses in

capstone interchanges.

PC3 JR:
I think it did influence me greatly just in forcing me to evalute my thoughts more carefully in order to write them out. Being able to see and respond to other people's thoughts and ideas helped me also to evaluate aspects of the piece I had not considered or felt differently about after further thought.

PC4 Velva:
The discussion did influence me a lot because I didn't really understand what Rumi was talking about until I read some of the comments that were made.

PC5 Josh:
Yes, I think the discussions on the piece influenced my rating. When I first read the piece I did not grasp what Rumi was trying to say but after reading what everyone else had to say, I understood the meaning of the piece and I felt that it was much clearer and understandable.

PC6 Marcus:
Yes, the Daedalus discussion influenced my rating. After reading comments about Rumi's piece I was able to understand it more completely. After the first rating the piece confused me and I was not able to give it a fair judgement. The discussion help me find another viewpoint to use.

PC7 Matt:
Yes, because I was able to see how my classmates rated it. From this, I was able to understand the piece better. The discussion helped me to see what others thought compared to myself.

PC9 Nathan:
Yes. The discussion on content made me change my mind the most. By reading other people's perceptions of the piece, I was able to find the meaning of the passages that I was confused and unclear on before. After understanding more about the piece, the style and writing conventions became a little clearer also.

PC17 Demi:
On a whole my ratings went up after the discussion because in some places I would not understand what he was saying, but after hearing what everyone else had to say some of my confusion was cleared up. For example, I was not totally sure how he was trying to use the fire and water, but after the discussion it was cleared up.

Example of student hostility to post-capstone question. One student expressed some hostility towards this activity. The tone of this response was unusual for this group.

> PC8 Candy:
> I think it did to some extent. First of all my first rating was done shortly after reading the piece. The second one was done after it had time to marinate in my mind, so of course it will be different. If you had someone fill out a survey and then fill it out again later, of course it would be slightly different. There was no real conclusive evidence in this "experiment" either.

Capstone Rating Data

Summary of Student Pre/Post Discussion Rating Scores

Students were asked to rate the writing selection presented in the assignment window twice. The first time was right after reading the Rumi selection and before joining the interchange discussion. The second rating came after the interchange discussions. The reason for asking students to rate this writing selection twice was to see if the electronic discussion had any influence on individual student ratings and if so, how was this influence expressed.

The rating scores presented in Appendix A show how the pre- and post-discussion ratings compared. The content rating questions addressed how "specific" the writing is (definite, detailed, precise, exact). The class mean for the content questions went down one tenth of a point from 3.5 to 3.4. Early in the content interchange Pacifici praised Matt's analysis of the Rumi piece. (See messages C2 and C11 quoted on pages 92-95.) The instructor's praise for Matt's comment (C3) and the subsequent comments by other students (Demi C6, Ian C12, Beth C17, Bryan C21, and Steve C21) are consistent with Matt's assessment that, "The author could have been more specific." These comments may

have influenced the class rating score to go down. The class rating of the author's use of writing conventions went down in both questions within this category: correct form and conventional grammar. Student ratings overall were higher after the discussion, and individual ratings tended to move closer to the mean in all three main categories.

Some of the changes in rating scores appear to be directly associated with particular interactions which occurred in the on-line discussion. Kahil had the most dramatic change in rating scores, and these occurred in the Writing Conventions section of the rating. The mean for all scores went down in this section and this section continued to have the most variable scores. Here is a strand of discussion from the Writing Conventions interchange which may have influenced students to lower their scores in this section.

WC1/19 Jeshua Pacifici:
Do you feel that this writing represents correct form (paragraphing, punctuation, spelling) and conventional grammar (sentence structure)? Explain.

WC2/19 Kahil:
THe words flowed while presenting proper grammatical form and punctuation. The writing was abstract, but still fit the poetry category.

WC3/19 Jean Blake:
Kahil:
Did you notice any instances where the author broke traditional grammatical rules to reinforce the content of the piece?

WC4/19 Matt:
I always thought than in a poem, there was no set grammar; the poet wrote as he thought and felt, regardless of the boundaries and rules that grammar have.

WC10/19 Ray:
Rumi uses punctuation in a manner that brings attention to his most important points. While his style may not be conventional, it is effective, and that should be considered more important.

WC11/19 Steve:
Rumi uses his sentence structure to reinforce his ideas. His spelling and punctuation is correct, although his paragraphing could be a little better.

WC12/19 Beth:
There were not any really noticeable grammatical or spelling errors, but in a poem any style or grammar seems to work to convey the author's meaning.

WC13/19 Kahil:
Yes, I did. I thought of these as following the rules of a non standard poetic grammar. Break the rules to complete thought!

WC14/19 Ian:
The paragraph format was different but then again I dont think there is really any real format for this type of writting. I like it. The spelling and so forth seemed fine to me.

WC15/19 Nathan:
This piece is not your typical A paper when it comes to grammar. But sometimes you have to break the "rules," to get your point across. That is what Rumi did. For the most part, the piece was conventionally correct. But at times he would stray from this correctness and write in an awkwardly. But crossing and breaking the conventional methods of writing helped him to convey what he is trying to get across, also I think it is a good change of pace and break from the norm.

WC16/19 Abby:
The way Rumi splits up sentences is to make a point. If he is trying to point out a specific line to the reader, he put it on another line to make it stick out.

WC17/19 JR:
I don't think it follows conventional rules of grammar, but I don't think that theres any reason that it has to. I think its important for authors, particularly poets, to question the manner in which they make their points. there can often be incredible meaning conveyed in a work purely through the grammar and division of the lines. I think Rumi uses this to good advantage.

WC19/19 Candy:
I don't believe in the traditional rules of poetry. Rumi speaks what comes from him.

Students in this strand of discussion excerpted from the Writing Conventions discourse achieved a consensus opinion that Rumi has not followed the conventional rules

of grammar, but his writing is convincing. In different ways the students suggested that since this is a poem, conventional rules don't apply. The participants in this discussion seemed to have some strong opinions that poetry and the meditational style of writing should not be evaluated by using traditional writing convention standards. However, while students expressed some strong opinions in this discussion, especially Candy in WC19, their second rating scores suggest that there was some confusion regarding how to rate the writing conventions used in this selection.

Several issues raised in this discussion suggest some interesting topics which could be pursued in a subsequent interchange or as a writing assignment. Ray's comment in WC10 addressed an issue which could be used to structure a subsequent interchange discussion: "Effective should be considered more important than being conventionally correct. True, but how do we determine when a piece of writing is effective? What would be your criteria for assessing whether a piece of writing is effective or not?" From this discussion students could develop their own Composition Rating Scale which they could use in evaluating their own writing and in peer reviews. While this particular assignment was never created, the assignments that were created through collaboration between Pacifici and this researcher came about in a similar manner. Student responses, previous experience, prior knowledge, and the kind of issues that came out the discussions had a great impact on what the next Daedalus assignment would be and how it would be structured.

Mail Message Tracking

An unexpected source of data came from the mail files in which students sent their rating scores. I found that along with the content of the mail message I could save a list of who viewed each mail message. This data provided some interesting descriptive information about the behavior of the class as a group and also about the behavior of specific participants who were at one or the other extreme in the number of messages they

viewed. The mail message data was of interest to this study because all messages were not viewed with equal frequency, and those messages that were viewed most frequently were of interest to the class for some reason. Those messages viewed less frequently were of less interest to the class for some reason. The fact that some students viewed many more messages than average and other students viewed many fewer than average suggests possible differences in the kind of activities that different students employed to form an opinion.

Table 8 provides a summary of the number of mail messages viewed as well as the number of times a given mail message was viewed by others for both the pre- and post-discussion rating. I also used the mail message tracking for additional descriptive data to see what influence the interchange discussion had on the composition ratings. The mail messages in the pre-discussion rating (which contained their rating scores) were viewed notably more times than the class average (17): More: Steve (26); Bryan (31); Marcus (28); Surfer (27); Velva (28); Matt (22), and Ian (29); Less: Candy (8); Nathan (4); John (2); Josh (7), an Houston (9). In the second post-discussion rating the following mail messages were viewed notably higher or lower than the class average (14): More: Surfer (26), Velva (34), and Ian (3); Less: Beth (4); John (0); and Houston (6). I looked back through the interchanges to see if students who received exceptionally higher or lower viewers were given any special recognition on-line either from the instructor or from another student. Surfer, Velva, and Matt were given positive evaluative comments from the instructor on-line. Velva and Matt also received positive evaluative comments from their peers in the on-line discussion. John, whose second rating was viewed by no one, mentioned in one of his on-line messages that he really didn't understand the Rumi piece at all.

Ian, whose mail ratings were collectively viewed fifty-nine times--second only to Velva, is more puzzling. Ian is described by Pacifici as someone who never spoke in the

Table 8

Mail Message Tracking

Alias	(1)Other mail messages this person viewed (#)	(1)Times this person's mail was viewed by others	(2)Other mail messages this person viewed (#)	(2)Times this person's mail was viewed by others	# Times checked their own mail message	# Times Comment Evaluated or Annotative Comment
Steve	13	26	19	10	4	
Demi	14	11	14	9		
Stephany	18	11	15	8		
Bryan	16	31	12	12		complementary critique, one criticism
Candy	31	8	13	18	1	complemented peer received agreement
Kahil	20	17	19	16	2	
Marcus	3	28	9	10		opinionated comment
Mac-Murphy	10	23	14	16		
Beth	15	18	14	4		
Abby	9	16	6	15		
Surfer	11	27	4	26	2	"good point" JP
Nathan	35	4	25	14	1	"good assessment" JP
Matt	17	22	25	11	3	"good assessment" JP
Velva	6	28	13	34	2	"good answer" JP "good point, I never thought of that" Matt
John	10	2	4	0	1	admints to not understanding piece
Josh	23	7	13	15	1	
JR	1		2			active in Interchange; no rating sent
Ian	1	29	1	30		well articulated critique
Houston	32	9	22	6	2	
Ray	10	12	5	11	3	"good evaluation" JP
Mean (student data only)	14.75	17.3	12.45	13.9		

traditional class. On-line Ian was a consistent participant, but his integration ratio is consistently zero. Looking back over Ian's comments on-line may explain why his mail message ratings were of interest to the class. Ian had a direct, concise, opinionated, and sometimes colorful writing style. This, according to Butler (1992), is the kind of writing on-line that gets read the most. Here are Ian's postings to the Capstone discussions:

C12/63 Ian:
The piece was convincing because Rumi used understandable examples to describe what he was saying. He organized the material in a way that each thing he said lead up to the next and explained it. Very expansive. different way of viewing things. I don't think it was very specific because itr can be applied to different aspects of life.

C57/63 Ian:
There is no free lunch!. There are only short term ways of getting by. If you want a full and honest life you must take the chances and make the honest attempt.

S7/21 Ian:
The piece was extremely colorful due to the authors use of detailed imagery. Therefore the piece came across as being effective and forceful.

WC14/19 Ian:
The paragraph format was different but then again I dont think there is really any real format for this type of writting. I like it. The spelling and so forth seemed fine to me.

PC14/18 Ian:
Yes, I think reading and responding to the Daedalus discussion influenced my rating of the piece. At first the reading was greek to me. After reading some of the discussion, I started to understand a little more of it. It also started to make more sense when it was applied to other subjects. For example, Pecks book.

Summary of Capstone Surveys

In the final part of the capstone event I asked students to share their views about

using Daedalus by answering an open-ended questionnaire. The student self reports obtained from the capstone activity and the end of semester survey describe extremely favorable experiences in this class as a whole and to the on-line interchanges in particular. Some of the positive influences from the electronic discussions reported by students are described below. One or more direct quotes from the survey are included with the topical summary to provide more detail about what students felt was valuable about their on-line discussions. Some of the student responses blended their comments about the interchanges with their evaluation of the course as a whole. To some students these two experiences were differentiated.

Student Benefits

1) Spend more time thinking before writing: Reported by 12 out of 22.

Examples:

- "I just think a lot more before writing now, ..." (Surfer)
- "...[I] think more before I write instead of just jumping in." (Josh)

2) Get new ideas, new perspectives, and increased understanding by reading responses from their classmates: Reported by 17 out of 22.

Examples:

- Reading responses of others... "helps a lot if I don't understand what a certain piece means it is very helpful to see how the others students interpreted it." (Demi)
- "It helps me to compose my thoughts and get ideas from other students. I have an easier time responding after seeing how others have responded." (Beth)
- "It opens up new ideas. Sometimes I will think of a whole new idea." (Ian)

3) More positive attitude toward computers based on the use of computers in this course: Reported by 6 out of 22.

Examples:

- "I see another way computers can be used." (Marcus)
- "It's been a more positive experience than all my other work with computers put together." (JR)

4) Gained confidence in their writing and became more relaxed about the process of writing through participation in interchange discussions: Reported by 14 out of 22.

Examples:

- "Yes, especially when I know what I'm writing about, and I can relate it to my life. I am more confident now as a result of the computer." (Surfer)
- "....more confident about writing. I have never liked to write, for I was always bad at it. I'm starting to enjoy it more." (Houston)

5) Felt more comfortable participating in discussions because they could think before sending their message and were not "in the spotlight" when their message was received by others: Reported by 11 out of 22.

Examples:

- "Let people feel more free to talk openly." (Velva)
- "Being able to speak your mind without everyone watching you talk." (Steve)

6) Have become more open minded and able to constructively criticize what others write: Reported by 9 out of 22.

- "I was able to accept other peoples' thoughts and integrate them into my own." (Matt)
- "Instead of just listing my thoughts down on a piece of paper, I think deeply about how a certain subject makes me feel and creatively write down those thoughts so that they become enjoyable to read." (Nathan)
- "I became more sensitive to others, not just to what they think, but also why they think that way." (Dave)

7) Found the discussion topics and reading assignments to be directly applicable to their personal life and increased their understanding of themselves: Reported by 7 out of 22. Examples:

- "I've learned a lot from my classmates and their way of thinking.....I've learned more about myself." (Beth)

Limitations Identified

In the capstone and end of semester surveys students were asked to describe what they liked least about the on-line conferencing. Their responses essentially fall into three distinct categories of criticism: problems with the computer interface, frustration with the electronic interaction, and task-related issues.

Interface. Two students reported that they didn't like having to type in their messages. One student mentioned being confused when the structure of the on-line activity changed. One student mentioned being frustrated by the time it takes to enter ideas. One person mentioned getting a headache from staring at the computer screen. Four students mentioned that they found it irritating that the screen would jump to a new message as it was received without their choosing to move forward. This "jumping" was disruptive for these individuals because it would happen while they were reading earlier messages.

Interactivity. One student reported that he didn't like the fact that there wasn't enough time to read and respond to everybody's message. Along a similar line, another student reported that, "You get so involved in reading other people's comments that you don't always say everything you want" (Stephany). Several students reported that it was frustrating waiting for responses from others. Another student was frustrated by the fact that participants seemed to repeat the same kind of comments over and over. This individual recommended, "We should talk more to each other, and worry less about answering the question." One student mentioned that "Not having eye contact" was frustrating. The student who was the most frequent participant in face-to-face discussions

and also the most frequent on-line participant expressed the most critical comment about the on-line interchanges.

> I became truthfully sick and tired with just coming in, typing for 1 hour and 1/2 and then leaving with no interactions. [Found it] difficult time-wise and conversation-wise to share ideas on-line. [Felt that on-line conferencing inhibits collaboration], "I can name maybe 3 people in the class--we've been here for 8 weeks. [Recommends for future offerings of this class] Less emphasis on computers--more on discussion in class." (Candy)

Task-related. One student reported that doing the interchanges "can get tiresome and boring at times." Another student's criticism was in regard to, "Answering question that I don't want to and reading really long essays."

Findings

Based on observations of this class in the face-to-face setting and observations and analysis of all the on-line discourse I found that the interactions occurring in the electronic interchanges are, as Levin, Kim, and Riel (1990) report, somewhat like traditional classroom interactions and somewhat different. As the message flow diagram in Figure 5 illustrates, the instructor had the most influential impact on the regulation, pacing, and direction of the on-line discussion in the Content interchange of the capstone activity. The instructor's initiations of new topics moved the discussion from one strand of discussion to a whole new focus. Positive evaluations by the instructor on-line were shown to have an impact on the subsequent frequency of participation of particular students, the social emotional message acts of some students, and the composition rating scores of the class as a whole.

The students who were the most frequent participants in the traditional classroom setting tend to be the most frequent on-line participants, but this is not true in every class.

As Table 9 shows, student participation varies in different interchanges. Those students who are more vocal in the face-to-face setting tend to have a higher integration ratio than students who are quieter in the face-to-face class; however, there are some exceptions. The five most frequent participants in the CMC discussions were Candy, Matt, Josh, Surfer, and Velva. Candy, Matt, and Velva were all described by the instructor as frequent participants to the face-to-face class discussion. Surfer was described as being among the "sometimes, but not consistent" contributors to the traditional class discussion. Josh was one who rarely if ever participated in the face-to-face class.

Table 9 provides further illustration that many of the students who rarely or never participated in the face-to-face class were average or more frequent participants in the on-line discussions. Comparing the "Face-to-Face Participation" column with the column titled "Total # Messages across 8 interchanges" shows which students who were rated as infrequent participants in the traditional class became more frequent participant in the CMC environment. JR exemplifies someone who never spoke in class, but who contributed often in the computer-mediated environment. This supports the findings and predictions by prior CMC researchers (Bump, 1990; Harasim, 1990; Hartman, Neuwirth, Kiesler, Cochran, Palmquist, & Zubrow, 1991), that use of CMC will increase student participation--particularly by those who participate infrequently in the traditional class setting.

Students in this class adapted to the CMC environment in different ways which are described in the analysis of the transcripts presented throughout this chapter. Based on comments from the surveys and comments by the instructor, those students who did not participate in the traditional class setting had much less personal recognition with their peers and with their teacher. The more vocal students in the traditional classroom setting had greater name recognition with their peers, and therefore, were more likely to receive directed messages on-line. These were also the same individuals who were sending a

Table 9

Summary of Analysis of Individual Student Participation: Freshman Writing Class

Student	Face-to-Face Partici-pation	Total # Messages across 8 inter-changes	Partici-pation Ratio (Capstone only)	Volume Ratio (Capstone Only)	Integra-tion Ratio (Capstone Only)
Steve	S	16	.02	.02	0
Demi	S	25	.05	.06	0
Stephany	S	9	.03	.06	0
Bryan	S	14	..03	.02	0
Candy	F	35	.06	.05	.5
Kahil	M	22	.02	.01	0
Marcus	M	22	.03	.03	0
MacMurphy	F	23	.03	.03	0
Dave	M	11	-	-	-
Beth	M	19	.03	.03	0
Abby	S	22	.02	.02	0
Surfer	M	31	.03	.04	0
Nathan	S	21	.03	.05	0
Matt	F	34	.08	.11	1
Velva	F	30	.03	.04	0
John	M	16	.03	.03	0
Josh	S	32	.05	.05	0
Max	S	6	.-	-	0
JR	S	21	.06	.06	0
Houston	S	24	.05	.03	1
Ray	M	15	.03	.04	0
Ian	S	18	.03	.03	0
Mean		21	.037	.04	0

higher percentage of the positive and negative social emotional comments on-line. However, the most frequent participant in the computer-mediated interchanges was also the most frequent participant in the face-to-face classes, and the least frequent participant on-line was also described as an infrequent to rare participants in the traditional classroom.

While the more vocal students were sending and receiving more directed messages on-line and were sending more of the social emotional messages, the lesser known participants also had an influence on the outcome of the discussion. The influence of the lesser known participants is documented in several sources. First, analysis of the mail message viewing shows that students read the rating scores of some students who were consistently quiet in class and who had nearly consistent integration ratio scores of zero. This suggests that the comments of these individuals on-line were read by their peers and were interpreted, and evaluated favorably. Second, in their self reports of what they liked about the on-line interchanges nearly all of the students responded that they got new ideas, new perspectives, and increased understanding by reading responses from their classmates.

Finally, a cursory analysis of the discourse created by each on-line interchange, suggests that different students respond to the on-line medium in different ways. Lea (1991), Rice and Case (1983), and Sproull and Kiesler (1991) found that users of electronic mail described it as somewhat like talking, somewhat like writing. Students appeared to adapt to the on-line discourse in ways that suggest that for some it was more like writing. These students submitted contributions that were more carefully crafted and were generally sent later than the more informal messages. Others adapted to this medium by applying their interpersonal skills to the electronic environment. These students interacted on-line in much more social, informal ways. Those who viewed this activity as more like talking had higher integration and participation ratios and may have had a greater impact on the discourse because of their tendency to respond with reactive statements which were directed to specific individuals. Those who viewed the on-line activities as

more like the process of writingwere further from the center of interactivity, but still had an impact on the discourse because of the beauty and/or persuasiveness of their more carefully crafted comment.

Critical Issues

The value of being able to read what everyone in the class thinks has an impact on all students which they described as giving them a new perspective, a way to imagine another point of view, an ability to view things differently, and a deeper understanding of the material. All of the student comments emphasized the positive impact of learning from each other. The interchange discussion provided a way for this communication to occur in a timely and manageable way within a class period. The message flow analysis in Figure 5 shows that while students are learning from each other they are interacting in a discussion forum which is highly structured, directed, and regulated by their teacher. The movement from the traditional to the electronic classroom does not disable all of the previous habits of the classroom, but in this class enhanced the instruction already in place with what Faigley calls "a faster, deeper discussion" (Faigley, 1992, p.181) than could occur in the traditional setting.

Other teachers at the higher education level describe similar kinds of success by incorporating CMC activities into their English and writing classes. Hatfield (1993, p. 5) reports that, "Computer-enhanced instruction creates a new space in which everyone in the class has a more equal opportunity to participate. Not only do traditionally more reserved students find a venue for discussion, but because the time-frame for discussion is not limited to class contact hours, everyone feels a greater sense of access to the conversation." Up until recently English classes have been using electronic mail as a means of enhancing student participation. Hatfield (1993) has found this use of electronic mail to be a low-tech way of bringing some of the benefits of computing technology into the English curriculum.

Significance and Implications of Findings

Student interactions in the computer-based interactive writing environment can lead to increased student participation, active learning during the class period, and variable pacing. The interactive writing environment offers an alternative social environment for the class which is much more active and can be less inhibiting for students, which results in increased participation as well as an increased tendency for students to share their ideas. Students learn from each other and are influenced by each other's on-line statements. Disruptive behavior can also occur on-line as can "brown-nosing" and just about every kind of on and off task behavior. The social atmosphere in the real-time classroom is an extension of the face-to-face classroom and can be a way of getting feedback about other class activities which are much less accessible to uninhibited feedback.

While students do interact on-line and do express some attempts at regulating each other through reinforcement, disagreement, and follow-up questioning of each other, students seem to adapt to the on-line environment in different ways. In the freshman writing class some students seemed to mimic the behavior of the instructor in giving feedback and reinforcement to each other. They also mimicked him in avoiding giving any direct criticism or other negative feedback to their peers. Other students, however, seemed to develop a different style of participation which involved less directed interactions with their peers and instructor. These students seemed to have a greater comfort with self-regulation and contributed statements to the interchanges which added to the discourse without being directed to anyone in particular. Comments from these students were more designed to fit into the context of the discussion. These students were less likely to direct their messages to anyone in particular or to receive any directed messages.

I don't want to paint too perfect a picture by describing only the potential benefits afforded by carefully designed applications of in-class use of computer-based interactive writing. This activity can become stale if the assignments don't vary or if the topic doesn't suit the structure of a given exercise which worked well on other occasions. The success

of any given interactive writing activity is determined by the social context in which it occurs. What works well for one instructor may have to be modified to work for another. An activity which works well one day may bomb on another because several students who help carry the discussion are absent or are not prepared. However, the very fact that each student's participation can make a difference illustrates the power this media has to engage students in active learning together within the class period. Unlike many classes where only the instructor's absence is felt, students build relationships on-line which fosters collaboration, cooperation, and an increased ability to listen and respect each other's point of view.

CHAPTER 4

Student Interaction and Regulation in the Plant Science Lab Electronic Community

Introduction

Using Daedalus in the plant science setting provided an opportunity to incorporate more discussion and structured dialogue in a scientific laboratory course. The content material presented to students in this course was complex and abstract in nature. The Daedalus interchanges offered a loosely-structured, highly interactive medium for encouraging all students to share their ideas. The computer-based writing exercises also seemed to offer a way to make the weekly reporting process traditionally a part of lab courses a more collaborative effort. The discourse created through the Daedalus interchange could be considered a group response to the lessons within that lab. On this campus, the plant biology lab was the first non-writing class to incorporate the Daedalus interactive writing program into the in-class instruction.

Getting students to share their ideas and interpretations in a structured interchange was suitable to the learning objectives of this course, which emphasized the importance of students becoming familiar with plant processes and recognizing how these processes influenced the ways in which plants adapt to their environment. The development of multimedia modules and other computer-based instruction for this lab was facilitated by a grant funding the creation of an alternative instructional delivery format that would be more appealing to students--especially students who have been disenchanted with traditional teaching strategies. While this research was underway, this was considered an

experimental course, which allowed some flexibility in the number of students enrolled and influenced how students were graded.

This course included a variety of applications of technology which were designed to enhance and enrich the presentation of topics covered in the course so that they would be more accessible and more appealing to students. When this course was observed students were graded on their participation and were asked to participate in a variety of evaluation activities for this project. The plant science lab course has had a substantial allocation of funding support for the investment in the incorporation of technology systems. Subject matter and educational technology experts also invested substantial time. This study provides a descriptive picture of how students responded to these technological enhancements and particularly focuses on the computer-based interactive writing activities.

The computer-based interactive discussions were positioned to take place near the end of each lab and were designed to get students to reflect upon what they learned in the lab that day and to recognize what were the most important concepts within that day's lesson. The process of writing and sharing ideas with each other in the Daedalus interchanges required each student in the class to think about what they learned from their observations and manipulation activities and other lessons and to construct their own interpretations and meaning. The questions asked by the teacher at the start of each interactive writing exercise required that students apply what they learned in the lab to interpret some related phenomena or relevant research report.

The capstone activity was a critical on-line event designed for detailed study and involved a more structured process than most of the weekly exercises. The capstone on-line event included a structured peer review process: first done independently, then discussed on-line, and then a subsequent rating. The structure of this activity was designed to make it a lesson as well as a procedure. The questions posed in the rating activity were

designed to show students the kind of questions they should ask in order to critically evaluate scientific information as it is reported in the news media or in professional publications. The discussion activity was intended to give students a chance to explain and describe their ratings. The subsequent rating gave students a chance to rethink their scores. All these activities gave the researcher a beginning, middle, and end that is rich with data which can be used to describe student responses to this kind of activity. This kind of application of computer-based interactive writing exercises was designed to facilitate some of the broad goals for this course--including attracting non-traditional students to the field of biology. The descriptive analysis of student participation, interaction, and regulation in the on-line interchanges and field observation data provided valuable information regarding how students responded to the computer-mediated social environment.

The computer network in the plant science lab consisted of seven Macintosh IIsi machines with color monitors, seven laser disc players with video monitors and a Macintosh Apple Workgroup 80 server. The server and ethernet connections linking the seven IIsi machines to the server were set up immediately preceding the first lab class. The number of students enrolled in the lab was twelve, so some students had to pair up and work together for the computer-based instruction and Daedalus discussion activities. The kind of questions asked in the capstone were designed to simulate a "peer review" of an article addressing a lab topic which appeared in a national newspaper. The questions students were asked to respond to with rating scores focused on issues evaluating the scientific credibility of the article, and not on the merits of the author's prose. However, both question series used for the rating activity had a similar intent: to give students a list of the kind of questions an expert in biology would use to evaluate the value of an article in their field.

Theoretical Framework

Incorporating the interactive writing activities into the plant science lab served several instructional goals. The on-line discussion provided one way to address the need for getting students to articulate what they learned from the multimedia presentations and simulations as well as what they observed in the wet lab manipulations of plant specimens. The interactive, electronic discussions are designed to provide a way to model how biologists think and interpret observable events so that students can learn the kind of interpretations and ways of discussing phenomena by practicing this activity within a structured interactive dialogue with their instructor and each other (Resnick, 1984). Rafoth (1988) describes the on-line interactions as creating a discourse community which introduces students to the familiar and expected ways of interpreting and discussing experience from, in this case, the biologist's point of view. Through the on-line interactions students become familiar with and have the opportunity to practice using the language of biologists (Rafoth, 1988, p. 143).

Creating an Interactive Writing Community

The interactive writing activities used in the plant biology lab provided a way for students to take time to describe what they did and what they learned in their own words. This is an important part of learning science. As Dewey suggests, meaning, as understood through language, derives its potency from functional use within a social setting (Dewey, in Gouinlock, 1976). The process of putting together a written account of the structured activities which occurred within a given lab was designed to provide "a means of evoking different activities performed by different persons so as to produce consequences that are shared by all participants in the conjoint undertaking" (Dewey in Roschelle, 1994, p. 9). Thus, the Daedalus discussions provided a way to integrate the variety of learning activities

which occurred earlier in the lab that day. While the students had an opportunity to individually interact with their instructor during class, and periodically the professor, Steve Scheckler, presented brief explications and/or demonstrations of particular phenomena to the whole class, the on-line discussions provided a unique opportunity for class discussions in which all students actively participated and simultaneously had the opportunity to pose individualized questions and insights for their teacher and fellow students. Each student was invited to send their written responses out to the group, which put another spin on their task: they were not simply asked to respond; they had to respond, share, interpret and compare their remarks with those of others and keep the discussion going. The questions asked by the teacher at the start of each interactive writing exercise required that students apply what they learned in the lab to interpret some related phenomena or relevant research report. Most of the relevant issues/research referred to in this lab were taken from publications like *Science*, *Scientific American*, or local or national newspapers so that the information would be presented in a fairly readable, simplified format.

As was discussed in chapter three, the interactive writing environment is somewhat like talking and somewhat like writing, and as we found in the freshman writing class, students were able to selectively adapt to this environment by focusing on different characteristics of this medium that especially suited their personalities and learning styles. Ferrara, Brunner, and Whittemore (1991) discuss the unique characteristic of interactive writing and suggest that no other form of communication provides real-time interaction which can be edited. As Hartman, Neuwirth, Kiesler, et al. (1991) report, using network technologies to supplement or enrich class discussions allows those students who are hesitant to speak out in class in an alternative and less socially intense way of interacting with their instructor. The analysis of data obtained from this class will discuss how

students responded to interactive writing activities as a medium for communication and will describe the distribution of participation of students and their teacher in the Daedalus interchanges.

The instructor-led interactive discussion via computer appeared to provide what Newman, Griffin, & Cole (1989; 93) refer to as a zone of proximal development (ZPD). The ZPD evolves from the interaction between people with different points of view on the same situation and when successful, results in the appropriation of one view by the other. This appropriation process leads to cognitive change. For example, a teacher may design instructional activities for her class which apply the process of appropriation within structured instructional interactions. In constructing a ZPD for a particular task, the teacher incorporates the student's actions into her own system of activity. As the novice does not have to know the full cultural analysis of a tool to begin using it, the expert does not have to have a complete analysis of the novice's understanding of a given situation to interpret the beginner's actions in terms of the larger system (Newman, Griffin, & Cole, 1989). "While in the ZPD of the activity, the children's actions get interpreted within the system being constructed with the teacher. Thus the child is exposed to the teacher's understanding without necessarily being directly taught" (Newman, Griffin, & Cole, 1989, p.64). The plant science lab used simulations of real biological research processes to achieve a similar kind of instructional event described in the ZPD.

In the biology lab, students used electronic simulations to engage other students in activities that mimicked the kind of hypothesis testing and examination of possibilities real scientists do as part of their work. As Scheckler explained in a proposal to the National Science Foundation (NSF):

> Goals for students: By engaging [students] with exercises that examine the most dynamic and synthetic aspects of plant biology in which the students interact, we aim to develop their capacity for insightful reasoning. We

> sincerely believe that facts and conceptual interpretations of facts are far easier to learn when they are placed within a synthetic framework - an operational paradigm... Such a paradigm seeks to explain causal relationships based upon our current knowledge. Even though paradigms sometimes prove to be only partly true, too simplistic, or even false, they still remain a powerful pedagogic tool so long as they are not dogmatically asserted. We want students to feel free to play "what if games" with these modules in order to encourage their creativity and imagination in the pursuit of scientific process by which hypotheses are constantly tested for their ability to explain observed events. (National Science Foundation Proposal, p.2)

Use of the electronic, interactive discussions was an important complement to student interactions in the multimedia programs and wet-lab activities because, as Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, and Suhor explain, it is through the process of participating in interactive discourse that "...vague impressions, undefined feelings, and unexamined experiences are given shape." (1988, p. 61).

The on-line writing activities proved to be useful to informally diagnose how well students understood the concepts presented in a particular lab. All students were active participants in the computer-based discussions. Knowing that they would be participating in an interactive discussion at the end of every class emphasized to each student that they would be asked to actively interpret what they learned before leaving each class. This activity provided both students and their teacher with information regarding what each individual student gained from that class and the kind of expectations the instructor had regarding what knowledge he considered most important for them to take away from that class. On this level, the computer-based discussions promoted independent learning and also gave students a means to be exposed to one or more strategies that the instructor and/or their fellow students used to organize and interpret the material covered in that class (Penrose & Sitko, 1993).

We began the semester anticipating a lot of ways to use the on-line discussions as described in this section. We found that some interactive writing activities were more

successful than others in accomplishing the learning goals described here. Some of the on-line interactions were inhibited because the content covered that day was difficult for the students to assimilate before the end of class. Some labs had more complex wet lab activities which took time away from the electronic discussions. The analysis of interchanges will summarize all the interchanges in general terms, will explain in more detail the capstone interchange, and will refer to other computer-based discussions which also proved to be informative for understanding the nature of student interactions in an interactive writing environment.

The analysis of the capstone activities and references to other lab interchanges and observations will provide descriptions and specific illustrations of the ways in which students participated, interacted, and regulated each other in the discourse community established in the plant science lab setting. Since the plant science lab provided a variety of experiences for students to informally interact with the instructor and with other students during the computer-based instruction and hands-on manipulation activities, the analysis will particularly consider how the electronic interactions differed from the informal face-to-face interactions in the lab.

The Design and Implementation of a New Kind of Class

The development of the plant science lab course received initial funding from the State Council for Higher Education (SCHEV) for the development of several multimedia modules. The College of Arts and Sciences awarded the funding for the purchase of computers, videodisk monitors and software to set up eight student workstations in the lab. Subsequent funding to continue the development of alternative methods for delivering instruction was received through a grant award from the NSF Undergraduate Course and Curriculum Development program.

Statistical data gathered by the National Science Foundation indicate that of the 750,000 high school sophomores who expressed an interest in studying science or engineering only 24 hundredths of one percent can be expected to continue their study of science to obtain a Ph.D. in a science or engineering field. Between 1966 and 1988 the proportion of college freshmen planning to major in science and mathematics fell by half (Tobias, 1990). The restructuring of the plant science curriculum is in part an attempt to respond to the need to attract more and different types of students to the sciences. Plant science is a foundation discipline of the agricultural sciences and biology that is taught at nearly all universities and colleges (Scheckler & Taylor, 1992). The importance of botany to the emerging research in environmental deterioration and agricultural production is evidenced by increased support for agricultural and biotechnology research and applications. However, merely recruiting more students is not the singular goal behind the redesign of the plant biology lab class.

Engaging students to pursue the study of plants is challenging, according to Scheckler and Taylor (1992) because plants lack the behavioral attributes that make the study of animals so appealing to students. In addition, traditional plant science classes do not address the global issues, interconnected processes, and testable hypotheses of genetic inter-relatedness of plant groups. The recently reorganized plant biology lecture and the plant science lab courses focus on interpretative activities rather than on description and memorization of facts, features and processes of plant groups and plant anatomy. Developing a lab that matched the abstract and conceptual nature of the lecture meant developing a different kind of lab course.

The major goal of the plant science lab course is to provide a variety of experiences with simulated biological research activities which will inspire students to pursue a future career in some area of biological science (S. E. Scheckler, personal communication, May

30, 1994). In order to accomplish this goal for inspiring undergraduates to study biology, students must be given opportunities "to realize the interpretive goals of a biology course in new and creative ways" (Scheckler & Taylor, 1992, p.8). Accomplishing this goal requires a re-examination of the purpose of the lab in science instruction which not only needs to provide training in motor skills according to White (1986; in Scheckler & Taylor, 1992), but should also:

(1) Give added meaning to the propositions that students acquire through the lecture course

(2) Provide training in the cognitive strategies of problem solving and learning

(3) Provide an efficient way of communicating an understanding of and the skills associated with the scientific method

(4) Help students comprehend what scientists do.

(5) Create a community within the lab that encourages and facilitates interacting and sharing ideas.

This summary of the goals for the lab illustrates how the computer-based discussion activities were perceived to offer a way for the lab to accomplish its overall objectives.

The Plant Science Lab

An early prototype version of the plant science lab course was presented to a group of four student volunteers in the spring semester of 1992 (Scheckler & Taylor, 1993). At this time two of the computer-based instructional modules were available as well as several of the interactive simulation exercises. A preliminary version of the videodisk was also available and used. The computers were not networked together for this lab, and no interactive writing activities were used. Informal interviews and student comments in structured questionnaires indicated the following:

(1) Students liked working independently when going through instructional (tutorial) programs on the computer, because they could move at their own pace through the material.

(2) Students would, however, prefer to work in pairs or small groups to share ideas in problem-solving activities.

(3) Students wanted more discussion of the objectives for each lab. Some students wanted these discussions to be in advance of the lab so that they could be more prepared for the lab activities; others wanted these discussions to immediately follow the lab to clarify what was learned, what was successful and what didn't work well.

These findings are consistent with those of Tobias (1990), who reports that science students wanted a classes that is half lab, half lecture. This lab focused on activities that involved interpretation of observed phenomena. It used the informal sharing around the microscopes to encourage students to discuss what they thought they had observed in their examination of the live plant specimens. The lecture half of the lab was presented via computer-based instruction with some formal presentation by the lab instructor. The demonstration/manipulation part of the lab was presented via multimedia interactions as well as traditional wet-lab experiences. The interactive writing activities via Daedalus provided a more formal environment for students to share their interpretations and relate their understanding of some aspect of plant processes to other broader concepts and issues related to biology. The Daedalus Assignment feature was used to give an overview of the lab activities for that day and the key concepts to be emphasized.

The lab map depicted in Figure 6 shows where the computers were positioned in the lab. Students sat in pairs or alone at one of these seven workstations to go through the computer-based instruction and to participate in the electronic writing interchanges. The

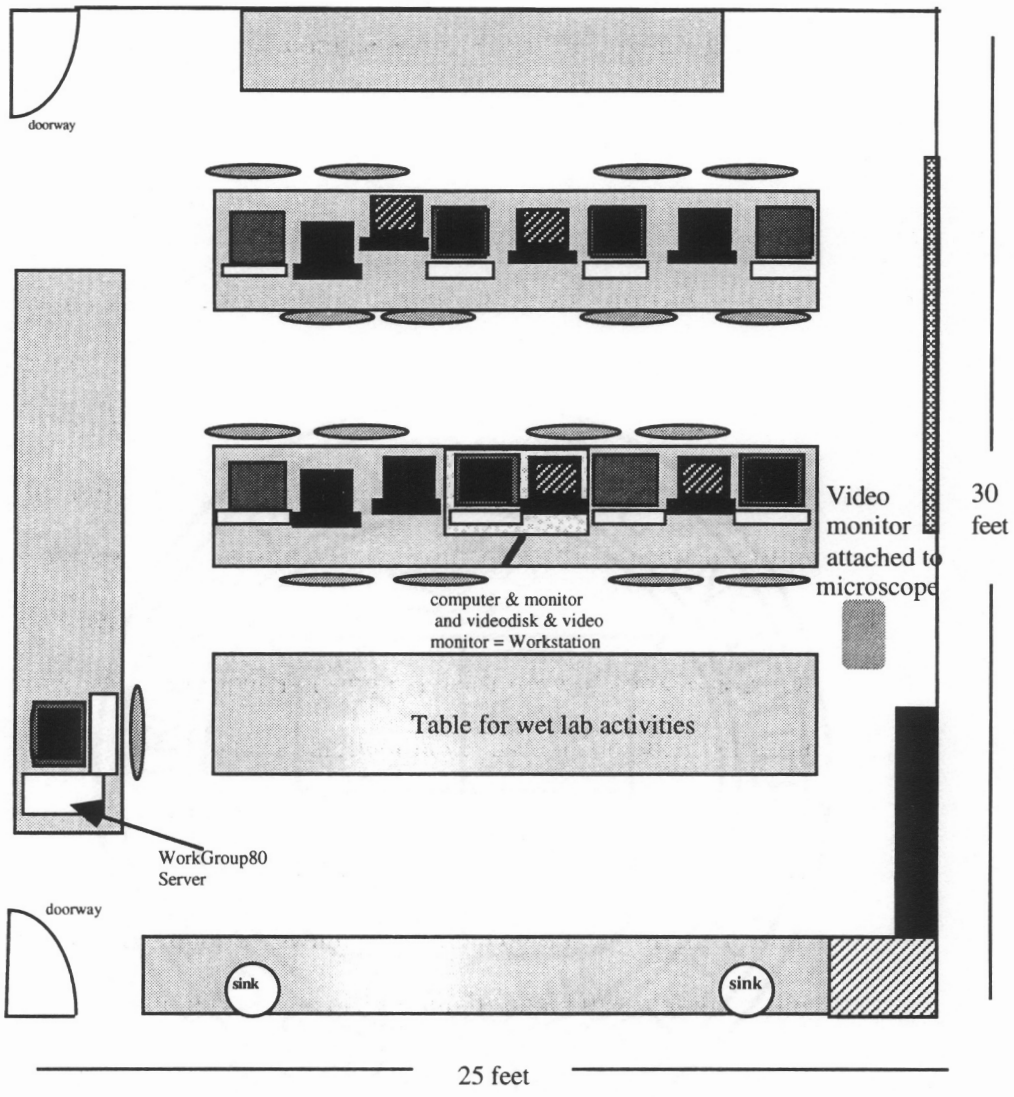


Figure 6

Map of Plant Biology Lab

table at which the manipulations of plant specimens occurred is shown on the map also; it is situated on the side of the room closest to the sinks which was convenient for wet lab preparations. Since there were seven students at the first lab, each student had their own computer and videodisk player to use and students did not need to pair up for any of the computer-based instruction or computer conferencing activities in this lab. The final class enrollment was twelve, so from the second through the fifteenth lab students self selected to either work alone, with a partner, or sometimes in a three-some at the seven computer workstations. (Figure 6 shows where the particular items of equipment and furniture are located within the laboratory room.)

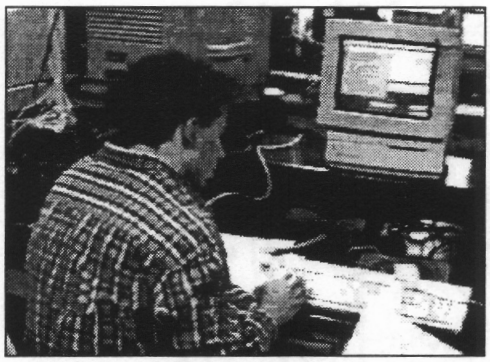


Figure 7
Student working through computer-based instruction module in preparation for wet lab activities.

Each lab consisted of the following general pattern of activities:

(1) Getting started with print-out and computer-based introduction to material. As students entered the lab, they would look for printed handout materials addressing topics in the current and upcoming labs which were laid out on the counter along side the server along the back wall of the room. These printed materials included a summary of the concepts and processes to be covered in the lab plus a printed outline of material and illustrations to be viewed on the computer and videodisk. The computer workstations were positioned on two tables as shown in the lab map. The workstations at each table alternately faced the east and west walls of the room. The computers and videodisk players and monitors were placed on top of a wooden plank above the lab table so that students had table-top space to work and to protect the equipment from water spills and other accidental damage. Students got started on their

own in each lab by reviewing the printed agenda of activities for the upcoming lab and by working through the computer-based module. These computer-based tutorials provided an introduction to the plant concepts and processes, as well as visual illustrations of plants, which were then subsequently demonstrated in hands-on lab activities (Scheckler & Taylor, 1992).

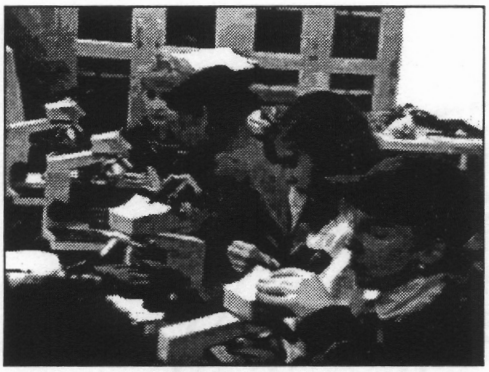


Figure 8
Students preparing and viewing microscopic slides from live plants.

(2) Hands-on exploring and preparing of live plant specimens. Students were guided by the instructor and graduate teaching assistant (GTA) to first examine the plant specimens in-tact and then were directed in the techniques for identifying, cutting, and mounting samples for microscopic inspection. In all but four of the labs the wet lab experiences were designed to simulate current experimental research activities so that students were exposed to the kind of decisions about land use, economics of forestry and field crops, and experimental design currently addressed by researchers in different branches of biological sciences.

Figure 9
Students collaborating during Daedalus activity.

(3) Concluding with participation in a Daedalus interchange discussion. Each lab included a unique topic (usually a few questions, sometimes a short reading selection followed by a few questions) that pointed out the critical issues, questions, and/or current events related to plant processes and experimental problems associated with the content and hands-on

activities covered that day. The on-line discussions occurring at the end of each lab were designed to illuminate the scientific questions about plants associated with the material they had just explored. These on-line discussions, in which all students and the instructor participated, allowed the instructor to readily accomplish several goals:

(a) Directing students to consider the key points in what was covered in the lab by asking them, "So what? Why is what we studied and practiced today important? Who cares?"

(b) Finding out what students learned from the material and activities presented in each lab by reading and archiving their on-line comments.

(c) Encouraging student-to-student as well as instructor-student discussions on conceptual aspects of the material covered in the lab.

The lab course was divided into four thematic units: (1) ecology/biomes; (2) plant growth and development; (3) plant reproduction; and (4) systematics and evolution. Appendix 4 contains a copy of a table which summarizes the topics covered in the printed hand-outs, computer-based modules, wet lab activities, and Daedalus interchange discussions for each of the fifteen labs. The nature of each of these activities varied to suit the conceptual goals of each lab. This study focuses on the interactions that occurred in the on-line discussions, but student and teacher interactions in other aspects of the lab will be referred to in order to provide context and meaning to interpretation of the Daedalus interchanges.

Description of Students

The lab was set up to allow a maximum enrollment of 16 students. Of the fifteen students pre-registered and listed on the class roll, seven attended the first class, and an additional six students started the class with the second lab. Two of the students on the

original roll dropped the class due to schedule conflicts. Thirteen students ranging from freshman to graduate level completed this course and participated in this study.

The students in the plant science lab differed from the freshman writing students in several ways. Table 10 provides a summary of student responses to the entry survey, which was the same survey used with the freshman writing students except that the last series of questions pertain to collaboration in a laboratory class setting as opposed to collaborative writing activities. Comparing the data in Table 10 in this chapter with the data displayed in Table 5 in Chapter 3 (p. 52), which summarizes the computing backgrounds of the freshman writing students, demonstrates a few key differences in the student groups in these two settings. There were 22 students in the freshman writing class and only 13 in the plant science lab. Every student in the freshman writing class reported some prior experience with a computer--using it at least for word processing. One student in the plant science lab reported to have rarely or never used a computer before and to have had no prior experience with even word processing on computer. In the freshman writing class 77 percent of the students owned their own computer; only 38 percent of the students in the plant science lab reported owning their own computer. In the freshman writing class 77 percent reported to have had a class in high school that required using a computer, while only 38 percent of the lab students reported having had a high school class that involved use of a computer. The students owning their own computer were not necessarily the same group as those reporting to have had a computing course in high school.

The students in the freshman writing class were younger than the group of students in the lab, and this difference in age was also expressed by differences of maturity and experience. All of the freshman writing students were between 17 and 19 years of age; all were in their first year of college, and all were less than one year out of

Table 10

Summary Computing Experience

Own their own computer	Yes (5) No (8)
Use computer: Daily Every other day Only as needed	Daily (4) Only as needed (6) Rarely (1) No response (2)
Program he/she is familiar with: Word Processing Hypercard Electronic Mail Other	all but one have used word processing programs (11) are not familiar with Hypercard; (2) are (8) have not used e-mail; (5) have
Had at least one course in high school which required using a computer:	Yes (5) No (8)
Previous exposure to collaborative activities: in high school	(10) had high school collaborative exp.; (3) have not
Student attitudes towards collaboration: Working collaboratively is...	(5) not frustrating, (4) frustrating
Working collaboratively is...	(9) said collaboration was productive; (1) said it was not
Working collaboratively...	(7) increases learning; (4) decreases learning
Student academic majors:	Architecture (1), Biology (10), History (1), Undeclared (1)

high school. The narrative introductions by the plant science students listed in Table 11 show that both Bill, Carrie, and Cynthia were returning to school after working in another area and wanted to change or further clarify their career pursuits. Many of the sophomores and juniors were simultaneously taking the Plant Biology lecture course which Scheckler was teaching, and had enrolled in this class based on his announcement at the lecture that the lab would complement the lecture with more hands-on manipulation activities and related experience with computer-based introductions and simulations.

Two other ways in which the lab participants differed from the freshman writing class were: 1) Ten out of the thirteen students in the lab class were biology majors, and of the three that weren't, two were considering changing to biology; and 2) Freshman writing is a required course (except for those who are placed in the honors English program and can skip over this introductory sequence) and the plant science lab is a recommended, not required, one credit hour course. The introductory postings and descriptions of each student in Table 11 suggest that the students in the plant science lab elected to take this course because of a personal interest in this subject matter, and in some cases a desire to improve their grade in the plant science lecture.

The introductory exchange on-line also offered students in the plant science lab a way to get to know their instructor and the graduate teaching assistant (GTA) for the course as well. Here are excerpts of the introductory comments by the professor and content expert for the development of this course, Scheckler, and the graduate teaching assistant, Stewart Hill:

> Steve Scheckler:
> I have enjoyed plant[s] all my life. When I was about 4-5, I tried to pollinate my mother's tulips with daffodil pollen to see what would happen. Nothing did, but I have always enjoyed the visual aspects of plant growth, My curiosity eventually led to choosing botany as a career, but this came after 5 other [science or engineering] majors in college.

Table 11

Student Short Introductions
(excerpts from CMC exercise)

Student Pseudo-nym	Goals for this class. Career goals. *The student comments are quoted from the Introductory Interchange. Three students did not participate in this interchange, and their descriptions are based on informal interviews and questionnaires.*
Angela	...I hope to better understand plants, since I have never taken a course about plants. I think it would be helpful to have a hands-on experience. Helpful for lecture and myself. I feel like I completely do not know anything about plants, YET! Everybody seems to have a pretty good background, but that's why I am here. to learn, learn, learn.
Bill	...I have been interested in plants ever since I can remember. I also intend to become, eventually, a professional botanist. I have a variety of house plants (which drives my wife crazy--they are everywhere) and I grow a vegetable garden every year.
Bill Bailey	I'm an argumentative Junior in biology with an edge towards Micro/Immuno...I'm also attempting a philosophy minor so watch out for my "flippant" philosophical comments...
Brandon	[Brandon is a history major in his junior year. He was unable to attend many of the lab classes.]
Carrie	[Carrie has an associate degree in fashion design. She has worked in that field for several years, and has found it to be an unsatisfying career. She is from northern Virginia and is returning to school to get a bachelor degree in biology]
Cynthia	My expectation for the class is to learn the basics of biology from the cellular to the ecosystem level. My career goals include a Master's or Ph.D. in some as yet unspecified field of biology. I am interested in and have done quite a bit of field work with tropical and neotropical birds, and I am interested in continuing in that vein. Eventually, I would like to be able to do my own research. For the meantime, I am not sure which discipline (Biology, Ecology, Wildlife, etc.) is best for pursuing my goals. I am here at Virginia Tech as a special undergrad student (I already have a BA) to find that out.
Fairly	[Fairly is a transfer student new to Virginia Tech this semester. She has not yet declared what her major is, but "it will be one of the sciences."]
Leigh Jones	I hope to become a veterinarian if I can get through undergrad...In this class I hope to learn more about plants to supplement the plant class.
Marble	...I hope to go on to graduate school and get my masters in biology and get into the teaching field. Plant classes that I have taken in the past have been full of information, at times a real bore. I do however feel that this class will challenge and stimulate me.

Table 11 (continued)

Student Short Introductions
(excerpts from CMC exercise)

page 2 of 2

Student Pseudo-nym	Goals for this class. Career goals. *...student comments (continued)....*
Plant-boy	...I hope to further my education in the field of botany as well as computers in this class. I think taking this class will definitely help me with keeping up in the lecture and hopefully I can even get ahead on the material covered in class. My career goals (so far) are to get my masters in some field of biology (to be announced) and possibly go into teaching, perhaps at a college level.
Ron	Plant biology seems like an interesting topic. The lab is going to be a good experience. I think that I am going to enjoy this lab a lot more [than] other labs in the past. Hopefully the learning process will be easier. My major was Architecture, but I am in the process of changing it to Biology. After I get into the Biology Department, I would like to go to medical school or do genetic research.
Sonia	well, I have had a class similar to this, but it was a different format. I just want to figure out the different methods of teaching while reinforcing my botany knowledge.... Well, I just kinda realized that you can send the answers to all of the questions at once. But anyway, I am considering adding an English major to my biology, to possibly do some magizine [sic] writing after college, or my other career possibility is teaching.
Tim	...I'm a biology major, I'm in the Pre-Med program. I'd like to get know more about plants to help in lecture.

Stewart Hill:
My interest in botany originated during a summer camp forestry class. That experience inspired my interest in plant identification. As an undergraduate, I majored in biology, and I found that plants were neat because they were so different from animals - yet uniquely complex in their composition. I simultaneously was interested in historical processes, and this led to graduate work with the history of plants - basically ancient forms of plant biology. I plan to teach biology and botany at the collegiate level, and I am excited by the potential that interactive learning holds for capturing student interest in plants. I'm really eager to break through the barrier that "botany" seems to present to so many students. Plants truly can be fun to learn about, and I hope that this class helps us all to find this out.

Like the 4,000 Ph.D. scientists and engineers employed by NASA and surveyed between 1962 and 1969 (Logsdon as cited in Tobias, 1990), Scheckler decided on a career in science well before completing high school and his intrinsic interest in the subject matter was very influential in his career choice, and was expressed very early. However although Scheckler fit readily into the established scientific community, he consistently encouraged students who were not "traditional" science majors on the initial insights and efforts to understand plant processes. In this later posting Scheckler emphasized that the tone of this class would be dramatically different than that of the lecture and most other classes.

Learning should be easier just because we will be having fun. If we are not having fun, then we will ask "why not?" and deal with that.

Scheckler's primary goal for this class was that it inspire more students to imagine the kind of interesting and rewarding career opportunities the study of biology can offer.

The introductory comments by Scheckler and Hill also gave students their first experience with the real-time interactive writing process. The instructor set the tone for this and future on-line interactions by posting messages that were brief, informal, usually

annotated with exclamation marks or other punctuation used to convey enthusiasm or humor. Nearly all the messages posted on-line had some kind of typographical, grammatical, or spelling error. The more lively and fast-paced the discussion, the more likely these errors were to appear. This also illustrated the informal quality of the communication between teacher and students, students and teacher, and between students themselves. These errors have not been corrected in any of the transcripts. Readers should consider the fast-pace of the interactions and informality of the discourse when viewing the transcript excerpts and should avoid dismissing any of the thoughts being conveyed because of some typographical errors.

Surveys, Field Notes, Videotapes, and Interviews

Information from student surveys was collected at the first and second (for those who missed the first class) labs, during the capstone event, and as part of the final exam for this course. Since the classroom experience in the plant science lab involved a great deal of visually-based instruction, on computer and via microscopic examination as well as hands-on manipulation of live plants, students as well as the instructor were asked for their consent to be videotaped as part of this research study. A copy of the informed consent form for the videotaping is contained in Appendix C.

As part of my role as a graduate research assistant working on this project, I was present at nearly all the lab classes. During the classes I was able to observe students as they performed different activities that were part of the computer-based instruction, wet-lab activities, or Daedalus interactive writing discussions. As a participant observer in the classroom I had several motivations for talking with students about what they liked, disliked, and found most useful or least useful about each lab's events. The results of these observations and informal interviews were written up during and after each lab and are included in my field notes. In addition, the team of people involved in the design and

development of additional computer-based instructional modules for this course met on a weekly basis to review what would be presented in the upcoming lab and what was successful and/or not successful in the lab just completed. Minutes from these meetings are included with the field notes.

One student in this class expressed some resistance to the initial multimedia program as "electronic books" and suggested that Daedalus was a step up from this type of computer interaction and that Daedalus did facilitate communication. Many of the students commented that use of the Daedalus program changed their attitude towards computers because they had not had much prior experience using the computer as a communication tool in this way.

Capstone Activities

Comparing Biology Capstone with Capstone in Freshman Writing

The capstone activity was adapted to suit the content of the freshman writing and plant science lab classes, but in both situations the students were essentially participating in a peer review activity that included a quantitative rating, which was done privately, and a discussion of the rating that was public and conducted in an open, interactive interchange. These two activities differed in the following ways:

1) The biology lab had eleven students present for the capstone which meant that at four computer workstations students were working in pairs and at the three remaining workstations students worked independently. This was true for every lab; with only seven computer workstations and thirteen students enrolled, some students had to work in pairs at the computer. By the time of the capstone activity,

the students who paired up and those who preferred to work independently became predictable and continued in this pattern until the end of class.

2) The kind of questions asked in the biology lab were different from the formal composition rating tool used in the freshman writing class. The seven questions used in the biology lab were put together by the researcher from some of the course development documents and represent the kind of questions students should ask when they review scientific writing. The two principle investigators associated with this project, Scheckler and Taylor, read over the capstone questions in advance and their suggestions were incorporated into the final document.

3) The instructor did not participate in the biology capstone interchange--although he reviewed the materials and provided the article used in the capstone activity.

Description of Capstone Activities

Lab 7, which was the lab immediately preceding the capstone, covered the topic of whole plant physiology and had students use a transpiration simulation program and workbook to explore the structural adaptations of leaves and stems that facilitate water movement in plant systems. A picture of the transpiration simulation computer screen is presented in Figure 10. The transpiration simulation exercises and wet lab activities took the whole class period, and the Daedalus discussion addressing the topic of water uptake, movement, and transpiration was scheduled for the beginning of the next lab period. The Daedalus discussion focused on a *New York Times* article that described recent research findings regarding a new view of how trees obtain and share water.

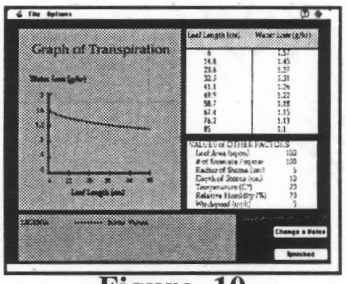


Figure 10

A picture of the transpiration simulation as it appears on the computer screen.

The capstone event was then scheduled for the beginning of lab 8 and included the following procedures:

1) Students got situated at a computer workstation at the beginning of class and were told to go right to Daedalus and read the assignment. If they did not have their copy of the *New York Times* article with them, they were asked to let us know, and we gave those who needed it a duplicate copy to help them complete the Daedalus activity.

2) After reading the assignment and reviewing the *New York Times* article students were asked to copy and paste the assignment into a mail message, key in their rating scores, and mail them to the instructor.

3) After completing their initial rating of the article, students were then asked to join a Daedalus interchange discussion to discuss what they considered to be the strengths and weaknesses of the article.

4) After all students had a chance to participate in the interchange, students were asked to again copy and paste the assignment into a new mail message, key in their rating scores a second time and then send their second rating scores to the class instructor via Daedalus mail.

Description and Interpretation of the Capstone Interchange

Message Act Analysis. Unlike the freshman writing class, the instructor was not on-line during the capstone interactive writing activity. While the researcher and the principle investigator from Educational Technologies, Taylor, posed questions to initiate the discussion, neither of these participants moderated or directed the interchange. In fact, this is the only interactive writing discourse in the plant science lab in which this researcher participated and in which the instructor for the course did not participate, with the exception of the final course evaluation. As Figure 11 shows there were essentially two topics which

initiated a series of responses and interaction sequences by students. Also as Figure 11 shows, there were five topic initiations and reply initiations by students in response to opinions and/or clarifications contributed by their peers. While the students appeared to be confident in their evaluations of the strengths and weaknesses of the articles they were reviewing, they did not evaluate each others comments. They did ask each other to clarify or further explain their point of view, and examples of these interactions are discussed later in this section.

Network Connections. The capstone interchange consists of 26 unique messages, and is considerably shorter than the overall average number of messages sent per lab interchange discussion which is 41. The percent of questions per total number of sentences for the capstone is 22 percent which is just slightly above the average of 19 percent. In terms of the number of words per message, the capstone interchange with an average of 45 words per message is close to the average for all interchanges, which is 44 words per message.

A specific description of the network connection in the capstone interchange is provided in Table 12. As this table illustrates, Bill Baily had the highest participation ratio, and participation frequency of 5.2, based on the five messages he sent over the course of the interchange. Cynthia, who had the highest volume ratio (words sent divided by the total number of words in the interchange), only sent two messages and had low scores in all the other quantitative descriptions of participation, but her two messages were quite long relative to the length of most messages. Angela and Plant-boy had the highest integration ratio of 1.5. Carrie & Ron and Fairly had the least number of network interactions and also had lower participation in this interchange. Ron and Fairly were sophomores and had not yet declared biology as their major. Students who had more experience in biology were

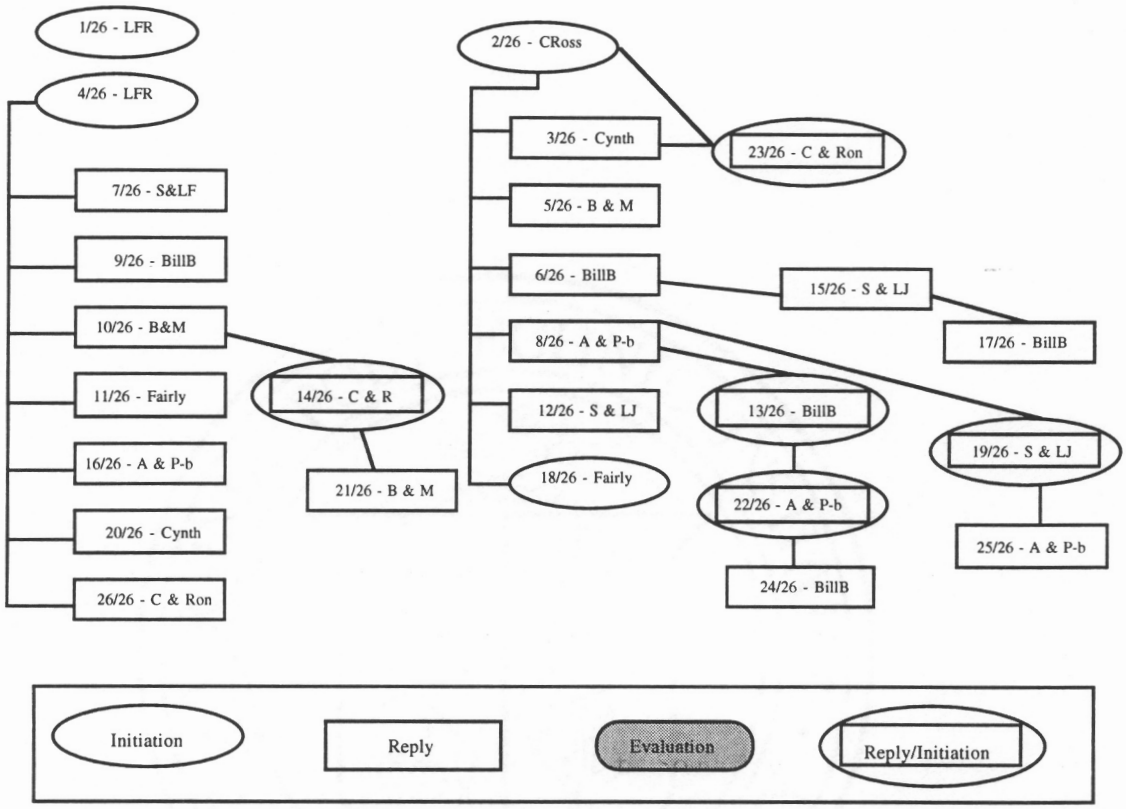


Figure 11

Message Flow Analysis of Capstone (Lab 8)

Table 12

Quantitative Descriptions of Participation and Interaction

Plant Science Lab Capstone Interchange Analysis

Student Alias	Words Sent % words sent. M's Sent	Partici-pation Ratio # messages sent/ # total messages	Partici-pation Frequency # total messages/ # messages sent	Volume Ratio # words sent/ # words total	Integration Ratio # messages received/ # messages sent
Angela & Plant-boy	(205) 18% 4	0.15	6.5	0.18	1.5
Sonia & Leigh	(182) 16% 4	0.15	6.5	0.16	1.0
Fairly	(60) 5% 2	0.08	13	0.05	0
Carrie & Ron	(76) 7% 2	0.08	13	0.07	0
Bill & Tim	(84) 8% 3	0.12	8.7	0.08	0
Bill Baily	(168) 15% 5	0.19	5.2	0.15	0.67
Cynthia	(233) 21% 2	0.08	13	0.21	0

more frequent participants in the discussion and contributed more regulatory comments than students who were new to biology.

Bales Interaction Analysis Scale: Table 12 describes the capstone interchange in terms of the number of words, directed messages, and type of social psychological message sent from the individuals and pairs at each computer workstation. As Table 12 shows, Bill Baily sent the most messages. Bill Baily sent the largest number of reaction-type messages: three of which were positive; one, negative; and two which were neutral. An analysis and coding of the capstone interchange showed that 56 percent of the discourse consisted of answers, opinions, or clarifications in response to questions or topic initiations posed by one of the instructors or by another student in the class. Seventeen percent of the discourse was composed of questions or topic initiations. Twenty-seven percent of the discourse could be described as either a positive, negative, or neutral reaction. Figure 13 illustrates this 3-way breakdown of those reactions.

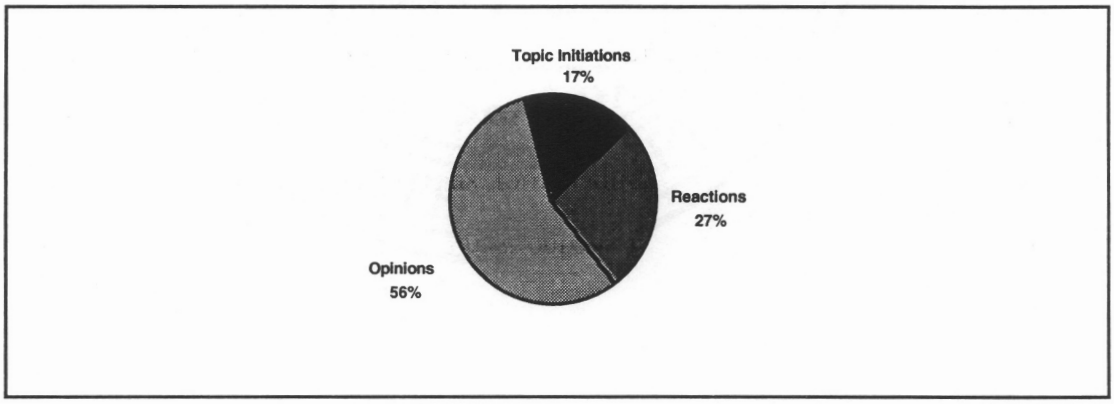


Figure 12

Comparison of Student Messages within Three Interaction Analysis Categories: Topic Initiation; Opinion; Reaction

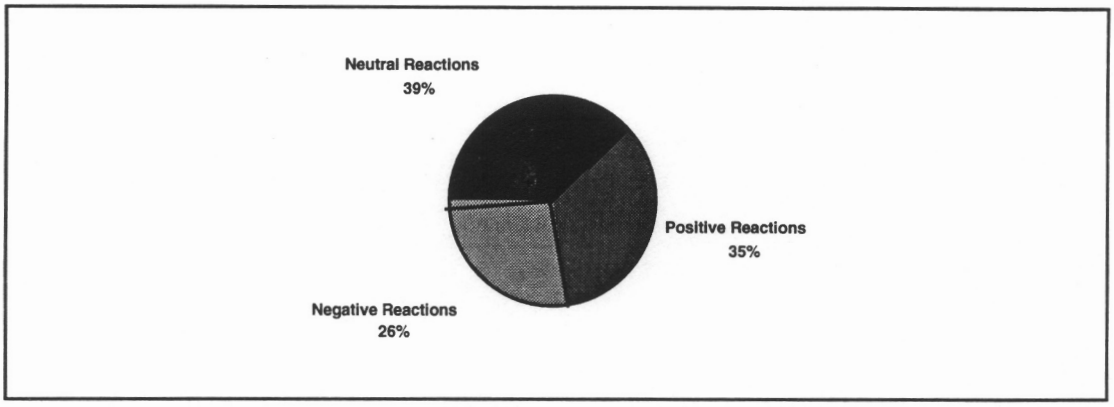


Figure 13

Comparison of Student Reaction Comments:

Positive, Negative, or Neutral

Description of Reaction Comments: The messages within the discourse described as "reactive comments" are important because in many cases these are the kind of comments that stimulated and in some cases provoked interaction and further discussion on a given topic. For example, the reactive comment by Sonia directed to Angela and Plant-boy prompted them to respond. Several examples of these reaction comments follow. In order to show the context in which these comments occurred, I have displayed the whole message and have underlined the part of the message illustrating the reaction comment.

(19/26)Sonia and Leigh Jones:
Angela Plant-boy
We are really confused by your statement. So What if the larger plants are taking more water the smaller ones don't need it.

(25/26)25 Angela Plant-boy:
TO SONIA AND AND LEIGH JONES: :
YOUR QUESTION IS PHRASED A BIT CONFUSING ...BUT WE WILL TRY TO ACCOMADATE YOU WITH A RESPONSE. OBVIOUSLY, NO MATTER HOW SMALL THE PLANT, IT WILL NEED A SUFFICIENT AMOUNT OF WATER FOR LIFE. WITHOUT IT...THE LARGE PLANTS MIGHT PROSPER BUT THE SMALL PLANTS WILL DIE.!!!

Even though there were positive, negative, and neutral reaction statements in the discourse, in this interchange there were no evaluative comments assessing the accuracy or value of each other's responses. The positive and negative comments were noted because they often influenced the interactions, participation, and direction of the discussion. Some of the reaction comments described student reactions to the rating questions.

(9/26)Bill Baily:
The article was full of scientific opinions, that's for sure. The author did a good job of explaining a topic in a manner that many people can understand, or attempt to understand. The questions asked about the article were a little strange, although most required tough decision making.

Some of the reaction comments described student reactions to the questions posed in the rating activity as well as the author's use of language and presentation of scientific information in a journalistic-style report on transpiration.

(20/26)Cynthia:
I thought the article was pretty interesting, but i'm not sure this process of hydraulic lifting should really be related to what is called "water sharing". It seems to me that both hydraulic lift and the flow of water from the shallow roots of a large tree into the soil layer are both readily explainable processes. To call it "water sharing" implies a kind of altruism which can be a misleading idea -- that is to say, ascribing "volition" to plants. Rather, it might be better to simply acknowldege that certain shade-tolerant plants thrive on an excess of ground water pulled up by the tree under which they colonize. To imply that the tree might purposely "share" water in order to increase overall producivity of the ecosystem could be misleading. Maybe it should be spoken of in terms of

evolutionary advantage instead. These are thoughts brought on by the questions we were asked to answer . The questions seemed to be encouraging a critical view of the article. The fact that we were asked to evaluate the scientificicity (is this a word?) of the article made me question its authority.

Cynthia returned to school after having received her bachelor's degree in liberal arts one or more years ago. She was using her experiences in this and other courses to help her decide which area of graduate study would be most appropriate to pursue her career interest in the study of neo-tropical birds. (Table 11, p.108, contains more details about Cynthia's background and interests.) As a more mature student and as a former liberal arts major Cynthia demonstrated a sensitivity to the language used by the author and had the confidence to question whether the wording chosen by the author was appropriate or misleading. Bill Baily, who described himself as having a dual major in biology and philosophy and was in his junior year at the time of this study, also commented on the nature of the questions asked about the article and the influence these had on his analysis. These students brought up issues which Rafoth (1988) discusses in his description of the characteristics of discourse communities within disciplines. According to Rafoth, "Different communities of arguers, readers, or speakers will have different yet valid expectations for carrying on arguments, formulating correct readings of a text, or speaking appropriately. In a similar vein, various groups of writers and readers have different, yet valid, expectations for what written discourse should be like....For example, in scientific discourse certain topics, such as ESP or divination, are not to be taken seriously by members of the scientific community or those who read scientific writing" (p. 135, 139). And as Cynthia suggests, in scientific discourse plants cannot be ascribed as having their own volition.

Interpretation of Pre- and Post-Discussion Rating

Unlike the composition rating activity in the freshman writing class, the rating exercise in plant science lab included some questions that required narrative answers. Included with the capstone materials contained in the Appendix are summaries of how each of the seven groups and individual students responded to the capstone rating. The questions that students were asked to answer as part of the rating activity are listed in Table 13.

These questions were developed based on the goals in the NSF grant. The first question asked students to examine the article and identify and then list the plant processes that were mentioned. In response to question one, students identified anywhere from two to five processes as being mentioned in this article and none of the groups/individuals changed their mind between the pre- and post-discussion rating. All students agreed that hydraulic lifting was one of the plant processes discussed in this article.

In the first rating all groups/individuals acknowledged that the author's depiction of plant processes was accurate. In the follow-up rating one team, Angela and Plant-boy, changed their rating from yes to no on question number two:

```
(from Angela & Plant-boy)
No, after reading Cynthia's response about hydraulic
lifting and water sharing we agree that the two shoul not
be considered the same
```

Two other students expressed increased doubt about their initial response to this question in the second rating:

```
(from Fairly)
yes, but I questioned it

(from Cynthia)
reply hazy
```

Table 13

List of Questions Used in Plant Science Lab Capstone Rating Activity

1. How many different plant processes were mentioned in this article?

   Please list the plant processes you counted as being mentioned in this article:
2. Based on your knowledge of plants, was the author's depiction of these processes accurate?

   (Yes) or (No)
3. How many different research studies were referred to in this article?
4. Did the author correctly apply scientific knowledge as evidence to support the facts presented in this article? (Yes) or (No)

   Support your answer by citing one example from the article.
5. Would you say that the point of view presented in this article is universally held by all plant scientists?
6. Briefly describe the major strengths and weaknesses of this article.
7. On a scale from 1 to 10 [1 being the lowest; 10 being the highest] how would you rate this article in terms of:

   (a) the value of the information presented:

   (b) the author's ability to provide a clear and logical explanation of the ideas contained in this article:

Sonia & Leigh working as a team and Bill Baily on his own revised their figure regarding the number of research studies referred to in the article. The wide variation in student responses to question three--from one up to eight--suggests differences in their interpretations as to what this question was asking.

All students/groups answered "yes" to question four except Carrie and Ron. In the second part of this question Carrie and Ron explain why they believed the author did not correctly apply scientific knowledge to support the facts presented:

```
(Carrie & Ron)from Rating #1
The first research example had a good start.  I t
discussed the steps to start the experimant, the models
and hypotheses.  But, It did not explain how the
experiment was done, the results, or the conclusions.

(Carrie & Ron)from Rating #2
The first research project that was mention had a god
start.  the author discussed hypoteses and models, and
what the research would explain.  The experiments were
not explaine to our satisfaction.  It went from
hypothesis to conclusion in one giant leap.
```

All the students agreed that the information presented in this article contained some basic principles that probably all scientists would agree with, but nearly all students mentioned that the article also described some new findings that are just now being more broadly circulated. As Bill and Tim said, "We've only seen a few points of view on the subject."

In their response to question six, rating of the overall strengths and weaknesses of this article, most of the students agreed that opposing views were not mentioned and it would have been helpful if the authors related the findings to a broader context. These views are exemplified in this comment:

```
(Sonia & Leigh Jones)from Rating #2
[The author] used enough evidence but did not show the
con side or rleate it to other process.
```

Several students felt that the article would have been more valuable if it had discussed some of the consequences of the discovery it described. Some of the student responses on this question illustrate how the discussion influenced their thinking to progress--although not necessarily change their minds:

```
(Angela & Plant-boy)from Rating #1
THE STREGNTHS OF THIS ARTICLE ARE ABUNDANT...HOWEVER,
THERE IS LITTLE SCIENTIFIC EVIDENCE

(Angela & Plant-boy)from Rating #2
the strengths are : how understanding the article was
to read, and the way they explained hydraulic lifting
was accurate and interesting.
the weaknesses:  not too much on the negative aspects

(Cynthia) from Rating #1
it only used one study and didn't present the opposing
views

(Cynthia) from Rating #2
perhpas a major weakness is (i'm not sure) lack of
understanding of scientisific processes by the author
and absence of opposing viewpoints. A strength is the
article's appeal to readers other than professional
botanists, it is written, and the idea is presented in
a framework that is easier to understand. For example,
the title is more appealing as "plants share water"
than as "trees roots leak" althought he latter title
might be more exact.
```

In their overall numeric rating of the value and clarity of the article in question seven, most of the students did not change their rating at all or only slightly modified it. Fairly was the exception, however, who seemed to be most influenced by the discussion activity to change her original assessment of the article. Her change from an initial rating of five to eight for the value of the information and to a ten for clarity was surprising. Other differences in Fairly's re-evaluation of the article may also have played a role in her changing her initial ratings. In the first rating, Fairly only partially answered the prepared

list of questions as they were asked, and responded by sharing her personal comments about the article in a more open-ended manner. In the second rating activity, Fairly completed responses to each question asked in the rating and appeared to be interpreting the activity more similarly to the rest of the class.

Carrie and Ron gave this article the lowest ratings, giving it a two in both the pre- and post-discussion rating. Throughout the capstone activity, Carrie and Ron were behind the rest of the class and barely had enough time to read through the interchange before quickly keying in their comments and moving on to the final rating due to time restrictions. This may not have been a normal day for either of these students. Ron had damaged her knee on the ice since the last class, and her left leg was in a cast and she was having to use crutches to get around. This temporary ailment was restricting Ron, an Army Cadet, from participating in ROTC activities. In a conversation with Scheckler about the students pre- and post-discussion rating scores, we looked closely at the scores by Carrie and Ron, which were so different from the ratings by the rest of the class. Scheckler suggested several possible interpretations. Ron's having to get around on crutches and being temporarily pulled out of her cadet program could have influenced her response to the rating activity--making her respond more critically than normal. Some variations in Carrie's and Ron's responses may be due to unusual circumstances that affected both students that day.

Scheckler also suggested that Carrie's and Ron's response to question four shows that they rated the article by a different standard than the rest of the class. The rest of the class seemed to acknowledge that this article was written by a journalist who was writing about scientific phenomena for the general public. Carrie and Ron appeared to be rating the article without giving it allowances for its shift to journalistic-style writing. Scheckler also commented that Carrie and Ron appeared to be the least experienced biology students in the

lab--both being newcomers to science. Ron, a sophomore, was considering switching from architecture to biology as her major. Carrie was in her first semester back in school after a brief career as a fashion designer. Carrie and Ron may have been out of step with the rest of the class because they are newer to biology, and the differences in perspective caused by inexperience with the subject matter should change as Carrie and Ron take more science courses.

Summary and Interpretation of Capstone Surveys

Students liked interacting with each other, but also valued Daedalus because it offered an alternative way to interact with the instructor. Several students commented that the ability to interact with their professor in the Daedalus environment was an important aspect of the on-line discussion because it provided them with timely feedback and guidance or approval. All students reported that being able to interact with their peers on-line increased and broadened their understanding of the topics addressed in class. Here are some examples of students written comments about the value of being able to read their classmates' responses:

- *It also allows me to judge my comprehension of the material with the rest of my class. (Carrie)*
- *It causes me to consider other viewpoints while I am developing my own response. Several times my response was modified by what I read. (Bill)*
- *It did change my attitude towards school. It allowed me to exchange ideas more freely. (Fairly)*
- *It allows us to maybe better understand things we otherwise wouldn't consider. (Angela)*
- *[Viewing] other responses raises new ideas that might have been overlooked or not thought of at all. By others offering objections to my responses, I can see <u>how</u> I might be wrong, not just know I'm wrong. (Plant-boy)*
- *Seeing other responses allows me to question my own thoughts and respond to new ideas presented to me [by] others. I have gained new views to biological topics from the responses of others ....(Bill Baily)*

- *I didn't realize there was so much room for contention, skepticism, [and] discussion. (Cynthia)*
- *Sometimes it clarifies concepts that I didn't fully understand -- sometimes I enjoy others point of view (my ideas about the world are still developing).*
- *It makes one think about the other point of view. At times you may have to justify your own answers and support or contradict other peoples' responses.*

The Daedalus discussions were voluntary and not graded--an important point to students. Students universally agreed that Daedalus discussions should not be graded and cited reasons such as: It would "cramp my style..." "If you graded the discussion, I would tend to be more concerned on answering the questions than forming a true opinion." "Putting grades on the interchange would cut down on creative and innovative thought." "Many people would be afraid to speak up." "I can't think clearly or originally under duress."

Several themes emerged from student responses to the Daedalus interactive writing activities in the capstone survey.

(1) Students reported that they liked being able to learn about others' opinions, and knowledge. Seeing opinions of others helped form a more well-rounded view. This theme was reported by 10 out of eleven students who were present at the capstone class. One student clarified that while she liked being able to read others' opinions she preferred a verbal conversation, "because it seems more heated" (Sonia, Q1).

(2) Students developed a more positive (or alternate) view of computers by using Daedalus. "It has made me more aware, in a practical sense, how useful computers are" (Bill, Q2). Eight students voiced similar responses, but there were three differing views--primarily by those who were already familiar with using the computer as a communication device: "Well, for me this is just another style of e-mail" (Sonia, Q2).

(3) Students reported that the Daedalus interchanges facilitated communication with others. This response was the most common, consistent response to Daedalus in this and

other surveys--in both freshman writing and in the plant science lab. For example, this student liked the " ...discussions on-line because it's an opportunity for free expression" (Cynthia). Nine students agreed that ideas can be shared on-line without inhibition, although two suggested there's a little give and take--everyone relays their ideas simultaneously which saves time, but it takes a while to read and decipher.

(4) A few students liked the fact that the interactive writing exercises helped them recognize that there is room for contention, skepticism, and discussion in this field (Cynthia) and helped them to see both sides of an issue (Leigh).

(5) Several students reported that the on-line discussions were enjoyable because these activities were good at making you think: "using my brain more..." (Leigh); "making you think "(Angela); "allow us to think for ourselves not simply absorb material" (Carrie).

(6) One of the students who had been a frequent user of e-mail prior to taking this class remarked that he liked the "Real-time responses to questions--(unlike e-mail)" (Bill Baily).

(7) A few students mentioned that they liked the Daedalus interchange activities because it go them "Involved in discussion with teacher" (Bill Baily) and they were "challenged by [the] teacher's responses" (Angela). Along this vein students suggested that broader use of interactive writing activities "Can benefit all classes & create a more closer relationship with the professor & classmates."

(8) Students saw great potential for this technology to expand access to the teacher or another "expert" out of class: a "help on-line conference or bulletin board would be an immense help if teachers would take the time to answer the students in an off-line" (Bill Baily). "If I could get on line and connect with someone (...TA or tutor) at any time...that would be great!" (Cynthia). "Out of class on-line conferencing would be very helpful in

an English class in which papers are required. Ideas can be easily exchanged in that case" (Tim).

(9) One student suggested that she perceived great potential for this technology to accommodate differences in student learning styles. Teachers can more readily " ... provide for diverse learning styles through the use of computers" (Fairly).

Criticisms of Daedalus

In addition to the enthusiastic comments about the Daedalus program, students shared a few complaints. One student reported not liking to have to learn new software commands in order to participate in the Daedalus interchanges. Several students mentioned that they did not like having to type their messages and that their typing slowed them down. A majority of the students mentioned that they would like more time allotted to the computer-based discussions, but only a few students thought it would be a good idea to keep the discussion open outside of class. A few students wanted the wording of some of the computer-based questions to be simpler, and some suggested that they needed more time to digest the lab material before they could feel comfortable participating in the discussion. Two students out of twelve mentioned that they were uncomfortable with the nature of the Interchange discussion and that the "jumbled" nature of the discussion was difficult to understand and included "tangents that do not apply at all."

Student criticisms of the Daedalus interchanges fall into the following three categories:

Interface Issues. "Having to learn new software commands"; "Being a slow typer... typing is frustrating." "Don't like reading from computer screen"

Interaction Issues. Trying to (not being able to read) respond to everything.... overwhelmed and not sure who to respond to...thoughts get jumbled...people get onto

tangents. "Not enough terminals to have computer for every student." However, this same student reports that on-line conferencing also facilitated collaboration: "especially with multiple people to each terminal." Leigh also mentioned this preference in her final evaluation. Lack of social quality to interactions: "Facilitates idea movement But you are not working together socially. I still do not know about three names in here" (Leigh).

Task Issues. "Not enough time to develop a good exchange of opinions. The wording of questions was sometimes difficult" (Sonia).

Interpretation of Other Data Sources

Increased Level of Interactivity in Lab 9

In several labs, the Daedalus discussions served several functions simultaneously: (1) Getting all students engaged in a conceptual discussion of some current event or controversial issue related to the biology processes addressed in that day's lab activities. (2) Asking students to talk about the lab activities and computer-based instruction modules they experienced and describe what worked well and make suggestions for areas to improve, change or eliminate.

A close examination of the descriptive data of interactions for each lab, shows that the discourse created in lab 9 differs from all the other labs in the number of questions generated in this discussion. Figure 14 provides a scatter plot comparing the percentage of questions asked in lab 9 compared with the percentage of questions asked in the computer-based discussions in other labs. The discussion in lab 9 contains noticeably more questions. The message flow analysis of lab 9 also illustrates differences in the question and answer sequence which occurred in this discussion. Comparing the message flow analysis for lab 9 with that for lab 8 (the capstone) shows that the interchange in lab 9 was

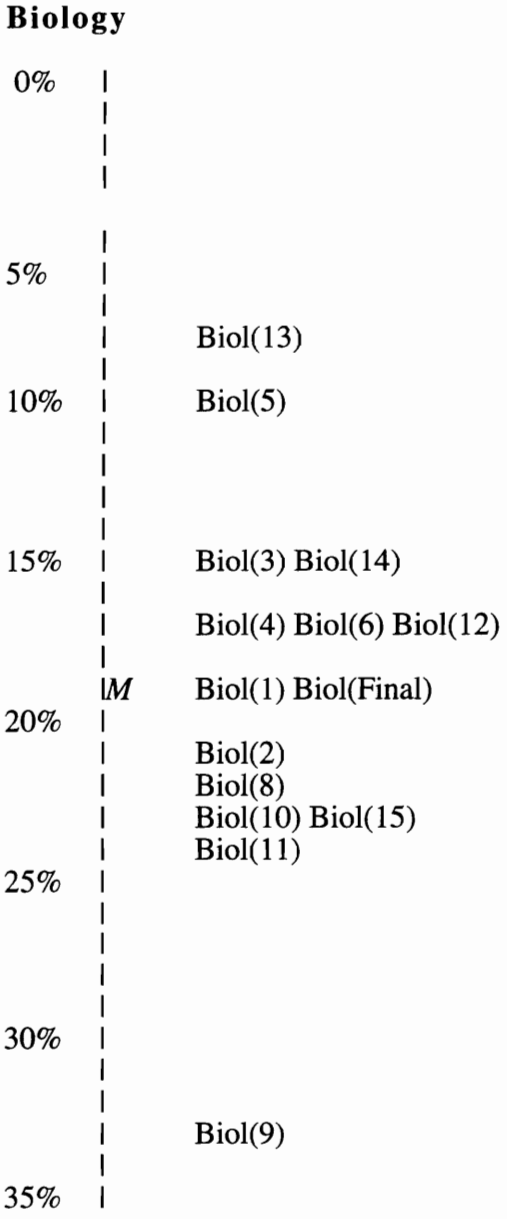
much more interactive than the computer-based discussion in lab 8. lab 9 also contained a variety of evaluative comments by the teacher and by students which were not expressed at all in the lab 8 interchange.

Lab 9 was also selected by many of the students as one of their favorite labs. Observation of the activities in lab 9 indicated that there was more teacher-directed face-to-face group interaction in lab 9 and more student-initiated verbal presentations than in any other lab. Students were actively engaged in describing and interpreting what they observed in the fruit and flower specimens, and there was a great deal of informal and structured interactions in the lab activities which occurred before the computer-based discussion.

As Table 14 shows, all participants had at least two messages directed to them personally in this discussion. The only discussion team which had an integration ratio of zero was Carrie and Ron, who were active participants in the discussion and were in fact the first students to participate in this discussion, but were still not accustomed to directing their comments to specific individuals by name. Leigh Jones took a leadership role in calling in student comments and contributing consensus building comments to the discussion. Tim and Marble were active participants in this discussion, but many of their messages were not taken seriously, and this is indicated by comparing their number of directed messages sent with the number of directed messages they received. Tim and Marble sent out seven messages, but only received two directed responses. As the "All Students" figures in Table 14 indicate, the students really took a leadership role in moving this discussion. By far the majority of questions and topic initiations and replies and socially regulating comments came from students and were directed to other students.

Figure 14

Percent of Questions Asked in Interchange Discussions



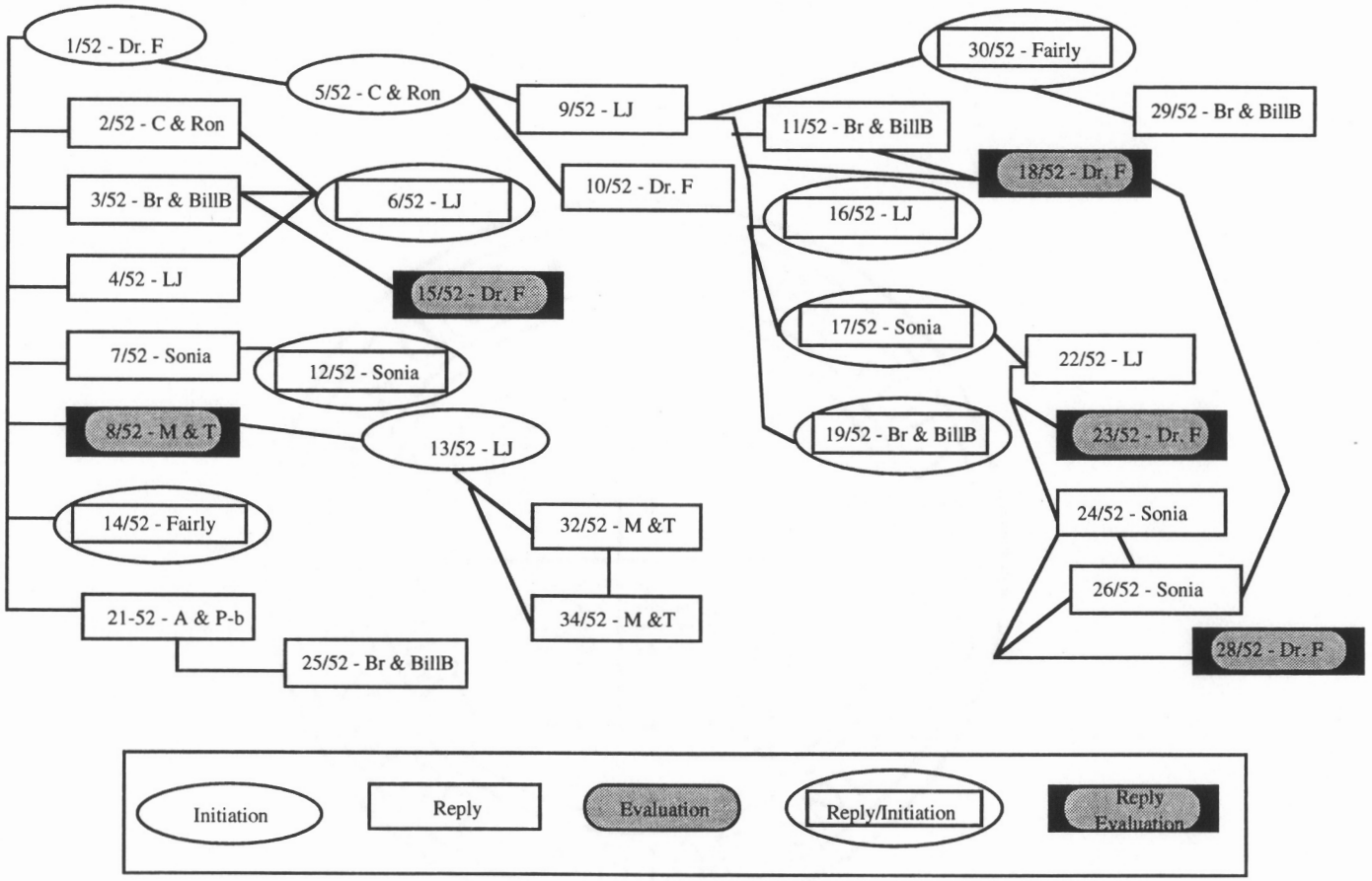


Figure 15

Message Flow Analysis - Lab 9

Table 14

Alias	# sentences (# M's)	Questions Initiations	Reply	Consensus Buildg	Evaluation	M's Dirct'd to Them	M's Dirct'd to Others
Angela Plant-boy	7 (3)	2	1.5			2 (6%)	2 (6%)
Sonia	16 (9)	5	1.5	1.5	.5	4 (13%)	5 (16%)
Fairly	24 (5)	10	2	1.5	1.5	3 (9%)	1 (3%)
Carrie & Ron	7 (5)	2	.1.5			2 (6%)	0 (0)
Tim & Marble	11 (5)	2	2	1	1	2 (6%)	7 (22%)
Brandon & Bill Baily	13 (7)	5	3	1		6 (19%)	6 (19%)
Leigh Jones	20 (9)	5	1.5	3		10 (31%)	5 (16%)
All Students	98 (43)	31				29 (91%)	26 (81%)
Steve Scheck-ler	24 (9)	10	4	2	4.5	3 (9%)	6 (19%)
TOTAL	122 (52)	41 (34%)	17	10	7.5	32 100%	32 100%

ANALYSIS OF LAB 9

Time Management Issues

Managing one's time on task in order to complete all the activities scheduled for each lab was not a problem for all students, but was difficult for some who indicated this in their final course evaluation. Some labs appeared to be too full--containing more printed material, worksheets for computer and videodisk player exercises, and hands-on activities than they could get through in the three-hour period. However, the instructor did make it clear to students that typically they weren't expected to get through all the material in one lab. The activities were planned for variable pacing so that those who chose to and had more experience in this subject matter could move through the material at a faster pace or could skip over some activities to jump to the more advanced activities. I think this may have caused some confusion at times, but a few students seemed to like this informal, variable pacing of lab work and focused on things that most interested them and tended to work on their own.

Typically the hands-on activities had to be called to a stopping point to get students to move to the Daedalus interchange. In the early labs, students had to be almost individually set up and encouraged to get into the Daedalus interchange. In time students became accustomed to the routine of getting their initial warning call and then final reminder to bring their hands-on activities to a close and move to their computer workstation either alone or with a partner for the on-line conferencing activity.

Student collaborations On-line and Off-line

All of the students reported in their surveys that the computer-based communications to some extent facilitated collaboration with their fellow students in the lab. A few students believed that the computer-based discussions facilitated collaboration, but had some concerns about the impersonal quality of this medium. Leigh Jones

expressed this concern in her comments, "[The computer-based conferencing] facilitates idea movement. But you are not working together socially. I still do not know about 3 names in here."

Since there were only seven computer workstations and twelve students enrolled in the lab, some students had to pair up at computer workstations and some students worked independently. Students chose where to work and who to work with and the grouping could change with every lab depending on what students were present. By the time of the capstone, a pattern of collaboration at the computer workstations evolved in the plant science lab. Cynthia primarily worked alone on the computer-based activities, and also worked individually on the wet lab activities, but interacted a great deal with other students, with the instructor, the graduate teaching assistant, with Taylor and me. Her comments in the written Daedalus survey also indicate that Cynthia enjoyed the on-line exchanges and felt more comfortable contributing her comments to the group in that environment, although she indicated that she would not like to take a whole course in this format and enjoyed personal interchanges that occurred around the lab work table (Refer to lab map in Figure 6).

Carrie and Ron worked together whenever both of them attended lab. While these two students seemed to be the two newcomers to biology and were least vocal in interpersonal exchanges during hands-on activities, they were both serious students. Their pacing through nearly all the lab activities was slower than the majority of their classmates, but their contributions to the in-class interchanges were thoughtful and reflected a serious interest in the subject matter.

Bill, Tim, and Marble were an unlikely team, but seemed to enjoy each other's differences. Bill was a post-bachelor's student with a great personal interest in plants, and he was planning on enrolling in a masters degree program in biology in the following

semester. Tim was a sophomore biology major who wanted to go on to medical school. While Tim and Bill were both fairly quiet, primarily on-task students, their third team member, Marble, was more outgoing and gregarious. Marble was a senior biology major who expressed an interest in getting a masters degree in biology and going into teaching biology, perhaps at the college level as a career.

Attempts at Humor On-Line

Marble volunteered in the second on-line class discussion that he would provide a "joke of the day" for each lab on-line interchange. Contributing some kind of joke in the final minutes of the interchange was a kind of self expression and contribution to the discussion for Marble. By the third lab, Marble was becoming quite uninhibited in his joke telling to the point that his humor was becoming offensive to others. I privately mentioned to Marble before class was underway in Lab 4 that he should be more conscious of what he was saying on-line since I was archiving all these transcripts as part of my research. Taylor and Scheckler teased Marble that the Dean might also be offended by his most recent joke. Marble got the message and subsequently made his joke of the day off-line to Tim, Bill, and occasionally Bill Baily.

This incident was important because it points out an important characteristic of the computer-mediated interface. Student behavior was less inhibited in the on-line discussions, which resulted in increased participation. The increased participation enabled more students to share ideas with their teacher and with their peers. This resulted in a shift in the social dynamics of the classroom so that those who spoke less in class had greater influence and impact on the computer-based discourse. However, some problems periodically occurred in the computer-based discussions due to the uninhibiting nature of the computer-mediated communication. Some student comments made in jest on-line were comments that this same student would have hesitated to say in a face-to-face environment.

Likewise, some attempts at humor that are inoffensive in a face-to-face situation may not be funny without the context and affective signals which are lost in the computer-mediated interchange. Both situations may easily be misinterpreted.

Another instance of student off-task interactions occurred in the discussion in lab 9. In this situation, Marble and Tim targeted in their discussion comments one student (a female) who was typically among the first to respond on-line. Having already posted her response to the initial questions, Leigh Jones was sending socially initiating comments to those normally active in the interchange to get the discussion moving.

```
13/52 Leigh Jones:
marble and tim :
Where is your creativity today?

32/52  Marble And Tim:
To Leigh Jones
              THE BEST PLANT WOULD BE ONE THAT WOULD HAVE STAMEN
THAT CONTAINED VARIOUS LEVELS OF POLLINATION DURING DIFFERENT
SEASONS.  FOR EXAMPLE A PLANT WITH LAMINAR STAMENS WITH ITS 4
POLLEN SACS ARE GOOD AT A TERRESTRIAL LEVEL, SO HAVING THIS STAMEN
TRAIT IN THE FALL WOULD BE BENNIFICIAL TO ANIMAL POLLINATION,
HOWEVER THE AMAZING THING WOULD BE FOR THIS PLANT TO THEN DEVELOP
VERSATILE STAMEN IN THE WINTER MONTHS WHICH ALLOW FOR BETTER WIND
POLLINATION.   SO OUR PLANT AS YOU SEE IS VERY SEASON SPECIFIC AND
CAN LIVE FOR VIRTUALLY EVER!!!!!!!!!!!!!!!!!!!!
HOW IS THAT FOR CREATIVITY MISSY??????????????????????????

34/52  Marble And Tim:
LEIGH IT'S CALLED THE PASSION FLOWER

35/52  Leigh Jones:
ok guys I'll give you one point for yu r creativity.  But I don't
think they would live forever just have "fun" with their
environment  for a long time.  And get pollinated all year.  But
.......... well there be a species to polllinate all year.

38/52  Marble And Tim:
LEIGH IF YOU DON'T BELIEVE US JUST ASK DR. SCHECKLER.

40/52  Marble And Tim:
YU R... WHAT IS THAT LEIGH?
```

This interchange between the Marble and Tim team and Leigh Jones shows how a discussion among students on-line can differ from face-to-face discussion. The comment Marble and Tim indirectly directed to Dr. Scheckler in message 38 was not addressed by the instructor. This line of discussion was probably not intended for serious analysis, but more likely intended to engage Leigh's attention. This strand became a dead-end tangent to the class discussion which was moving ahead in a more serious tone to other topics. (See Figure 15, the Message Flow Analysis.)

Student Regulation in the On-line Environment

These incidents regarding student behavior on-line leads into the discussion of student regulation in the on-line environment and of student expression of themselves in this new social world. Marble initiated a role on-line, and often in class, as the jokester. This incident becomes interesting and perhaps exemplary for several reasons. Marble appeared to have a different attitude towards school than Bill and Tim. Marble also put a lot of energy into humoring the class. This appeared to be a role Marble created for himself in this and perhaps in other classes as well. In a way Bill and Tim benefited by Marble's joking around--they didn't do it themselves, but enjoyed the break in the routine Marble provided and paid for on their behalf. Research by Cronshaw and Ellis (1991) indicates that group members with a high degree of self-monitoring behavior tend to emerge as group leaders. This means Marble was not likely to be a leader among the plant science group, and probably didn't desire that role. By pairing up with Marble, Bill and Tim reduced their likelihood of emerging as leaders. Eventually, Bill stopped working with Marble and Tim for the computer-based discussion activities--even when this required staying after class to wait for a free machine. This and other issues regarding how face-to-face classroom behavior transfer to the computer-mediated environment can be answered by further research addressing on-line interactions.

Summary and Interpretations

The real-time computer-based writing activities provided an alternative social environment for students to interact and participate in the class discussions. Students in this setting were in the same room and knew each other and also knew what position each had in the class with his/her peers and with the teacher, and this knowledge of social standing made some difference in how students wrote to each other on-line. However, the pattern of on-line interactions do not mirror the face-to-face class interactions. For example, one of the students who typically withdrew from group activities in class joined the group in the on-line discussions. Computer-based interactive writing activities conducted in class provided a social environment with many of the characteristics described in CMC research.

Students had more control of and influence on the discussion in the computer-based writing exercises. Student dominance in the on-line discourse was exhibited in several ways: (1) in overall volume the students outnumbered the teacher, and student comments dominated the discourse in quantity; (2) in some interchanges students took on more active roles of regulating the discussion by reacting to comments by their peers with agreement, evaluative comments, and follow-up questions and/or comments to peer responses. Faigley (1992) and Butler (1992) have described this phenomena in their respective studies regarding the creation of meaning as a social process in on-line discussions which also used the Daedalus Interchange program. Faigley (1992) and Butler (1992) propose that the same social structures which exist in our culture are evidenced on-line. The findings from this research suggest a different interpretation.

Butler (1992) suggests that a power vacuum is evidenced in the on-line environment because suddenly the teacher is no longer in control of the discussion in the same way that the teacher controls the traditional face-to-face class. The computer-based discussions that occurred in the plant science lab indicate that the teacher had a strong influence on the nature of participation and interactions that occurred in the on-line environment. To some extent students participating in the plant science lab discussions learned from and modeled a method of thinking and responding they saw represented by their instructor in class and in the on-line discussions. This is evidenced by the nature of the student responses which included a lot of questions as well as evaluative statements which mimicked the instructor's comments in the plant science lab discussions off-line as well as on-line.

Another, unique characteristic of the on-line discussions was that while this medium facilitated increased participation and interactivity among students, it also allowed a diversity of responses to the on-line discourse and to the on-line social context. While some students enjoyed directing and receiving responses and being highly integrated into the discussion, other students appeared to prefer having a less integrated role, and carved out their own level of "satisfaction" in participating. One student in the plant science lab typically asked and answered questions within a given comment and rarely directed any comments to others, but would respond to directed comments received. This student referred to by the pseudonym, Fairly, avoided face-to-face interactions in the lab, but reported that the computer-based discussion, "...did change my attitude toward school. It allowed me to exchange ideas more freely."

The integration ratio developed by Butler is a helpful descriptor of an individual's position in an interchange discussion, but I don't think this figure can be used to infer how influential an individual was on the discussion. As was shown in the plant science

capstone, one of the student's with a zero integration ratio had a great deal of influence on subsequent rating scores which occurred after the on-line discussion. Even though students may not have been responding to a given students messages, they were reading and evaluating all or nearly all the messages--this is documented in the ratings in which one group of students revealed that their ratings changed based on questions raised by another. In the real-time, in-class, computer-based discussions, face-to-face interactions and social ranking had considerable impact but were moderated by the quality and content of each message--regardless of who sent it.

Students need to know that while the CMC environment may feel less inhibiting, it is much like print in that all messages sent can be archived and preserved or reused. Students should be informed that the computer-based discussions represent a public forum and each student must learn to be his or her own monitor to some extent. At the same time, teachers and researchers who use electronic discussions need to consider the ethical issues associated with moving pieces of on-line interactions from a private context to a public one. Participants must be informed in advance as to whether a computer-based discussion will be saved and if saved how it will be used and whether individual identities will be preserved or changed.

Implications of These Findings

The process of giving students more control of and responsibility for in-class discussions can offer a stimulating and encouraging learning experience for many students. As some students indicated in their Daedalus surveys, the on-line exercises made students think--they were actively engaged in the discussion and their minds were working. This indicates that the on-line discussions were successful at getting all students actively engaged in interpreting and sharing their ideas. Students reported in both classes that

through these discussions they learned from each other and that the discussions helped them move their initial thoughts to more confident statements of their personal views.

On the other hand, as some of the exercises showed, student control does not always come at the right time. Sometimes students didn't feel ready to make the conceptual connections they needed to make to engage in these dialogues. Sometimes the discussion wasn't accessible to the students and needed to be rephrased in a simpler context. Sometimes students were tired, rushed, ill prepared, or unmotivated to make the best use of the on-line discussion. The success of an on-line interactive discussion is dependent on a number of variables which suggest that on-line discussions are most successful when they can be suitably placed within the context of other learning activities. In addition, just as student preparedness for a given on-line, interactive writing exercise is based on previous class activities and assignments, the on-line discourse needs to be integrated into subsequent class activities so that what is discussed in the computer-mediated discussion is brought back into the context of face-to-face and individually assigned activities. This could be done in several ways:

- Teacher summarizes key ideas brought out in discussion by students
- Students (individually or in groups) summarize key/interesting ideas which emerged from on-line discussion
- Outside-of-class assignment emerges from discussion from comments made or questions raised in on-line discourse
- On-line discussion becomes a class journal which is kept parallel and integrated with individual student journal.

One of the most valuable characteristics of the on-line discussion is that it gives the instructor a way of tracking what students are thinking about the material addressed in class. The on-line discussion environment also provides a public, but less threatening

environment in which a teacher or fellow students can praise as well as constructively criticize a student's comment. Some clarifications to students interpretations and ideas can be made before they leave class if a problem emerges. On the other hand, teachers may find students are grasping the material more quickly than they had planned and the instructor can adjust the pace to go into more depth or move more quickly through the material.

Computer-based writing activities are obviously not the only way teachers can interact with their students and facilitate and encourage their students. Students don't need computers to interact with each other either. However, this study shows that on-line interactive writing is a viable alternative for facilitating student participation and interaction and is especially useful in getting more students actively engaged in the in-class discussion and thereby participating and joining in the social environment of the classroom.

Chapter 5

Summary of Findings and Implications

Instructional applications of computer-mediated communication (CMC) are being used to facilitate collaboration and sharing within and across classrooms. This study describes how two classes, a freshman writing class and a plant science lab, used CMC within the traditional class setting for real-time interactive writing activities. This research included participant observation of two settings using CMC technology over a full semester in both cases. The key issues addressed in this study were to identify and interpret the following research questions:

1. What are the characteristics of student interactions and participation in the computer-mediated environment?
2. How do CMC interactions have an impact on student learning?
3. How are CMC interactions the same and different in these two settings?

Both cases incorporated a capstone event which was a CMC activity designed to provide multiple sources for gathering data regarding: (1) student participation, interaction, and regulation in the CMC environment; (2) student attitudes and preferences toward CMC activities; (3) individual student and group performance in a content-based CMC activity; (4) how the computer-based discussion influences student performance; and (5) student interpretations of how they respond to CMC interchanges with their teacher and peers.

Summary of Findings in Context of Research Questions

This section will summarize the data and interpretations from this study as responses to each of the research questions. Appendix D provides an abbreviated summary

of how the findings from this study compare with the reported findings from prior research.

1. What are the Characteristics of Student Interactions and Participation in the Computer-Mediated Environment?

Increased Participation

The most common attribute of CMC reported in the literature (Bump, 1990; Harasim, 1990; Hartman et al. 1991; Hiltz, 1990, Sproull & Kiesler, 1991) is that use of this medium increases participation and facilitates a more democratic distribution of participation. Selfe (1990) reports that women participate as often as men in computer-mediated interactions and that women are equally likely to be the first initiators in a CMC discussion. These observations were generally true in both settings observed in this study. However, some differences between the two classes emerged from a more detailed analysis of the transcripts in both cases.

Freshman Writing. In the freshman writing class, men outnumbered women in the enrollment nearly two to one. (A demographic description of the class is provided between pages 41 to 53.) The two women who were frequent participants in the face-to-face class were also frequent participants in the CMC environment and early on directed a lot of their on-line messages to other students. These two students were more quickly integrated into the CMC discussions because of their own initiations. Other women in this class who did not adopt the convention of directing their on-line comments to specific individuals were as frequently participants and early initiators in the discussion, but had less impact on the discussions with their responses and topic initiations. The message flow diagram (Figure 5 on page 65) visualizes the topic initiations, linkages between comments, and evaluative comments in the capstone activity. This diagram shows that only a few students initiated messages that were more than replies. Those that directed their messages to either the instructor or to other students received responses and, thereby, had some impact on the

discussion. Directing messages to other students was one convention many of the students in this class adopted by the end of the semester.

The summary section in chapter three (pages 81 to 87) compares the CMC participation with that of the face-to-face sessions of this class and shows that student participation in the CMC discussion could not be predicted by participation in the face-to-face class. Some students who rarely or never spoke in the traditional classroom were frequent participants to the on-line discussion, and some like JR were likely to send longer, well composed messages which included new topic initiations as well as responses to the questions posed. Responses by those who participated frequently in the face-to-face class were more likely to receive a response--perhaps because these students have unanimous name recognition and quieter students don't. Responses that were directed to another student or to the teacher (signaled by a name at the beginning of the message) always received a response--unless the message came too late to be seen before the discussion was closed or the message was delayed in the server and was not distributed before the class was over.

Plant Science Lab. Participation in the computer-based discussions in this setting was more evenly distributed, and the class demographics were more equal: seven men and six women. Women were equally likely to be early initiators in the CMC discussions. The participation in this setting was similar to that in the freshman writing class in several ways. Students responded to the interactive writing environment in different ways. Participation by some students was more informal and spontaneous and targeted towards a response or initiating an interaction from an individual or from the group. This is similar to what Lea (1991) found in an assessment of attitudes and behavior towards CMC--most respondents described their use of CMC to be like informal note messages. Others, however, responded differently to the CMC environment and, as predicted by Ferrara, Brunner, and Whittemore (1991), responded with messages that were more carefully composed and

conveyed more complex thoughts and ideas. Specific examples of these two different styles can be seen by comparing responses by Bill Baily with those of Cynthia (See Table 12, page 117). Cynthia's participation ratio is among the lowest in the class, but her volume ratio is the highest. Bill Baily has the highest participation ratio and an average volume ratio.

The lab was equipped with seven computer workstations, however, some students had to pair up for their participation in the interactive writing activities. (See pages 97 to 102 for a brief discussion of student pairing up at computers.) Some students partnered up for the Daedalus discussion on a routine basis. In some of these situations the pairs would talk together first, and then submit their comment. In other pairs, students would take turns responding--or would let one person respond until they disagreed with their comment.

Sense of Anonymity, Increased Privacy Associated with CMC

Research reported by Kiesler, Siegel, and McGuire (1984) and Sproull and Kiesler (1991) suggests that the CMC environment promotes a sense of anonymity and privacy and that individuals are less influenced by social conventions because of this sense of "deindividuation" (loss of identity) and are more likely to offer comments reflecting more extreme points of view or more unconventional, more creative ideas. The sense of deindividuation is also described by Faigley (1993) and Myers (1987) who suggest that some individuals respond to this characteristic of CMC by adopting a new persona for their electronic participation. While Sproull and Kiesler suggest that the sense of privacy in CMC interactions may create more honest responses in self disclosure statements, Faigley and Myers suggest that individuals may respond to this environment with unpredictable personal adaptations. Student participation in both settings indicate that the CMC environment does both: (1) encourages students to express diverse opinions and ideas and (2) may open access to less socially regulated comments.

Freshman Writing. Nearly all students reported in their capstone and final surveys that the computer-based discussions facilitated participation. (See pages 77 to 81.) Both male and female students reported that the interchange discussions made participating in class discussions more comfortable because they felt less in the spotlight in the CMC environment. Student responses like those described on pages 64 to 67 show that some students did sense more privacy in the CMC environment and shared comments to the discussion that were as if they were thinking out loud.

The discussion in the "Writing Conventions" interchange had the most noticeable impact on rating scores (See pages 67 to 68 and 71-77). Students were less confident of their abilities to rate the writing selection in terms of its grammatical conventions, so many students took the view that this piece was a good example of how breaking conventional rules of grammar can be effective.

Plant Science Lab. Students in the plant science lab also felt that the computer-mediated environment facilitated their participation. The summary of student surveys provides excerpts of student reports regarding the benefit of CMC in allowing people who are more shy or prefer to remain outside the group to participate (See pages 125-128). This sense of privacy and anonymity was also expressed in a less predictable way. One of the students initiated a "joke of the day" to be one of his contributions to the on-line interchange. This student's attempt at on-line humor is described on pages 136 to 138. Essentially what happened was that this student began telling jokes on-line that he probably would never have told to the whole class--it is easy to forget that the whole class is still there on-line.

Shift in Status

Research by Harasim (1990), Levin, Kim, and Riel (1990), and McGuire, Kiesler, and Siegel (1987) found that those with higher status (such as the teacher) do not dominate the CMC interchange, and even those with greater expertise in a given area will have less

impact in the CMC environment. The discourse created in the electronic interchanges in both settings supports this finding to some extent. In both cases the teacher was by far the most influential participant and influenced the outcome of the discussion a great deal. Some unpredicted outcomes in this area were that students who were very frequent participants in the face-to-face classroom setting were also frequent participants in the CMC environment, but reported that they were less satisfied with the computer-mediated activities. Perhaps these students felt their impact to be diminished in the CMC environment, or that the rewards for participating in the CMC environment were not as satisfying as those associated with the face-to-face setting. Specific examples of this are provided within a separate discussion of each setting.

Freshman Writing. Some specific examples of the influence of the instructor to the on-line discourse is presented on pages 62 to 63. The message flow diagram (Figure 5, page 65) illustrates how the instructor directed and moderated the on-line discussion. As this diagram shows, the instructor was the primary topic initiator in this discussion, and student comments were strategically evaluated by the instructor. However, student comments from the capstone survey suggest that students were equally influenced by the comments of their peers in the on-line discussion, and that being able to read the comments and opinions of fellow students provided many new insights into the material and alternative perspectives. These comments are described on pages 77 to 81 of chapter three.

An unexpected outcome is described on pages 64 and 71 and 73. The student (pseudonym Candy) who was most integrated into the discussion in both the face-to-face and CMC discussions did not respond as favorably to the computer-mediated environment as the rest of the class. Her comments as quoted on page 81, indicate some strong frustrations with the CMC activities which were not voiced by other students. Perhaps this is partly due to the shifts in status in the CMC environment, or to the fact that rewards for

participation in the CMC environment are not as satisfying as the face-to-face environment because of the limited sensory and social factors.

Plant Science Lab. The findings in this setting were similar to the freshman writing class as described above. The most influential participant was the instructor. However, the instructor interacted with students in a very different way in this class which can be seen in the message flow analysis of lab 9 (Figure 15 on page 132). The instructor set the initial questions and topic for discussion, but as Figure 16 shows, students were the first to begin evaluating responses to this topic and students initiated new topics to the discussion--sometimes before answering the initial questions. As Table 14 (page 133) shows, students received and directed more messages to each other than to the instructor. The instructor moved into the role of moderator to this discussion which was being led by students.

Multiple Threads and Increased Student Initiations

The message flow diagrams illustrated in Figures 5, 11, and 15 shows that multiple strands of discussion that occurred in both settings. The discussion in the freshman writing class was more directed than the plant science lab, because the different discussions were nearly sequential, and not simultaneous as was obviously the case in lab 9 (Refer to message flow analysis diagram for lab 9, Figure 15). The existence of simultaneous strands of discussion is more related to student initiatives than teacher dominance. Appendix E provides an illustration of a message flow analysis of an interchange which was used to pilot test the capstone task in the fall semester of the freshman writing class. As this figure shows, separate, simultaneous discussions were initiated by students, and the instructor became the respondent to student initiations.

Establishment of Social Conventions Specific to Each Setting

Social conventions for participation and interaction emerged in both settings. In the freshman writing setting, students were aware that they would be graded on their participation and most students submitted at least two comments during each class meeting

in the Computer Integrated Classroom (CIC). As the semester progressed more students began directing their messages to specific individuals and thereby receiving more messages. An atmosphere promoting positive reactions and constructive criticism was sustained, and very few off-task comments were initiated in the on-line discussion. The CMC discussions did seem to restrict quieter students from becoming known outside the CMC environment, however. The pattern of participation in the face-to-face class was not impacted by the CMC participation level. Thus, the CMC environment reinforced and/or intensified a hierarchy of participation defined in the face-to-face setting.

In the plant science lab, students interacted more with each other on-line and initiated more questions. There was an atmosphere of inclusion in the on-line interchanges and several students (Leigh Jones, Sonia, and Bill Baily) consistently played roles on-line to keep all students involved in the discussion by directing messages to them if they were late in their responses and by directing follow up questions to responses made by less active students. In the plant science lab, several students initiated group solidarity and reinforcing comments which supported the development of a group cohesiveness among participants. Examples of this are illustrated in Figure 15 (page 132) which shows the linkages between comments and also identifies the nature of the comment made.

2. How do CMC Interactions have an Impact on Student Learning?

Students in both classes reported benefiting from the computer-based interactive writing activities in several ways. This discussion summarizes how the CMC activities in the two cases described in this study had an impact on student learning in the following areas: student attitudes towards computers and greater knowledge of their use; increased access to the instructor and increased involvement with course content and related concepts, and; students taking on more responsibility for their learning.

Increased Understanding of Computers

Students who had not previously used the computer as a communication device reported some change in their attitude towards computers. Students in both settings who had previously had limited exposure to computers or who had only used a computer to do word processing or computational programs, reported that using the Daedalus interchange program broadened their view of computers. For specific examples of this see the discussion of student surveys in Chapter 3 (pages 77-81) and Chapter 4 (pages 125-129). The shift in attitude towards computers did not, however, have an impact on student scores, in the computer attitude surveys.

Increased Access to Instructor and Course Content and Responsibility for Learning

Newman (1993) and Scardamalia and Bereiter (1993) suggest that strategically planned instructional use of CMC will put increased responsibility for learning onto students. This is a difficult issue to evaluate, but the student comments in the capstone and exit surveys suggest that students did experience some increased responsibility and increased involvement in the computer-based interactive writing activities. Students in both settings described the CMC exercises as being helpful by providing a non-evaluative forum in which everyone could express their ideas, compare their responses with others, and rethink and expand upon their initial thoughts. Attributes of the computer-mediated environment such as the sense of privacy, anonymity, and spontaneity described by Sproull and Kiesler (1991) facilitated informal sharing of tentative ideas among students.

Freshman Writing. The instructor for the freshman writing class found that, over the course of the semester students came into the CIC knowing they had to work, and the class gradually took on the responsibility of making the interchange discussions interesting and effective (Fieldnotes). Looking at individual student responses to questions asked in the capstone survey offers useful information to address this issue because, while these comments all relate to a similar theme, each response is uniquely reflective of a student's

individual reaction to this technology. Student responses to one of the survey questions provided provided data regarding how each student learned to use the CMC activity selectively to suit her/his own personal style, preferences, and requirements. Students used the Daedalus interchanges to:

- build on ideas initiated by others
- stimulate and open-up their own thoughts
- get new perspectives on their own thoughts
- find alternative ways to express their thoughts
- use the ideas of others to think through their own ideas further.

Even the strongest critic of the CMC activities responded that, "It's a good supplement, but shouldn't be the only thing" (Candy).

Plant Science Lab. In their evaluations of the computer-based discussion activities, every student in the plant science lab setting reported that they gained a new perspective and were able to refine their own ideas by viewing comments of others. An equally important part of the computer-based interactions in the plant science lab was each student's ability to interact with the instructor in a new way. Several students reported that they really enjoyed having increased access to their instructor through the CMC discussions. The characteristics of the text-based CMC media have been reported to equalize status and to facilitate idea initiations by novices who are not intimidated by their lower status in the computer-mediated environment (Dubrovsky et al., 1991; Hartman et al., 1991; Sproull & Kiesler, 1991). The message flow analysis of lab 9 (See Figure 15, page 132) demonstrates how students in the CMC environment were able to take responsibility for initiating ideas, responding and following up on ideas represented by their peers, and facilitating continued discussion with evaluative and encouraging remarks.

Limitations of the CMC Technology

Student responses to the computer-based discussions were not all positive. The multiple strands of discussion illustrated most vividly in the message flow analysis of the interchange conducted in lab 9 (Figure 15, page 132) were confusing for several students in this class. While some students learned to adapt to the complex flow of multiple strands of conversation, one student in the plant science lab reported that she was very uncomfortable with the scrolling group messages in which it seemed that, "A lot of thoughts get jumbled..." (Ron, capstone survey). Another student was able to participate and sort through the interchange discussion, but reported that she missed the emotional quality of face-to-face interchange. These comments suggest that improvements in the computer-mediated discussion interface could provide some accommodations for both criticisms. Some graphic organizers would be useful to electronically group comments by sender and labeled with a small video window which could be selectively activated for two-way interactive video communication.

3. How are CMC Interactions the Same and Different in These Two Settings?

The real-time computer-based writing activities provided an alternative social environment for students to interact and participate in the class discussions. Students in this setting were in the same room and knew each other and also knew what position each had in the class with his/her peers and with the teacher, and this knowledge of social standing made some difference in how students wrote to each other on-line. However, the pattern of on-line interactions did not mirror the face-to-face class interactions. For example, one of the students who typically withdrew from group activities in class joined the group in the on-line discussions.

Comparison of Findings with Prior Research

Butler (1992) and Faigley (1992) suggest that a power vacuum is evidenced in the on-line environment because suddenly the teacher is no longer in control of the discussion in the same way that the teacher controls the traditional face-to-face class. The computer-based discussions that occurred in the plant science lab indicate that the teacher had a strong influence on the nature of participation and interactions that occurred in the on-line environment. To some extent students participating in the plant science lab discussions learned from and modeled a method of thinking and responding they saw represented by their instructor in class and in the on-line discussions. This is evidenced by the nature of the student responses which included a lot of questions, as well as evaluative statements, which mimicked the instructor's comments in the plant science lab discussions off-line as well as on-line. (See discussions regarding the influence of the teacher in the CMC environment in Chapter 3, pages 62-67, 81-87 and Chapter 4, pages 129-130, 139-143.)

Another, unique characteristic of the on-line discussions is that while this medium facilitates increased participation and interactivity among students, it also allows a diversity of responses to the on-line discourse and to the on-line social context. While some students enjoy directing and receiving responses and being highly integrated into the discussion, other students appear to prefer having a less integrated role, and carve out their own level of "satisfaction" in participating. One student in the plant science lab typically asked and answered questions within a given comment and rarely directed any comments to others, but would respond to directed comments received. This student referred to by the pseudonym, Fairly, avoided face-to-face interactions in the lab, but reported that the computer-based discussion, "...did change my attitude toward school. It allowed me to exchange ideas more freely" (capstone survey, March, 1994).

The integration ratio developed by Butler is a helpful descriptor of an individual's position in an interchange discussion, but this figure cannot be used to infer how influential

an individual was in the discussion. As was shown in the plant science capstone, one of the student's with a zero integration ratio had a great deal of influence on subsequent rating scores which occurred after the on-line discussion. Even though students may not be responding to a given student's messages, they are reading and evaluating all or nearly all the messages. In the real-time, in-class, computer-based discussions, face-to-face interactions and social ranking have considerable impact but are moderated by the quality and content of each message--regardless of who sends it.

Significance of These Findings: Freshman Writing

Teachers who have access to in-class use of interactive writing programs like Daedalus can use this tool to make the face-to-face class sessions more active and can involve more students in sharing and interpreting ideas and concepts addressed in the class. The on-line writing exercises can be a useful diagnostic tool for the instructor to find out how well the students are understanding the content being covered before a more formal assignment is given. The interactive writing transcript can provide a way for the teacher to look at how the students are interacting, influencing, and regulating each other.

The computer-mediated environment can also serve as a way for teachers to demonstrate and model behavior they want their students to learn. Some students in the freshman writing class reported that this class helped them learn how to give constructive criticism to fellow students as well as helped them be more able to critique their own writing. Some of the learning that went into this came from other structured activities and assignments such as the rating activities which were done independently and the peer reviews which were done in pairs. The computer-based interactive writing assignments complemented these other activities by giving students a social context in which to practice the critical skills they were learning. Most of the on-line discussions in the freshman writing class were tightly structured discussions directed by the instructor, who modeled his own style of critical analysis for his students through his on-line participation.

Applications of the in-class use of computer-based interactive writing can become stale if the assignments don't vary or if the topic doesn't suit the structure of a given exercise which worked well on other occasions. Comments from a student from each setting indicate that some of the pleasure students receive from the interactive writing would be lost if exercises became too repetitive. (Student comments regarding this are documented in Chapter 3, pages 80-81, and Chapter 4, page 128-129.)

The success of any given interactive writing activity is determined by the social context in which it occurs. What works well for one instructor may have to be modified to work for another. An activity which works well one day may bomb on another because several students who help carry the discussion are absent or are not prepared. However, the very fact that each student's participation can make a difference illustrates the power this media has to engage students in active learning together within the class period.

Significance of These Findings: Plant Science Lab

The process of giving students more control of and responsibility for in-class discussions can offer a stimulating and encouraging learning experience for many students. As some students indicated in their Daedalus surveys, the on-line exercises made students think--they were actively engaged in the discussion and their minds were working. Students reported in both classes that through these discussions they learned from each other and that the discussions helped them move their initial thoughts to more confident statements of their personal views.

On the other hand, as some of the exercises showed, student control does not always come at the right time. Sometimes students didn't feel ready to make the conceptual connections they needed to make to engage in these dialogues. Sometimes the discussion wasn't accessible to the students and needed to be rephrased in a simpler context. The success of an on-line interactive discussion is dependent on a number of variables, which

suggests that on-line discussions are most successful when they can be suitably placed within the context of other learning activities.

The computer-based discussions were shown to offer a valuable way to give the instructor access to what students are thinking about the topic currently being addressed in class. The on-line discussion environment also provides a public, but less threatening environment in which a teacher or fellow students can praise as well as constructively criticize a student's comment. Some clarifications to students interpretations and ideas can be made before they leave class if a problem emerges. If students are grasping the material more quickly than planned, the instructor can adjust the pace to go into more depth or move more quickly through the material.

Computer-mediated interactive writing in these settings was shown to offer: (1) a viable alternative for facilitating student participation and interaction, and (2) a way of getting more students actively engaged in the in-class discussion and thereby participating and joining in the social environment of the classroom.

Conditions Influencing Interpretations

The Technology

One of the difficulties associated with the topic I have chosen to study is that the technology I am observing is undergoing constant change and improvements. As we master one area of competency with the computer, we soon become frustrated with the limitations of the computer as we push onward to new user levels. As we learn to use more tools, we become dissatisfied because what used to be acceptable is now slowing us down. No matter how large the hard drive, sooner or later we bump up against the limits of capacity. No matter how fast the machine, we become frustrated with the processing speed as we create more complicated human-computer interactions. Technology keeps

changing, because users needs continue to expand and change in response to new system capabilities.

Thus, as I write up my observations of these two classes, I realize that some of the conditions I observed and documented will not apply when this class is offered again. There will be changes in the human-computer interaction--some will be insignificant, but others may be important. Therefore, in my interpretations of my results I must look for those issues which will be helpful within the tidal waves of change. To some extent this means not dwelling on technical issues which will be irrelevant to the next semester, but instead trying to discriminate what aspects of the human-computer interactions I observed offer information which transcends time and circumstances. I have tried to apply the "conservative, pragmatic" judgment Garrison (1986) discusses in his discussion of the new paradigm for scientific research. However, the value of this research is in its specific link to a real context, so careful, detailed descriptions of the examples cited will make the information conveyed here most valuable and useful to others.

The Limited Bandwidth of the CMC Used in This Study

The computer-based discussions described in both cases observed in this study were restricted to text-based interactive writing exercises. As the discussion of electronic communities in chapter two describes, there are also CMC technologies which provide a much richer interface for CMC, which more closely simulate the kinds of visual, verbal, and nonverbal cues available in face-to-face conversations. However, even as wider bandwidth for computer-based interactivity becomes more readily accessible there may still be many uses for CMC which are selectively restricted to text or some other symbol system for communicating. Having only text characters to communicate with puts greater emphasis on the written message to convey a lot of information within this one mode of communication. This is a good exercise for teaching writing. In fact, during the course of the interactive writing activities which took place on March 31 in the freshman writing class

the instructor wrote to his students "Without any prodding, all of you are writing much more clearly and grammatically correct than when you started" (March 31, 1994, Freshman Writing Class Interchange).

Being limited to text emphasizes the features of CMC that make it much like print as a communication channel. Teaching students to represent their ideas in text appears to be an effective way to focus their attention and to force them to articulate their ideas, but within the highly interactive real-time CMC setting. While multimedia programs capture our attention with colorful images, movement, and sounds, the fact remains that text--and by that we mean written language--remains an essential way we communicate ideas (Arnett, 1993). Graphic interfaces are useful for many things, but they can also limit communications because graphics cannot describe abstract ideas as effectively as text and can't describe ideas not contemplated by the interface designer. The ideal interface for CMC and other interactive computer activities includes a combination of text and graphics, which is more powerful than either one alone (Arnett, 1993).

Students need to know that while the CMC environment may feel less inhibiting, it is much like print in that all messages sent can be archived and preserved or reused. Students should be informed that the computer-based discussions represent a public forum and each student must learn to be his or her own monitor to some extent. At the same time, teachers and researchers who use electronic discussions need to consider the ethical issues associated with moving pieces of on-line interaction from a private context to a public one. Participants must be informed in advance as to whether a computer-based discussion will be saved and if saved how it will be used and whether individual identities will be preserved or changed.

The Social Context

Both the freshman writing and plant science lab cases have shown that the computer-based communication context has a social environment of its own and does not

mirror face-to-face interactions. The most obvious feature distinguishing the CMC social environment is that all students can participate at the same time. What these two cases showed is that the CMC environment also allowed students to participate and interact in different ways. While some students preferred to post their response to the teacher-initiated question quickly, other students could take more time to think through a response and post it later--sometimes incorporating previous comments and providing a statement which incorporates some of the ideas previous mentioned. Some students will naturally take the lead in regulating the discussion on-line and will encourage those who have not yet posted a message to speak up or will comment on messages already posted. In both cases the course instructor was the most influential participant in the on-line interchanges. Both interchanges reflected the pedagogical style of the instructor which is evidenced in the message flow analysis diagram for the freshman writing capstone and lab 9 interchanges. (See Figure 5, page 65 and Figure 15, page 132).

Real-Time Versus Asynchronous Computer-Mediated Conferencing

One of the survey questions students in both groups were asked was whether they would like to have access to the Daedalus discussions outside of class. Only a few students responded positively to this suggestion, and from the positive responses came a few specific suggestions regarding how out-of-class access to CMC could be helpful. One student suggested that the Daedalus assignments be done via e-mail before class and student responses could be read during class. Another suggestion was that out-of-class access to the instructor or to a knowledgeable graduate teaching assistant would be very helpful for getting tutoring assistance. This was suggested as being particularly helpful for chemistry where the homework involved solving assigned problems and it would be fairly easy to ask and answer questions related to specific problems in the e-mail environment.

Students generally did not want to continue the discussions conducted on Daedalus outside of class. Occasionally students would want more time to participate in the plant

science interchanges so we would leave the discussion open till the next lab and let students continue the previous discussion at the beginning of the next lab. Most of the students had lost their fire or inspiration over the week's period and carrying over an interchange from one week to another was not effective.

The time delay in between reactions characteristic of e-mail is also a feature of interactive writing; the time delay is less pronounced, but still has an impact on the discussion. For example, some comments sent toward the end of an interchange were not distributed to all the participants before the end of class or the movement to another discussion. This problem was consistently apparent in the freshman writing interchanges due to the size of the class. Frequently messages would be sent, but would not be viewed until the interchange was compacted at the end of class. This was also a factor in the plant science lab for different reasons. Frequently one or more students stayed after class to finish their interchange message. One student was typically sending in his comment after every other student had left. The late message senders in both cases seemed more motivated to express their thought than to be a part of the discussion--this was the case for several students in both classes.

However, while some messages delivered late or during a busy time were lost, the real-time interactive writing facilitated some fast-paced, highly interactive exchanges which were clustered together and were easy to follow. This can happen also in the e-mail environment, but it is different when it happens on-line while the participants are in the same room and can here each others' laughs, or howls, or fast-paced keyboarding. There is more intensity to the real-time interchanges just because the reactions are closer in time. However, as one student in the plant science lab reports "It's not as heated as verbal [face-to-face] interactions."

Implications

Use of Computer-Mediated Communications Technology in the Instructional Setting

A recent article by Alexander, Kulikowich, and Schulze (1994) suggests that knowledge of subject matter, level of recall, and interest in a given subject matter are strongly related. This qualitative assessment of the use of Daedalus in the plant science lab suggests some further investigation of this hypothesis. Those students who felt that this course encouraged their interest in a future career in biology were also the same students who felt that the use of the Daedalus Interchanges should become an on-going part of this course. This supports the hypothesis suggested by Alexander et al. (1994) that the mental effort required to understand and assimilate abstract concepts usually requires an individual interest in that subject area, and that this level of learning will be passed over when a students lacks the genuine interest in the subject material. The plant science lab used Daedalus as a way to engage students in some higher-order thinking and problem solving. Observations of students in this class showed that those with a personal interest in the subject enjoyed these activities more than those who were less interested in the subject.

Student interactions in the computer-based interactive writing environment can facilitate increased student participation, stimulate increased active learning during the class period, and accommodate variable pacing of student learning. The interactive writing environment offers an alternative social environment for the class which is much more active and can be less inhibiting for students, resulting in increased participation as well as an increased tendency for students to share their ideas. Students learn from each other and are influenced by each other's on-line statements. Disruptive behavior can also occur on-line as can "brown-nosing" and just about every kind of on- and off-task behavior. The social atmosphere in the real-time classroom is an extension of the face-to-face classroom

and can be a way of getting feedback about other class activities which are much less accessible to uninhibited feedback.

While students do interact on-line and do express some attempts at regulating each other through reinforcement, disagreement, and follow-up questioning of each other, students seem to adapt to the on-line environment in different ways. In the freshman writing class some students seemed to mimic the behavior of the instructor in giving feedback and reinforcement for each other. They also mimicked him in avoiding giving any direct criticism or other negative feedback to their peers. Other students, however, seemed to develop a different style of participation which involved less directed interactions with their peers and instructor. These students seemed to have a greater comfort with self-regulation and contributed to the interchange statements, which added to the discourse but without being directed to anyone in particular. Comments from these students were more designed to fit into the context of the discussion. These students were less likely to direct their messages to anyone in particular or to receive any directed messages.

Implications of Findings: Facilitating Meaningful Many-to-Many Dialogue

As technology is incorporated into classroom activities in different ways, we find that the social context of learning is changing for both teachers and students. Computer-based communication offers a unique capacity to support group collaborative work that is not time or place dependent, can support variable response rates, and can manage multi-leveled topical themes simultaneously (Johnson-Lenz & Johnson-Lenz, 1991). These characteristics have the potential to greatly impact the social structure of the classroom. In the case of the plant science lab, the interactive writing exercises facilitated more students to participate and share their ideas. The instructor for this class felt that appropriate applications of the computer-based interactive writing activities enabled students in this class to go farther and deeper into the subject matter (Fieldnotes, August, 13, 1994).

Many of our ideas about schooling and about teaching are founded on concepts of learning and instruction originally conceived in ancient times by Socrates, Plato, and Aristotle. Participation through dialectical conversation was the ideal way for a student to learn the most complicated lessons (higher order-learning such as problem solving and interpretation of facts) which the ancient scholars believed could not be taught, but could only be learned by modeling and interacting with a more knowledgeable teacher (Plato in Bailey, 1965; Bigger, 1968; Copleston, 1962; Haroutunian-Gordon, 1989). The view that learning requires interactive, face-to-face relationships is expressed again in the twentieth century by John Dewey who suggests that:

> The final actuality is accomplished in face-to-face relationships by means of direct give and take. Logic in its fulfillment recurs to the primitive sense of the word: dialogue. Ideas which are not communicated, shared, and reborn in expression are but soliloquy, and soliloquy is but broken and imperfect thought (Dewey, 1927, in Garrison, 1994, p. 13).

However, the experiences of computer-based interactions in the two cases observed in this study suggest that a new paradigm is possible for teaching complicated, abstract lessons requiring higher order learning. Students can learn to model and adapt the problem solving strategies of their instructor when it is portrayed for them in an on-line setting. To some extent and with uneven success, this is what happened in both cases observed. This goal was not articulated at the outset of this study, but in part was considered in the design of the capstone event. Students in both cases were given a list of questions that an expert in either field would use as a template for evaluating a piece of writing from the perspective of each discipline. The on-line exercises in both classes were structured so that the students were faced with a problem or set of questions to address and the teacher moved among the student comments sometimes to model an appropriate response, and sometimes to probe one or more students to further consider their initial efforts.

The references to the importance of the dialectic method for modeling higher order learning as expressed by Plato and Socrates represents the one-to-one expert-to-novice

model of learning. Dewey's representation of the importance of dialogue and interaction within a social context suggests the importance of providing a social context for meaning. The interactive writing activities which took place in both cases described in this study suggest that CMC offered a way to bridge the need for one-to-one dialogue and the need for ideas to be communicated within a social context. The traditional face-to-face classroom cannot effectively facilitate one hundred percent participation, but the computer-mediated classroom can. Both classes provided carefully thought out questions and reading material to frame the discussions which occurred on-line, and the instructors were active participants modeling, sharing, evaluating, and prompting student participation. While the less inhibiting bandwidth of CMC allows more students to participate, the text-based communication allows reflection and even editing before responses are shared.

The interactive text-based discourse can respond when questioned unlike the printed page which disallows the interchange required for dialectic:

> Socrates: A terrible thing about writing, Phaedrus, is this, and here, in truth, it is like painting. I mean, the creations of the painter stand like living creatures, but if you ask them anything, they maintain a solemn silence. And so it is with writings; you might think they spoke as if they had intelligence, but if you put a question with a wish for information on a point in what is said, there is one, one only, invariable reply. Further, once a word is written, it goes rolling all about, comes indifferently among those who understand it and those whom it no wise concerns, and is unaware to whom it should address itself and to whom it should not do so. When it is mishandled, when it is unjustly railed at, it always needs the assistance of its father; it cannot defend itself, nor help itself (Plato, In Bailey, 1965, p. 49).

The interactive writing activities performed within a structured context can be represented as writing, but can respond in a text-based dialogue. The written words which roll about in the interactive interchanges can be rephrased by their author or expanded on as questions arise. CMC offers a medium for interacting which is somewhat like writing and somewhat like talking, and having the characteristics of both of these other channels can offer an

effective new format for modeling higher levels of learning within a social context which may enhance participation, interaction and learning.

Finally, the observations and analysis from these two settings show that carefully constructed CMC activities can result in increased and more equal student participation. Students in both cases reported that their understanding improved by being able to read responses composed by their peers. As an active participant in the discussion, the teacher was the most influential participant. As student responses dominated the computer-mediated discussions, the students took on more responsibility for the outcomes of the on-line interchanges by sending more reactive and supportive comments as well as more elaborations and initiations to the messages by their peers. This is documented in the comparison of interchanges created from the beginning to the end of the semester. While the teacher has a strong influence on the CMC discussions, the status of the teacher and of the frequent student participants in the face-to-face class setting is reduced. The CMC discussions are regulated by social conventions which are imposed or which evolve from the initial and continued use within each setting. The conventions for participation and interaction in the CMC environment did not mirror the face-to-face conventions in either class.

Finally, the analysis of electronic interchanges revealed that student participation and interaction in the computer-mediated environment differed from the traditional, face-to-face setting in both cases in the following ways: (1) increased student participation; (2) increased student-to-student interactions; (3) students initiated more socially regulating comments to each other in the computer-mediated communication (CMC); (4) students responded to the CMC environment with varied timing in their responses and with variable styles of adapting to the sense of anonymity associated with the solely text-based communications. The social conventions for participation and interaction in the CMC interactive writing activities were influenced by the computer interface and limited

bandwidth of the media, the instructor's behavior as exhibited in the CMC discussions, the nature of the topic being discussed, and comments by their other students.

The CMC activities conducted as part of the capstone were found to have a noticeable impact on student learning in the following ways: (1) students reported increased understanding of computers; (2) the instructors in both settings reported that student on-line behavior showed that students were taking more responsibility for the interchanges; (3) students reported that they were less hesitant to share their ideas and that their understanding of the content material increased by being able to read the responses of their peers.

Three areas for further study are suggested by this study. First, the CMC interface as a text-only media may be too limiting to appeal to some students. Several students reported that they did not like having to type their responses and felt that this slowed them down. One students did not like having to learn new software commands in order to use Daedalus. However, for most students, the software was easy to use. Second, some students felt overwhelmed by the number of messages and multiple, consecutive tangents in the CMC discussion. Some students adapted to the multiple threads readily; one student continued to be confused by the interchange discussions. Third, is the need to provide more specific guidelines for designing appropriate activities for this technology which can be readily integrated into existing course-based learning and assessment activities. The quality of the discussions are contingent upon coming up with interesting and suitable topics. Student assessment activities need to be linked to interchange discussions without having the discussions themselves graded.

The on-going challenge will be to continue to think of new ways to use this technology which match the media characteristics with the task requirements and social context for learning. The most significant impact CMC will bring to education is yet to be discovered, but will come about naturally as what we call "new" technologies become fully

integrated into our everyday lives. As Simon (1987, p. 4) suggests, "We have to think about technology in terms of human knowledge...new technology is simply new knowledge; and as such it resides not in machines but in the human brains that invent them, develop them, and use them."

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Appendix A

Capstone Materials for Freshman Writing Class

(text copied from Daedalus Assignment Window)

Thursday, March 17, 1994

Today I want you to read the following piece carefully and then go to Mail and rank it according to the criteria listed in the Composition Rating Scale already sent to you. (You will need to copy and paste this mail file to type in your numeric ratings. We will guide you through this process.)

After you have mailed your ratings, you will then discuss your comments about this piece of writing in three different interchange conferences already set up which address the following three criteria: content, style, and writing conventions.

The Question
by Rumi

One dervish to another, What was your vision of God's presence?
I haven't seen anything.
But for the sake of conversation, I'll tell you a story.

God's presence is there in front of me, a fire on the left,
a lovely stream on the right.
One group walks toward the fire, into the fire, another
toward the sweet flowing water.
No one knows which are blessed and which not.
Whoever walks into the fire appears suddenly in the stream.
A head goes under on the water surface, that head
pokes out of the fire.
Most people guard against going into the fire,
and so end up in it.
Those who love the water of pleasure and make it their devotion
are cheated with this reversal.
The trickery goes further.
The voice of the fire tells the truth, saying I am not fire.
I am fountainhead. Come into me and don't mind the sparks.

If you are a friend of God, fire is your water.
You should wish to have a hundred thousand sets of mothwings,
so you could burn them away, one set a night.
The moth sees light and goes into fire. You should see fire
and go toward light. Fire is what of God is world-consuming.
Water, world-protecting.
Somehow each gives the appearance of the other. To these eyes
you have now
what looks like water burns. What looks like
fire is a great relief to be inside.
You've seen a magician make a bowl of rice
seem a dish full of tiny, live worms.
Before an assembly with one breath he made the floor swarm
with scorpions that weren't there.
How much more amazing God's tricks.
Generation after generation lies down, defeated, they think,
but they're like a woman underneath a man, circling him.

One molecule-mote-second thinking of God's reversal of comfort
and pain
is better than any attending ritual. That splinter
of intelligence is substance.
The fire and water themselves:
Accidental, done with mirrors.

Composition Rating Scale

Type in a number from 5 to 1 which describes how you would rate this piece of writing in the following categories. The higher the number, the higher (more positive) the rating.

Content (50%)

1. Convincing (persuasive, sincere, enthusiastic)---------- Unconvincing
   5 4 3 2 1

2. Organized (logical, orderly, planned)----------Jumbled
   5 4 3 2 1

3. Thoughtful (reflective, perceptive, inquiring)---------- Superficial
   5 4 3 2 1

4. Expansive (comprehensive, complete, inclusive)---------- Narrow
   5 4 3 2 1

5. Specific (definite, detailed, precise, exact)---------- Vague
   5 4 3 2 1

Style (30%)

6. Fluent (expressive, colorful)---------- Restricted
   5 4 3 2 1

7. Cultivated (varied, mature, descriptive, smooth)---------- Awkward
   5 4 3 2 1

8. Strong (effective, forceful, striking, fresh)---------- Weak
   5 4 3 2 1

Writing Conventions (20%)

9. Correct Form (paragraphing, punctuation, spelling)---------- Incorrect
   5 4 3 2 1

10. Conventional Grammar ---------- Substandard
    (sentence structure, agreement,ref)
    5 4 3 2 1

Capstone Survey

(Student Responses to Daedalus Activities)

1. In what ways does being able to read responses from your fellow students influence your thinking about the topics being discussed in this class?

2. Has using the Daedalus on-line conferencing changed your attitude towards computers in any way?

3. Has using the Daedalus on-line conferencing changed your attitude towards writing in any way?

4. What aspects of using the on-line conferencing have you most enjoyed?

5. What aspects of using the on-line conferencing have you least enjoyed?

6. Would you like to have access to the on-line conferencing to continue the discussions outside of class?

7. Has use of the on-line conferencing made it easier or more difficult to share ideas?

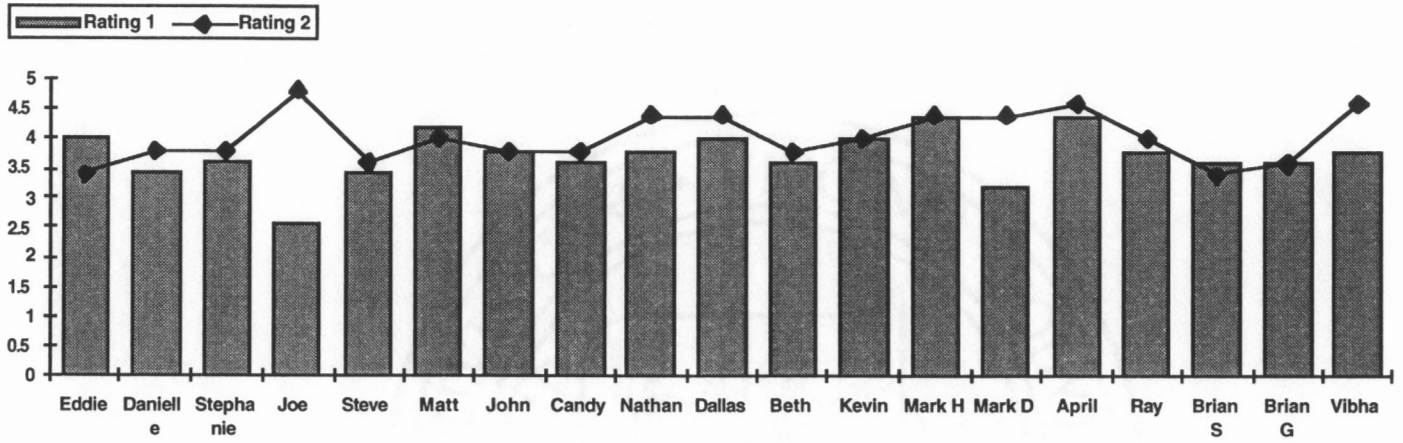
8. Do you think on-line conferencing facilitates or inhibits collaboration with fellow students in the lab?

9. What other uses of on-line conferencing do you think would be helpful for this or other classes you have taken at Virginia Tech?

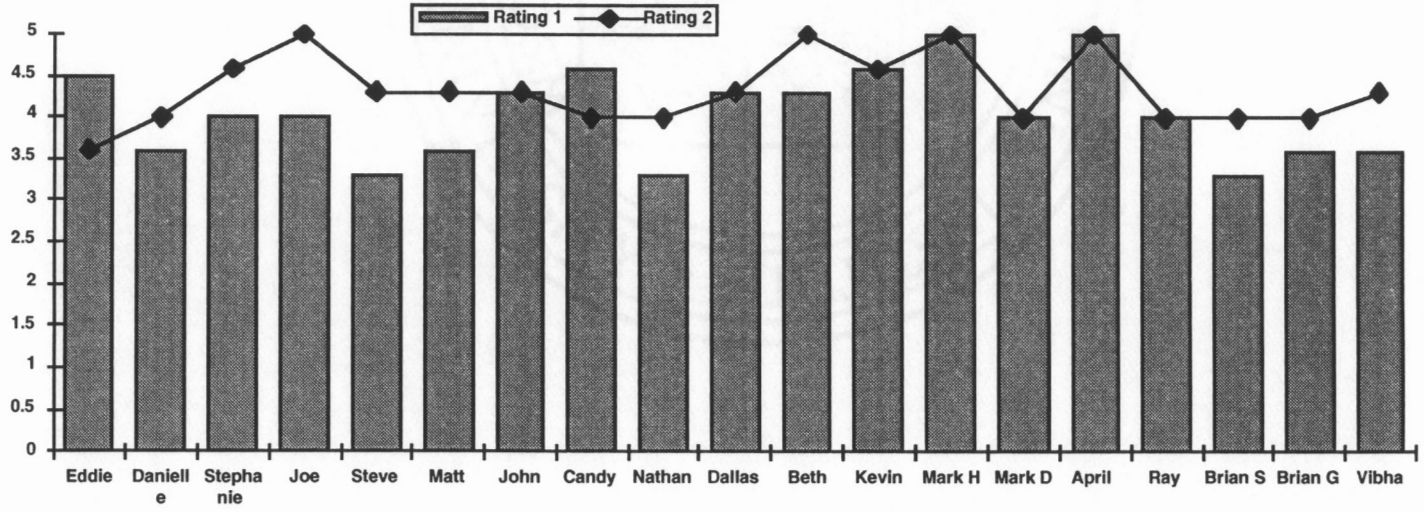
10. Do any of your other courses use on-line conferencing?

Any additional comments:

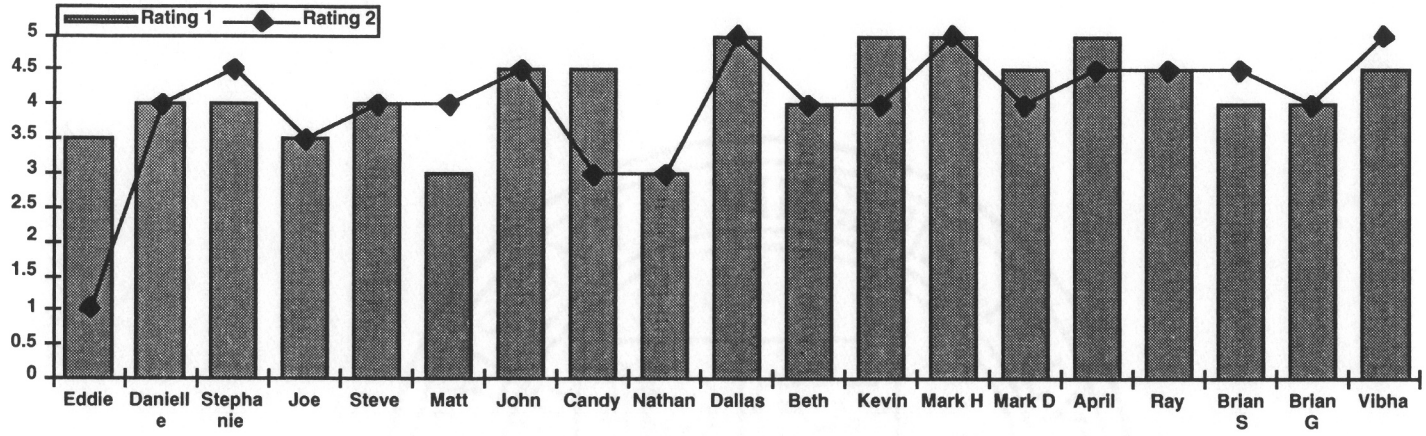
Pre- and Post- Discussion Ratings of Rumi selection
Rating 1 and 2 of *Content*



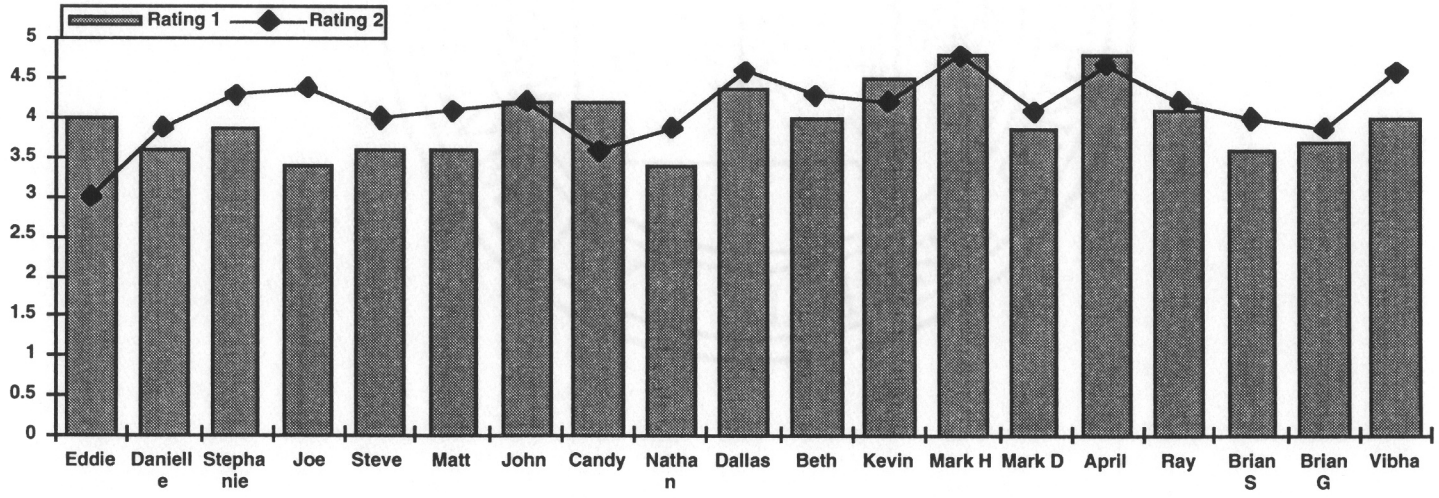
Ratings 1 and 2 of *Style*



Ratings 1 and 2 of Writing Conventions



Ratings 1 and 2 of overall average of ratings for Rumi piece



APPENDIX B

Capstone Materials for Plant Science Lab

(*text copied from Daedalus Assignment Window*)

March 16, 1994
Lab 8

Daedalus Activity Addressing Whole Plant Physiology and Transpiration

(You will need to copy and paste this file into a new *Daedalus Write* window.)

The following questions refer to the article from the New York Times distributed in last week's lab on transpiration. Please provide brief answers to the following immediately following each question.

Plant Science Lab
Peer Review Rating Guidelines

1. How many different plant processes were mentioned in this article? _____
   Please list the plant processes you counted as being mentioned in this article:

2. Based on your knowledge of plants, was the author's depiction of these processes accurate?
   (Yes) or (No)

3. How many different research studies were referred to in this article?
   _____

4. Did the author correctly apply scientific knowledge as evidence to support the facts presented in this article?
   (Yes) or (No)
   Support your answer by citing one example from the article.

5. Would you say that the point of view presented in this article is universally held by all plant scientists?

6. Briefly describe the major strengths and weaknesses of this article.

7. On a scale from 1 to 10 [1 being the lowest; 10 being the highest] how would you rate this article in terms of:

   (a) the value of the information presented: _____

   (b) the author's ability to provide a clear and logical explanation of the ideas contained in this article:

   _____

Once you have answered all these questions. Save the new DaedalusWrite file you have created, and then copy and paste your completed questions/answer into a Mail message and send it to Steve Scheckler.

After you have mailed your answers, share your comments regarding the strengths and weaknesses of this article in the class discussion in the Main interchange.

Capstone Survey
(Student Responses to Daedalus Activities)

1. In what ways does being able to read responses from your fellow students influence your thinking about the topics being discussed in this class?

2. Has using the Daedalus on-line conferencing changed your attitude towards computers in any way?

3. Has using the Daedalus on-line conferencing changed your attitude towards biology in any way?

4. What aspects of using the on-line conferencing have you most enjoyed?

5. What aspects of using the on-line conferencing have you least enjoyed?

6. Would you like to have access to the on-line conferencing to continue the discussions outside of class?

7. Has use of the on-line conferencing made it easier or more difficult to share ideas?

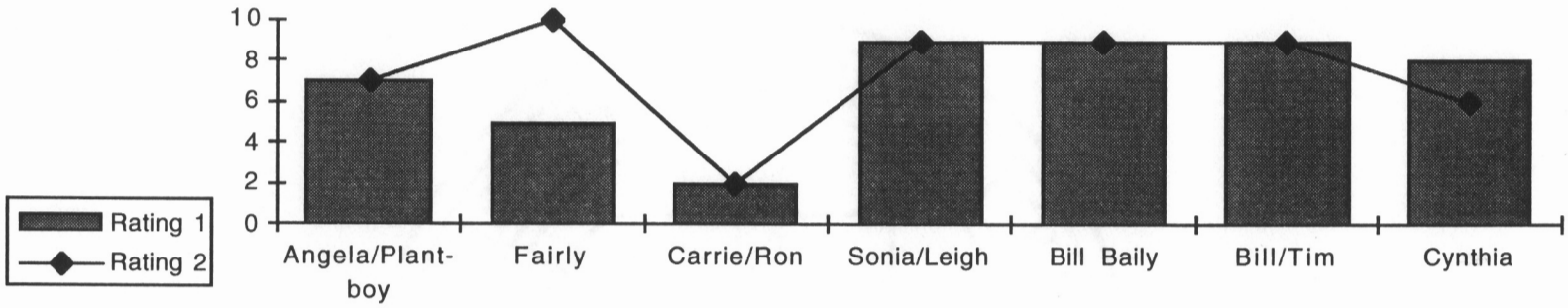
8. Do you think on-line conferencing facilitates or inhibits collaboration with fellow students in the lab?

9. What other uses of on-line conferencing do you think would be helpful for this or other classes you have taken at Virginia Tech?

10. Do any of your other courses use on-line conferencing?

Any additional comments:

Comparison of pre- and post-discussion rating.



This combination bar/line graph shows the change (if any) in students initial and post discussion rating of the transpiration article.

APPENDIX C

Informed Consent Agreement for Videotaping

(Plant Science Lab)

Addendum to the Informed Consent Form

TO: Students currently enrolled in BIOL 2614

FROM: Laurie Ruberg

TOPIC: Specifically addressing use of audio and/or videotaping of activities in the Plant Science Lab (BIOL 2614).

I am seeking your informed consent to videotape your participation in the variety of instructional activities which occur within the educational context of the Plant Science Lab classes. In the attached consent form I have agreed to remove all identifying names from printed and electronically produced texts to protect your privacy. However, I cannot protect your privacy in the videotape material. Transcripts of and all references to the videotape material will remove all identifying names and a pseudonym will be used to conceal your identity. Therefore, in this Addendum to the Informed Consent form I seek your informed consent to use the videotape material of instructional activities in the lab for the following purposes:

- Demonstrating student use of multimedia workstations in the lab
- Demonstrating student collaboration activities during in-class activities
- Demonstrating student participation in on-line discussions during class period
- Demonstrating students participation in hands-on wet lab activities as assigned within each lab
- Demonstrating informal student interactions with each other and with the instructor during the course of the lab.

This videotape material will document the above mentioned class activities for research purposes. Selected segments of this footage may be shown at educational conferences and/or meetings. The videotape footage will be viewed, transcribed, and interpreted by me, but may also be viewed by Dr. Steve Scheckler, as the major professor associated with this course, and Dr. David Taylor, with Education Technologies, who has been involved in the development of multimedia instructional programs used in this course. Stewart Hill, a Graduate Teaching Assistant in biology, may also view these videotapes since he will be involved in the on-going instructional development for this lab course. The videotapes will be stored at the Educational Technologies Building and will be destroyed upon completion of this project.

Please sign your name and check the box below to indicate that you are giving your informed consent for the individuals named here to have access to the audio and videotapes of Plant Science Lab class activities for the purposes described above.

_____
Signature

[ ] I agree to be videotaped for the purposes described above.

Thank you for participating in this research project!

APPENDIX D

Profile of Expected Social Psychological Characteristics of CMC

Profile of Expected Social Psychological Characteristics of CMC

Research Question 1: What are the characteristics of student interactions in the computer-mediated environment?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
CMC groups function better with a larger number of participants than analogous face-to-face groups	Sproull & Kiesler (1991)	The pilot testing of different CMC activities showed that small groups did not work well in the computer-based exercises.	Chapter 3, Discussion of pilot testing for capstone, p. 87.
Real-time, synchronous text-based interactions represents a new kind of register.	Ferrara, Brunner, and Whittemore (1991); Feenberg (1990)	Students responded to the CMC activities in different ways as described in the analyses of quantitative network connections and analysis of discourse in transcripts	Variations in student responses to this environment are discussed in the summaries of Chapters 3 & 4.
Increased participation and more democratic participation with Students contributing 75 to 85 percent of the discourse. Women make the first proposal as often as men in electronic groups. Increased participation and broader access to information and decrease in the power of traditional gatekeepers.	Bump (1990); Feenberg (1987; 1990); Harasim (1990); Hartman et al. (1991); Hiltz (1990); Newman (1993); Selfe (1990); Sproull and Kiesler (1991)	FW[1]: Women participated as often as men and were as often early initiators in the discussion; however, women overall were not as often integrated in the discussion (receiving & directing messages) as the men in the group. (This class had nearly twice as many men as women enrolled.) PSL[2]: Women were equally likely to be early initiators in the CMC discussion. Women were more integrated into the discourse. (This class had an even number of women and men enrolled.)	See Chapter 3 pp. 115-122 and Chapter 4, pp. 190-195.
Sense of anonymity assoc. w/ CMC interactions and are less influenced by social conventions.	Kiesler, Siegel, and McGuire (1984); Sproull and Kiesler (1991)	This sense of anonymity and privacy in the CMC environment is mentioned in both settings in student responses to survey questions.	See pp. 111-115 in Chapter 3 & pp. 176-179 in Chapter 4.

[1]Freshman Writing.
[2]Plant Science Lab.

Who sets the topics in student-to-student on-line interactions?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
Those with higher status (such as the teacher) do not dominate the CMC interchange.	Harasim (1990); Levin, Kim, and Riel (1990; McGuire, Kiesler, and Siegel (1987)	The quantitative analysis of network connections and the message flow analyses show that student messages far outnumbered teacher messages.	See Tables 11 & 14 in Chapter 3 and Tables 17 and 18 in Chapter 4. See also Figures 6, 12, and 16.
Increased responsibility for regulating themselves	Newman (1993); Scardamalia and Bereiter (1993)	In both settings students took on more responsibility for generating a meaningful computer-based discussion by providing thoughtful responses and by reacting comments by their peers.	See Chapter 3, 115 - 122 and Chapter 4, p. 190 and pp. 193-195.

Do students truly interact on-line? If they do, how do they influence and regulate one another?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
CMC discussions characteristically have multiple threads and a non-linear pattern	Levin, Kim, and Riel (1990)	The message flow analysis shows that this is true, but also shows that some discussions will have this tendency more than others. Comparing the message flow analysis of the FW and PSL shows that the more interactive discussion had a greater tendency towards multiple threads and a non-linear pattern.	See Figures 6, 12, and 16.
Repeated use of CMC within a clearly defined social setting will result in the establishment of social conventions in both settings.	Hartman et al. (1991); Hiltz (1990); Hunter (1993); Newman (1993) Scardamalia and Bereiter (1993); Sproull and Kiesler (1991)	Students: Respond to questions (posed by the instructor and by other students). Respond to opinions presented by other students. Initiate questions. Evaluate each others comments. Elaborate and/or further clarify comments from their peers. Express their reactions to the CMC activity and related class activities (often without being asked).	Refer to Figures 6, 12, and 16 & discussion on pp. 115-122 and 193-195. The mail message analysis and discussion also provides some insight into another kind of student-to-student sharing (See pp. 108 - 111.

CMC discussions will lead participants (students) to pay attention to different things, have contact with different people, depend on one another differently, and ultimately lead to established conventions which can be uniquely defined within each setting.	Hartman et al. (1991); Lea, (1991); Sproull and Kiesler (1991).	Based on observations of student face-to-face behavior as well as on student comments in surveys in both settings, students interacted with different persons in the CMC environment than in class--although the settings observed used real-time, in-class use of CMC so some hierarchical conventions of the face-to-face setting carried over to the CMC environment.	FW: See the mail message analysis on pp. 108 - 111 and the discussion of findings on pp. 115 - 117. PSL: Analysis of student comments in surveys on pp. 176-179.
Equality in participation linked to individual personalities, learning styles, prior experience with subject matter, computing skills, and access to technology.	Butler (1993)	These issues are discussed throughout Chapters 3 and 4. Students' prior experience with computers and with the subject matter is addressed throughout the analysis in both chapters. Access to technology was less of an issue, because this study looked at in-class use.	See Chapters 3 and 4.

Research Question 2: How do CMC interactions have an impact on student learning?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
More positive attitude toward computers and greater knowledge of their use. Successful use of CMC puts responsibility for learning onto students.	Hiltz (1990); Hunter (1993); Newman (1993); Scardamalia and Bereiter (1993)	This was primarily true for students who had not previously used computers for collaborative work or for communications functions such as e-mail.	See pp. 111-115 in Chapter 3 & pp. 176-179 in Chapter 4.
Individuals can learn to use CMC selectively as suits his/her personal style, preferences, and requirements	Myers (1987); Mackay (1989)	The variations in student responses to the CMC environment was observed in both settings.	See Chapter 3, pp. 115-122 and Chapter 4, pp. 190-195.

What impact does the on-line discussion have on each student's assessment and rating of the text used in the peer review activity?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
Students express more extreme, more divergent, and less predictable points of view in the CMC environment.	Kiesler, Siegel, & McGuire (1984); McGuire, Kiesler, & Siegel (1987); Sproull and Kiesler (1991)	This can be seen in the description of the pre- and post-discussion ratings in both settings.	See Chapter 3, pp. 104-108 and Chapter 4, pp. 171-176.

How do students believe they benefit from the on-line discussion?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
Increased access to the instructor and to other educational experiences. Increased level of interest in the subject matter. Provides a means to support collaborative conversation about a topic and the ensuing construction of understanding.	Brown (1989); Hartman et al. (1991); Harasim (1990); Hiltz (1990); Sproull and Kiesler (1991)	Students describe benefits by increased access to responses by their peers in the FW capstone surveys. This was reported by students in the PSL in the capstone survey.	See Chapter 3, pp. 111-115 and Chapter 4, pp. 176-179.

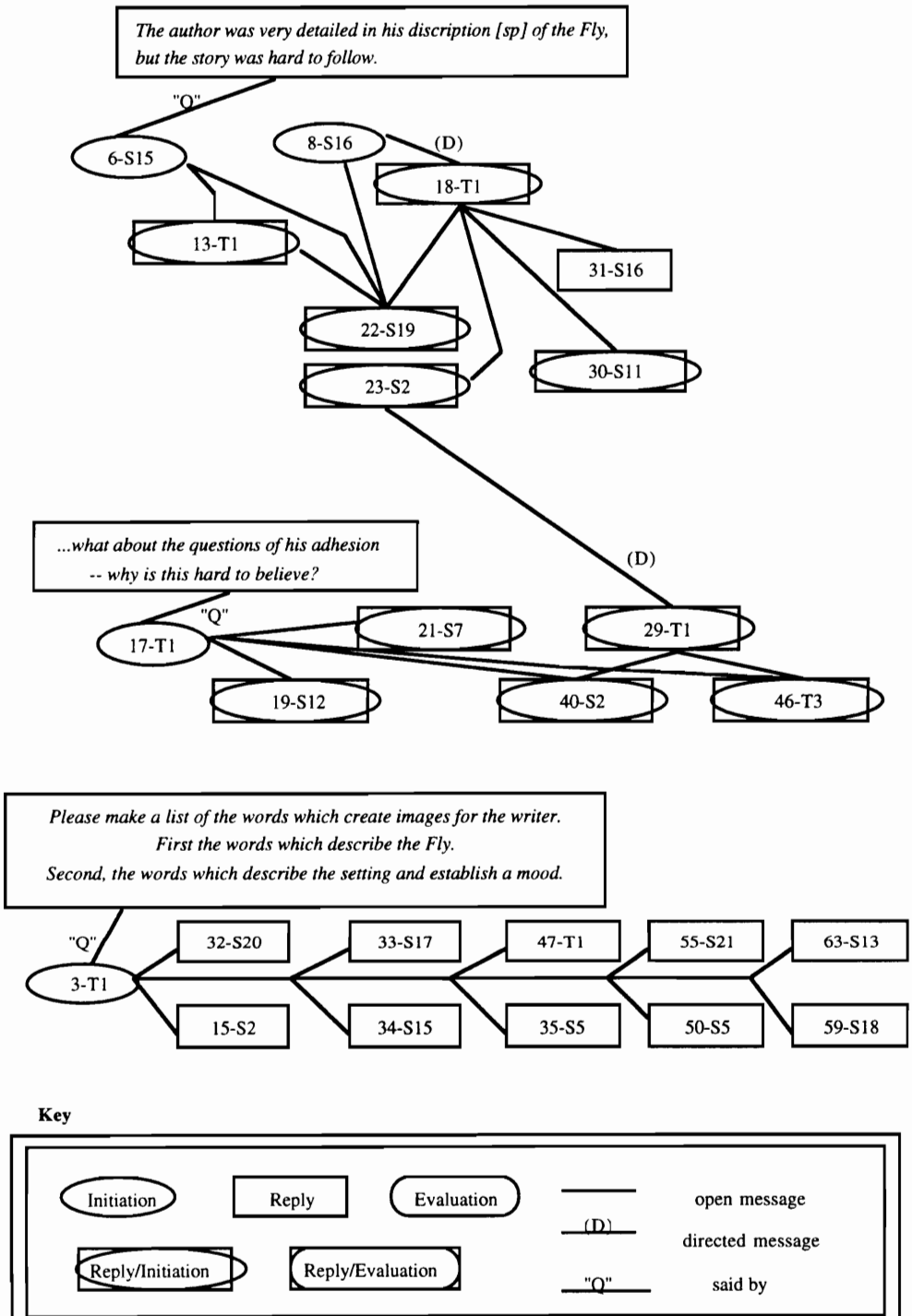
Research Question 3: How do CMC interactions differ in these two settings which teach different content and the procedures of different disciplines?

Reported in Prior Research	Reported by	Findings from this Study	Documentation of Finding
Student interactions on-line create new opportunities for new connections among students and their teacher and to attend to pay attention to different aspects of the subject matter.	Sproull and Kiesler (1991); Uhlig, Farber, and Bair (1979)	This was confirmed in student responses to the surveys in both settings.	See Chapter 3, pp. 111-115 and Chapter 4, pp. 176-179.
Need to consider the social situation in which the CMC activities occur. Need to include analysis of the social meanings conveyed by language and participants attitudes toward that language and social setting.	Morine-Dershimer (1985); Stubbs (1976)	Differences in the physical layout of each setting influenced interactions as well as some students being paired up at the computers in the PSL. The face-to-face interactions influenced the CMC interactions in that those who were more vocal in the face-to-face setting had more name recognition in the CMC setting. The analysis of the computer-based writing from both settings describes characteristics of social interactions which were expressed in the CMC environment.	Refer to Figures 5 and 7 to see how the physical environment of the two settings differ. The analysis of the transcripts in Chapters 3 (pp. 86-122) and Chapter 4 (pp. 161-195).
Children (& adults) learn language through an active process of concept acquisition: as the concepts in the two subject areas differ, so the activities associated with process these concepts would differ and these differences should be reflected in the language processing activities employed in CMC activities.	Chomsky (1969, In Morine Dershimer, 1985)	These differences are reflected in the questions asked in the rating activities as well as in the activities within and outside of class which preceded and followed the CMC experiences.	These differences are described in the introductory section to Chapter 3 (pp. 56-80) and Chapter 4 (pp. 123-152) and in the description of the capstone activities and rating questions used in each case: Chapter 3 (pp. 86-89) and Chapter 4 (pp. 158-162)

Appendix E

Message Flow Analysis of Pilot Study

Message Flow Analysis: *The Fly*



Linear flow of comments over 50 minute period:

1..... 30

..... 63

Appendix F

Vita

Lorena (Laurie) Ferguson Ruberg

I received a Bachelor of Science from Drexel University in Philadelphia, Pennsylvania, where I majored in psychology with a minor in education. After working in Philadelphia for just over a year, I went back to school and received a Master of Arts in English Literature from the University of Iowa, Iowa City, Iowa. Upon completing my masters degree, I applied my background in rhetoric and communications to working with non-profit organizations in several positions which required a combination of public relations, program development, and teaching skills. Eventually my work with private and public organizations in the dissemination of information led to increased use, application, and development of digital technologies. As the project director for a non-profit organization established to disseminate public service information to citizens via interactive cable technology, I was exposed to the legal, social, technical, and political issues involved in creating new avenues for information distribution. Later, as a research associate working with an interactive design and development team with the Virginia Cooperative Extension Service, I gained greater insight into the design and development process through my involvement with the creation and placement of thirteen touch-screen interactive video kiosks installed at various public-access locations throughout Virginia.

My area of research interest focuses on computer-mediated communication (CMC) and how this technology can be used to improve and enrich the social context of instruction--in schools and in other situations as well. CMC technologies like those described in this dissertation offer teachers and students an alternative social environment for sharing ideas, interacting, and learning together. Changing technological interfaces and increased access by more diverse participants will continue to impact our understanding of this new technology which also makes this area of research both technically and socially interesting, challenging, and potentially rich with implications for improving instruction.