ONLINE EDUCATION

Perspectives on a New Environment

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Chapter 8

Analyzing Instructional Interactions on Electronic Message Networks

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INTRODUCTION

More and more schools are starting to explore the uses of electronic message systems for instruction. Networks have been used in social science instruction (Cohen, Levin, and Riel 1986), in science instruction (Levin and Cohen 1985; Newman 1986; Katz, McSwiney, and Stroud 1987; Levin, Waugh, and Kolopanis 1988), for writing (Riel 1985), and in other domains. Research has started to focus on the impact of this sort of long-distance instruction based on the interchange of electronic text messages in "nonreal time" (Hiltz and Turoff 1978; Quinn, Mehan, Levin, and Black 1983). One obvious question that arises is whether instruction on electronic networks is more or less effective than face-to-face instruction.

We have been focusing on a different, more interesting question: In what ways is instructional interaction on electronic networks different from face-to-face instruction and in what ways is it similar? Once we have a more detailed understanding of the nature of the interaction, we will be in a good position to address the issue of which medium is more effective and for what purposes. We can also learn new aspects of the more familiar instructional medium by contrasting it with instruction in a very different medium.

Research on instruction conducted on electronic networks has the advantage that the interactions are self-transcribed. Also, because of current limitations of the media, interactions are largely text-based, avoiding the difficult problems of interpreting nonverbal communication. Finally, the data can be collected without the intrusiveness of video cameras or human observers. Despite these advantages, however, one soon ends up with a massive number of pages of messages, without established methodologies for analyzing a mass of messages.

In this chapter we describe a number of techniques we have developed for analyzing messaging on electronic mail networks, and we point to some of the conclusions we have reached based on these analyses.

THE INTERCULTURAL LEARNING NETWORK

The analytical techniques presented here are illustrated by applying them to the interaction that occurred on the Intercultural Learning Network (ICLN). The ICLN has a loosely organized set of participants, including elementary, middle, and high school students and teachers, junior college, undergraduate, and graduate students and faculty, and a few participants from outside the educational system. It has included participants from California, Illinois, Connecticut, Alaska, Hawaii, and other states in the United States, from Puerto Rico, from Tijuana and Mexico City in Mexico, from Tokyo, and from Jerusalem. Participants typically write messages on a microcomputer using a word processor, and then send these messages to the other participants through the electronic mail system on The Source, a commercial computer system available from all of the sites on the network. Group communication was maintained through the use of "memo lists," so that a message sent to a group name went to each of the participants on that list.

Since the ICLN was created as part of research projects to explore the nature of instructional networking, the number of sites has remained fairly small. Nevertheless, it has been a fairly active network since it was established in 1983. In the analyses below we analyze in depth various "time slices" of the ongoing interaction in messages sent between March 1986 and March 1987.

Interaction on this network has been organized around "activities," proposed by different participants on the network, and then pursued by the subset of participants that volunteer to join

in. To give a better feel for the type of activity pursued, below is a message that was part of an activity called the Moon Observation Project. In this project, students in different locations first drew pictures of what they thought the first quarter moon looked like, the full moon, and the last quarter moon. Then they went out to observe and draw the moon that night. The message that follows is one of the early, organizational messages:

```
From: BCF302 (TOKYO)      34 Lines
On: 27 APR 1986  At: 12:24
To: STK148    To: BBW928    To: TCM869    To: BDR323
Dear Jim,

I did the moon exp. to 9 nonnetworking students of my
college.  Here come the results.

First quarter crescent: 2 correct; 7 incorrect.
Last quarter crescent: 2 correct; 7 incorrect.

Correctness is only counted by the direction of the
horns.  Somehow, all the drawn moons are, what should
I say, standing upright on one of their horns.  None
drew a slanted crescent.

Full moon figures:
      clear rabbit 2 (one drew two facing each other)
      fuzzy rabbit 2 (one is lying down on the bottom)
      meaningless shapes 4; "rock" 1.

Clear rabbits have pestles.

In addition, I asked them what Americans/Israelis see
when we see the full moon in Japan.

   # of answerers        U.S.            Israel
        2                full            full
        2                half            half
        1                crescent        dark (no moon)
        1                half            crescent
        1                waning          waxing
        1                crescent        NA
        1                dark            half

I got good variety, didn't I?  So this question appears
to be more difficult than we thought.  Naomi
```

This message, the sixth in a set of interchanges, was followed by a long series of other messages stretching over five months that led the conduct of the project in which a number of different sites involved students in the actual observational and message. These Moon Observation Project messages are among those analyzed later in this chapter. At the same time this inter change was taking place, there were numerous other activities taking place in parallel, as illustrated by our analyses.

PARTICIPANT STRUCTURES ANALYSIS

Interaction in educational settings has been analyzed in terms of "participant structures" (Philips 1972, 1982). Participant structures provide a way to compare interaction in different educational settings. Used in efforts to compare home and school interactive patterns, participants structures have helped explain why students from certain cultures systematically function poorly in the conventional Western classroom setting (Florio 1978; Mehan 1979; Au 1980). The following list of participant structures was used to contrast teacher-student interactions and students' interactions with computers (Mehan, Moll, and Riel 1985):

1. Organization of the work group
2. Task organization
3. Response opportunities
4. Response obligations
5. Evaluation.

These same participant structures, with some modification, provided a schematic frame for comparing interaction on a range of different networks (Riel and Levin 1985). It helped isolate features that contribute to more and less success in the development of networks.

Participant structures modified for examining network interaction are as follows:

1. Organization of the network group: its size, common knowledge, experiences, or interests, the physical location of the participants
2. Network task organization: the types of activities that participants engage in over the network
3. Response opportunities: ease of access to the interaction, including social and technical resources for sending and receiving messages

4. Response obligations: the tacit or formal requirements for responding to messages
5. Evaluation and coordination: the assessment of the quantity or quality of the exchanges on the network and efforts to facilitate group interaction.

Riel and Levin (1985) reviewed efforts to develop a number of network communities. The participant structures provided a framework for the comparison of successful and unsuccessful efforts. This analysis pointed to a set of factors that were more likely to result in a functioning network community. The following descriptions are of participant structures most likely to lead to success:

1. A group of people who work together or share interest in a task, but who find it difficult to meet in the same location and/or at the same time
2. A well-specified task to be accomplished by this group
3. Ease of access to a reliable computer network
4. A sense of responsibility to the group and/or task
5. Strong leadership and final evaluation of the group task

While these features make the task of building a networking community much easier, there does not need to be a perfect overlap of all features to succeed at network building. It is important to note that all of the successful networks that were described by Riel and Levin (1985) deviated from this pattern by only a single feature. All the networks that failed to sustain interaction differed from this pattern on two or more of these features.

This analysis of participant structures was used to frame the development of the ICLN. They give a descriptive profile of the network that provides the background for more detailed methods of message analysis that we will introduce in the next section.

Organization of the Network Community

The organization of the group is multilayered, with the site coordinators having had the experience of working together on previous projects in face-to-face settings. Other participants meet and interact only through their work on ICLN. The personal contact and trust between the site coordinators helps to facilitate the functioning of other members of the group.

The locations represent a wide cultural and geographic diversity. Students enjoyed writing for and reading the work of other students even when they knew little about them. But with increasing knowledge about their partners came increased interest in the interactions. Exchange of other media—photos, audiotapes and videotapes—provided a common meeting ground for students who work together across distances. This exchange enabled students to create their own tasks on the network. In the absence of knowledge of participants, there seems to be a higher need for a well-specified task.

The size of the group varies with each project. The group of participants on a specific project would include the teachers and students from between three and eight classrooms as well as university students and researchers.

Organization of the Network Task

The activity approach to networking adopted by those who have organized ICLN ensures that participants are joined together to accomplish a specified goal. The task shared by all participants is to create functional learning environments in which students cooperate with peers and adults in other locations to share ideas, explore issues, and solve problems. The university researchers and students were interested in mapping out the properties of electronic message systems and their usefulness for instructional interaction. The pre-service and in-service teachers were interested in principles and design of cooperative learning on the network. The students were involved with the content of projects in science, social science, and language arts.

Examples of student projects include an analysis of international news coverage, a comparison of educational systems, a study of career choices and how these have changed across generations, a study of how the water cycle operates in different places and of techniques for dealing with water shortages, food prices and import and export policies, and comparisons of TV watching patterns.

Response Opportunity

The ease of access varied across the different locations. In sites with university support, the cost and technical support were supplied by the university. In cases of teachers working without this support, the cost in money and time was sometimes too great to assure regular interaction.

Response Obligation

Schools working closely with ICLN coordinators agreed to spend some part of the school week on the networking activities. Despite strong personal commitment to this project by most of the teachers, state- and district-mandated curriculum, differences in school holiday schedules, and testing periods sometimes resulted in response delays.

Coordination/Evaluation

To coordinate this network, a person in each location was designated as a "site coordinator." This person was responsible for locating and working with the teachers and students at each site. In addition there are "activity coordinators," who took the initiative in developing and running an activity on the network. These activity coordinators provided the group leadership that is so important to keeping a task functioning.

ICLN activities that lacked a coordinator were less likely to be successful, if success is equated with sustaining interaction. There were many messages with good ideas for projects that were exchanged. Those that had at least one person strongly committed to the project were likely to continue. Good ideas without the commitment of a coordinator rarely instigated much activity. A strong coordinator seemed to be a necessary but not a sufficient condition. It is the purpose or function of the activity from the perspective of the participants that seems to determine its likelihood of success.

Evaluation is a critical element of ICLN. The rest of the analysis presented in this chapter provides some of the strategies we are developing for examining the interaction on networks.

The design and development of the ICLN draw upon the framework of a participant structure analysis of networking. This framework gives us a way to see the dimensions of variant possibilities in this new institutional medium. However, the most important fact leading to successful educational networks is the presence of an important function that the network serves. The nature of this function determines the particular form that the network should have.

INTERMESSAGE REFERENCE ANALYSIS

In reading through a set of electronic messages, one gets a strong feeling that there are "multiple threads": multiple topics that are being pursued in parallel. Previous research has pointed to the "multiple thread" nature of electronic message interaction (Black et al. 1983; Quinn et al. 1983). These previous approaches relied on an analysis of the topic content of the discussion.

In order to trace these "multiple threads" more easily, we have developed an alternative approach, which we call Intermessage Reference Analysis. This is a more "syntactically" based analysis, performing the analogue of a repeated reference analysis for text. For each message, a coder determines whether reference is made to previous messages. Sometimes these references are clear: if the message sender used an "Answer" or "Reply" command in the message system, the program will automatically place in the "Subject" line of the header a reference to the previous message. Sometimes the message sender will include an explicit reference to a message in the text of the message: "...your message yesterday...." Other times, the reference is less explicit, as when a message supplies an answer to a question asked in a previous message: "...Yes, I agree."

Although this analysis leaves the analyst scratching his/her head about some borderline cases, the reliability between coders is fairly high. Two independent codings of a corpus of 104 messages agreed on the intermessage references in 99 of the messages, reaching 95 percent reliability. From this analysis, we can immediately address a number of questions. Which messages are referenced a lot? Does that depend on the sender of the message, or the topic of the message, or how the message is addressed? Who references whose messages? That is, is the referencing stratified according to the different roles of the participants, or does it cross role boundaries?

To address the questions raised above, we selected a corpus of messages in the ICLN: those messages sent during April 1986. There were 104 messages sent during this time period, and there were 76 intermessage references made in these 104 messages. Table 8.1 shows the number of times messages were referenced by other messages.

Table 8.1 How Often Were Messages Referenced by Other Messages?

# of References	# of Messages	% of Messages
5	1	1
4	3	3
3	6	6
2	13	13
1	25	24
0	56	54

As can be seen, a few messages were referenced multiple times (one message was referenced by five other messages; four messages were referenced by three others; etc.), while a majority of messages (54%) were never referenced. There is an interesting analogy between the results of this analysis and the results of citation analyses: most papers published in journals never are cited by other papers, while a few papers are cited again and again (Garfield 1972).

What determines whether a message is referenced or not? Are messages from adult participants referenced more than those from children? Let us start with the question of whose messages are referenced. Are the messages from the adults referenced and those by children ignored? Table 8.2 shows that this is not the case. In fact, it shows that messages from students are referenced slightly more often than those from adults. It also shows that a majority of messages from each group are not referenced.

This table shows us that messages from participants in the different roles in the network are referenced. But it doesn't tell us anything about who is referencing whose messages. Do adults in the network reference only other adults' messages? Do the stu-

Table 8.2 Whose Messages Are Referenced?

Author's Group	# of Messages	Percent Referenced
Site coordinators	35	42.9
University students	33	48.5
Precollege students	28	46.4
Unknown author	2	50.0
Joint authors across categories	6	66.7

Table 8.3 Who References Whom?

Author of Referenced Msg	Author of Referring Msg AD	US	ST	AD&US	UK	Total	Percent
AD	11	3	1			15	17.4
US	14	11	8		2	35	40.7
ST	15	2	11	1		29	33.7
UK	2					2	2.3
AD&ST	2					2	2.3
AD&US	1					1	1.2
US&ST		2				2	2.3
Total	45	18	20	1	2	86	
Percent	52.3	20.9	23.3	1.2	2.3		100

Key: AD = Adults (site coordinators, graduate students, teachers)
US = Undergraduate student
ST = Precollege student
UK = Unknown author
XX&XX=Joint authorship

dents reference only other students? Table 8.3 shows who references whom.

These data shows that there is a weak tendency for people in a given role to reference messages of those in the same role. But there is also a lot of crossover. The correlation is 0.015, which is very low.

These are the kinds of global facts we can derive from the intermessage reference analysis. However, a much more powerful outcome is what we call a "message map." Each reference of one message to another can be thought of as a link in a graphical representation of the messages. So, if we lay the messages out in a space with time as the horizontal axis and different senders as the vertical axis, a particular set of messages can be displayed as a message map, with the intermessage references as directed links (arrows) between the messages. Figure 8.1 shows a simple message map.

Each rounded rectangle in this map is a message, and the arrows point from each message to a previous message that it references. Time is the horizontal axis, labeled in weeks at the top, and different senders are listed along the vertical axis. The naming convention for messages is that the first two letters indicate the sender; the next three or four the date sent; and the last, either the destination or the topic of the message. To simplify the diagram, several reference links to the same message are sometimes joined into a thicker line. The name of the cluster is the subject header of the "root" message, which is in quotes below the root message. This cluster is "Mexican Aliens Migration to America," shown near the bottom of Figure 8.1. This message was referenced by five other messages, which were in turn referenced by other messages. Even this simple message map shows that these electronic interactions deviate from the most common face-to-face "whole group" instructional pattern, which is a string of alternations in turns between teacher and different students (Mehan 1978). Figure 8.2 shows the message map for all the messages sent during the months of April and May 1986 on the ICLN.

This message map is quite complicated, and difficult to read. However, the nature of its complexity is informative. It certainly makes clear the "multiple thread" nature of electronic message interaction, previously documented by Black et al. (1983) and Quinn et al. (1983). Perhaps of greater utility is the possibility of using the intermessage reference analysis, which created this messy messages map, to pull out smaller and more manageable clusters of messages. A cluster consists of all messages that are interlinked with reference links. Figure 8.3 shows the map of the largest such cluster during this period. We will name these

Figure 8.1 A Simple Message Map

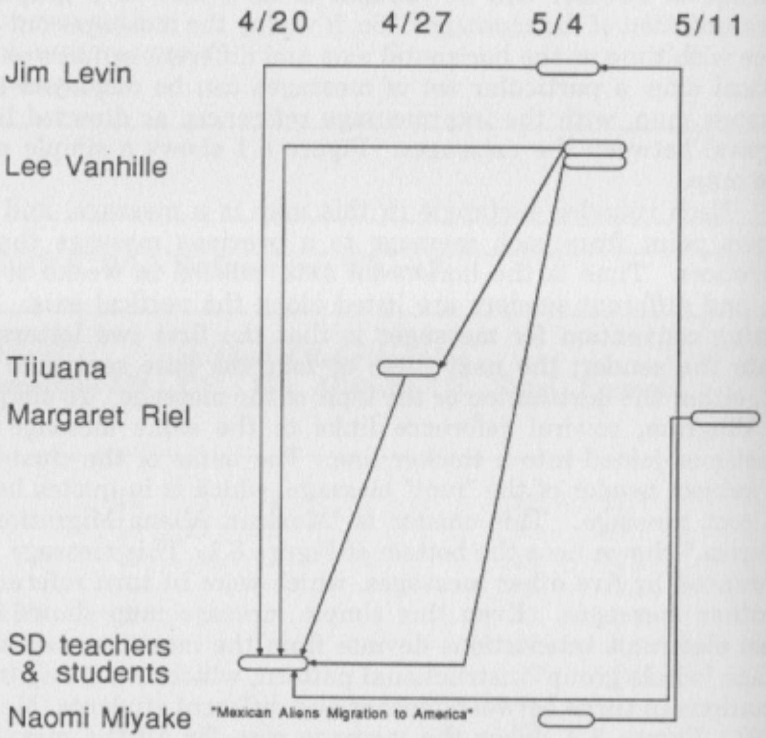
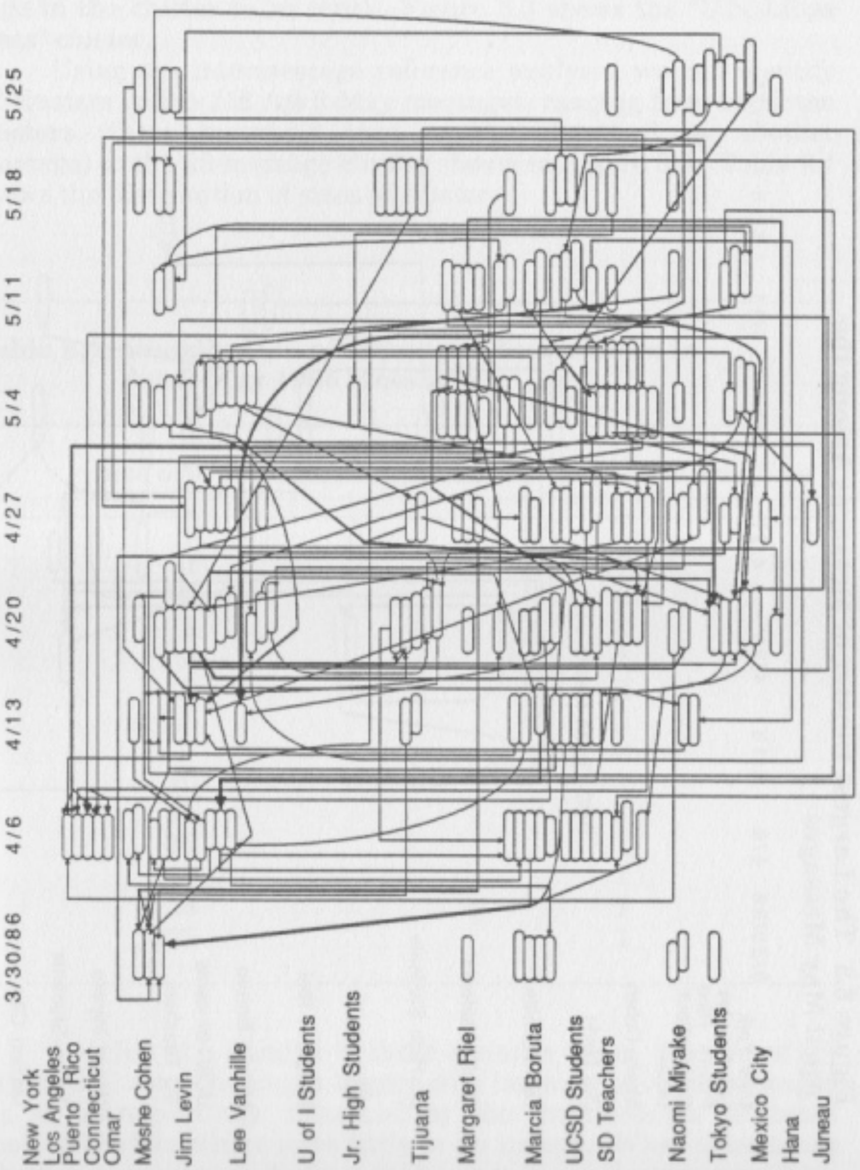


Figure 8.2 The Complete Message Map for April-May 1986



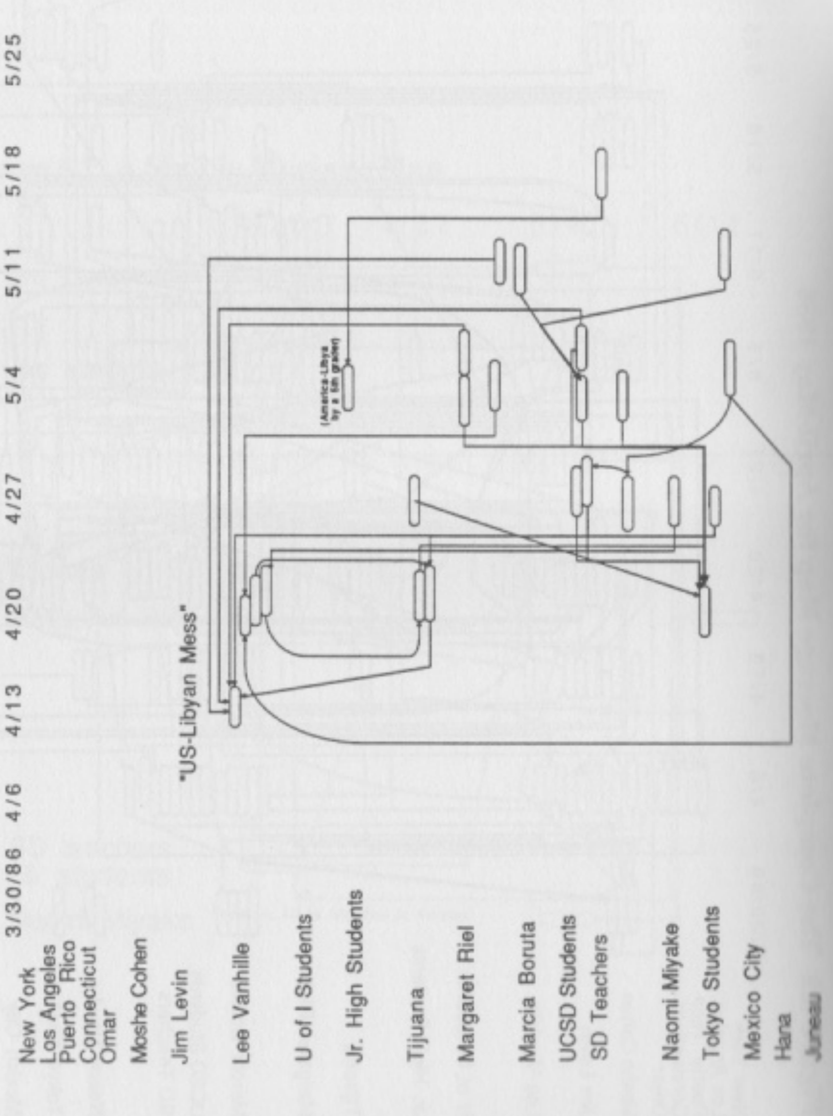


Figure 8.3 The Largest Cluster of Messages Among the April-May Messages

largest such cluster during this period. We will name these clusters by the "Subject" header of the root message (the first message in the cluster to be sent). Figure 8.3 shows the "U.S.-Libya mess" cluster.

Using the intermessage reference analysis, we can identify 77 clusters in the 218 April-May messages, ranging from singleton clusters (those messages that aren't referenced by another message) to the 25-message cluster shown in Figure 8.3. Table 8.4 shows the distribution of sizes of clusters.

Table 8.4 Distribution of Message Cluster Sizes in April-May 1986 Messages

Size of Cluster	Number of Clusters This Size
1	57
2	6
3	3
4	1
5	2
6	1
7	2
10	1
14	1
16	1
17	1
24	1
25	1

Looking at a number of these message maps, it becomes apparent that some messages trigger off a large set of other messages (as at least partially measured by the intermessage reference analysis), while others have little or no impact. What determines whether a message is "influential" or not in an electronic mail interaction? Before we can address this question, we need some sort of measure of "influence." The simplest measure would be the number of direct references. This is the measure implicit in Table 8.2 —the most influential message with this metric would be the one that was referenced five times. However, a message often sets off a long sequence of other messages, not all of which directly reference the initial message. For example, in Figure 8.3, one "root" message of the "U.S.-Libya mess" cluster is directly referenced 5 times, and the other only 8 times, even though they are the root of a cluster of 25 messages. To better measure this cascade effect, we developed an "influence" measure that is the sum of all messages that reference a message, either directly or indirectly (by referencing a message that references the original message, etc.). An even more sophisticated measure would count these indirect measures but would dilute their impact in proportion to their indirectness. For our purposes, a simple sum has been sufficient.

The Intermessage Reference Analysis described here can be criticized for largely ignoring the content of the messages, focusing instead almost entirely on the relatively superficial repeated references. However, language typically has sufficient redundancy that one measure of connectivity is highly correlated to other measures. So, even though we admit that there is more to the structuring of message interactions than references between messages, we also claim that analyzing these references is a good initial approach to sketching out the interactional patterns.

As a start, the Intermessage Reference can serve as a way to identify clusters of messages that we can then analyze more deeply with other techniques. For example, Waugh, Miyake, Levin, and Cohen (1988) use it as an initial step for the Semantic Trace Analysis that Miyake developed. In this chapter, we will use it as a first step in an alternative semantic analysis, which we call a "message act analysis."

MESSAGE ACT ANALYSIS

Individual utterances have been analyzed by philosophers of language, linguists, psychologists, and others according to the "speech acts" that they perform (Austin 1962; Searle 1969; d'Andrade and Wish 1985). In oversimplified terms, a speech act is the function that an utterance is to accomplish. We have carried out an analogous analysis of messages, aimed at identifying the functions that each message is to accomplish. We call this analysis a "message act analysis." While we have not completed a general message act analysis, we can report here a more specific message act analysis, one focused on instructional functions.

Mehan (1978) developed a partial classification of instructional speech acts in documenting a common classroom interactional pattern that he calls "IRE sequences." These sequences consist of an initiation act by the teacher, a reply by a student, and then an evaluation by the teacher. Here is an example that Mehan (1978) gives of this pattern:

Initiation by teacher:	Uh, Prenda, ah, let's see if we can find, here's your name. Where were you born, Prenda?
Reply by student:	San Diego.
Evaluation by teacher:	You were born in San Diego, all right.
Initiation by teacher:	Um, can you come up and find San Diego on the map?
Reply by student:	(goes to board and points)
Evaluation by teacher:	Right there, okay.
Initiation by teacher:	Now, where, where did, where was your mother born, where did your mother come from?
Reply by student:	Oh, Arkansas.
Evaluation by teacher:	Okay.

This pattern is very common. In fact, Mehan (1978) found that "This sequence was the predominant form of teacher-student interaction, comprising 53 percent of the total in the nine lessons that Mehan and his associates analyzed," pp. 41-2.

We analyzed the messages in our corpus, classifying them according to whether they initiated a new topic, replied to a previous message, or evaluated a previous message. Figure 8.4 shows the IRE pattern for a cluster of messages.

Note that the conventional IRE sequence is largely missing. Instead, there are much more complex patterns of initiation, reply, and evaluation in this interaction. While the patterns are complex, there seem to be two common patterns among the messages we've analyzed. One is a "star" pattern, as shown in Figure 8.5 below.

In this pattern, the replies are largely to some one initiation. A second pattern is more linear in structure, with a chain of replies. This is much more similar to the kinds of discussion "threads" found in other electronic interactions (for example, Quinn et al. 1983). Figure 8.6 shows this "thread" pattern.

We did find a few instances of the IRE sequences that Mehan found to be so common in face-to-face instruction, but they were rare and usually embedded in a more complex pattern. For

Figure 8.4 An "IRE" Cluster of Messages

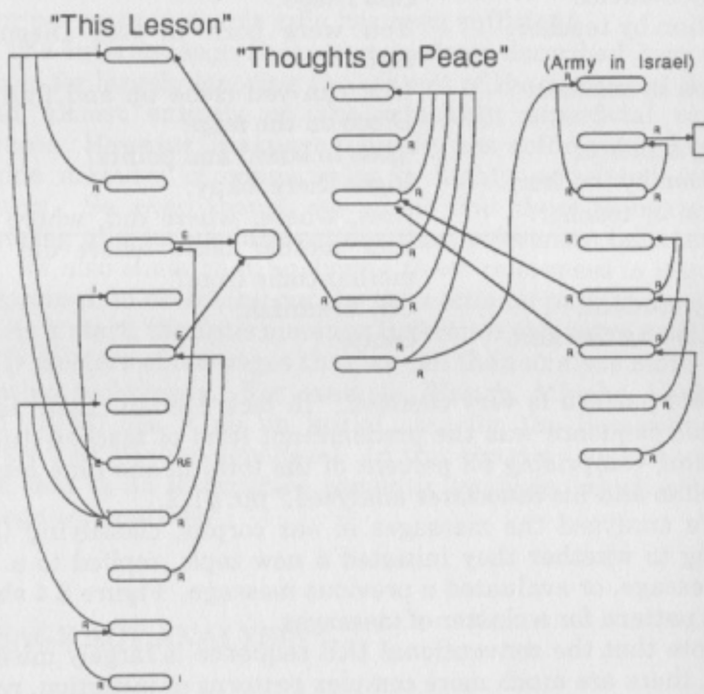


Figure 8.5 A "Star" IRE Cluster

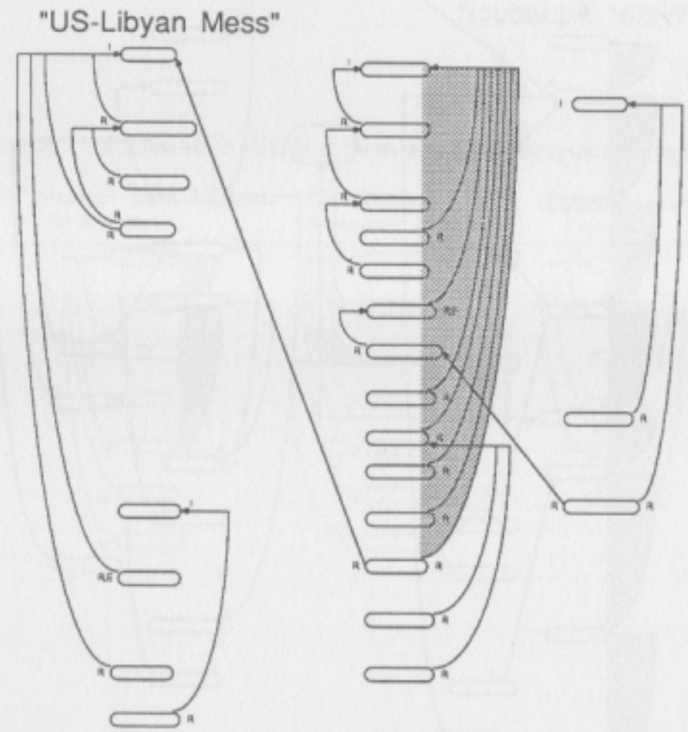


Figure 8.6 A "Thread" IRE Cluster

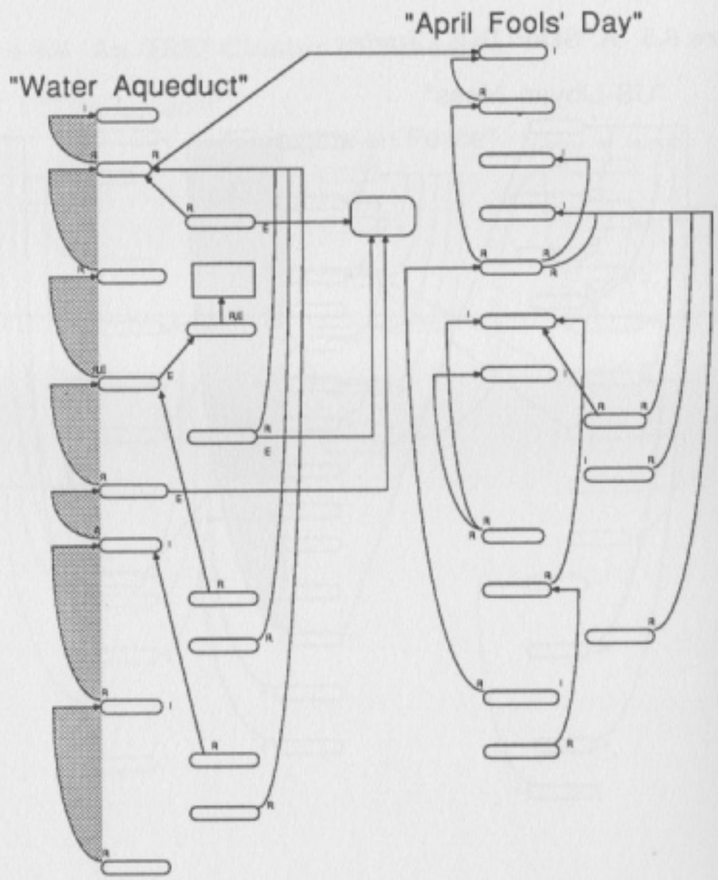
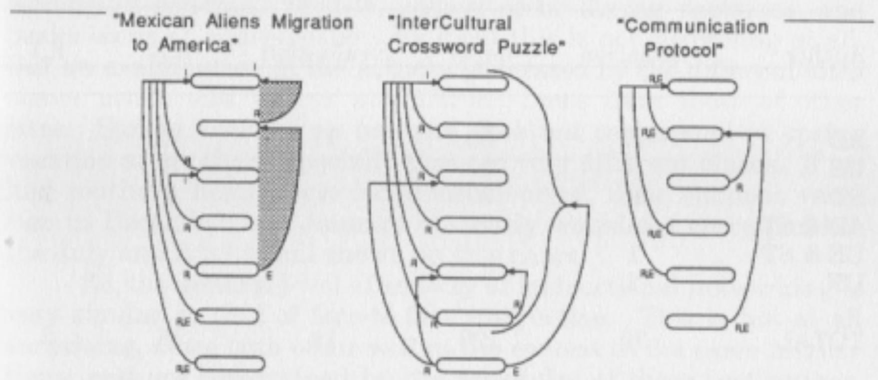


Figure 8.7 A Cluster With a Simple IRE Sequence as Part



example, Figure 8.7 shows one of these "pure" IRE sequences, as part of a larger, more complex cluster.

In the Mehan analysis, almost all initiations and evaluations were by the teacher, and almost all replies were by the students. Table 8.5 shows who made the initiations, replies, and evaluations in the network interactions analyzed here. While a majority of the evaluations (71%) were made by the adults, there were a substantial number by students. Less than half (39%) of the initiations were made by adults.

Table 8.5 The Distribution of Initiations, Replies and Evaluations Across Groups

Author	Initiation	Reply	Evaluation	R,E	R,I
AD	27	63	17	10	
US	14	20	1	3	
ST	20	20	1	5	2
AD & ST	6	6			
US & ST	1				
UK	2				
TOTAL	70	109	19	18	2

Key: AD = Adults (site coordinators, graduate students, teachers)
US = Undergraduate student
ST = Precollege student
UK = Unknown author
XX & XX = Joint authorship

One of the main conclusions that we can draw from this "message act analysis" is that there are substantial differences between face-to-face instruction and instruction conducted using electronic networks. However, there are also important similarities. Our next analysis points out some of these.

MESSAGE FLOW ANALYSIS

One of the simpler kinds of analyses to perform on a set of messages is to plot the density of messages per unit time, and follow that across time. Anyone who has participated in electronic message interactions has certainly experienced the feeling that there is an ebb and flow in messages. We have plotted the flow of all the messages in the ICLN across a full year (March 31, 1986-March 31, 1987). Figure 8.8 shows the plot of the number of messages per week.

The top line shows the total number of messages, and the lower lines chart the flow of messages sent by several of the most active sites (San Diego, Illinois, Tokyo, Jerusalem). The most notable thing to learn from this view of message activity is how the ebb and flow of messages corresponds to the ebb and flow of school activity in general. That is, valleys occur during vacations, and peaks occur at midsemester. By itself this is not surprising at all. But an examination in the activity generated by the different sites shows peaks and valleys at different times from those of other sites. Spring vacation in one site does not correspond to spring vacation at another, especially those in very different places. If we had southern hemisphere locations involved, their summer vacation in December and January obviously would not correspond to the July and August lull shown on this chart.

So, the general level of activity of instructional networking is very similar to that of face-to-face instruction. This is not at all surprising, since both occur within the context of the same institutions, and are constrained by the schedules of those institutions. Yet it is important to keep this fact in mind when organizing network instructional activities. If you don't, you end up assuming that everyone else on the network has the same schedule that you do, and then fail to understand a lack of response.

Another important point to learn from this global message flow analysis is how long it takes for activity to start at the beginning of each semester. Partly because not all schools start at the same time in the fall and partly because some of the participants needed some training to be able to participate fully, the ramp up to fall activity took longer than the ramp up for the spring semester (14 weeks in the fall vs. 6 weeks in the spring).

Using the Intermessage Reference Analysis to identify clusters of messages, we can carry out the Message Flow Analysis on individual messages. Some activities arise and reach a peak of activity over a short period of time, while others start out more slowly. This is shown in Figure 8.9 below.

Figue 8.8 Flow of Messages Across a Year

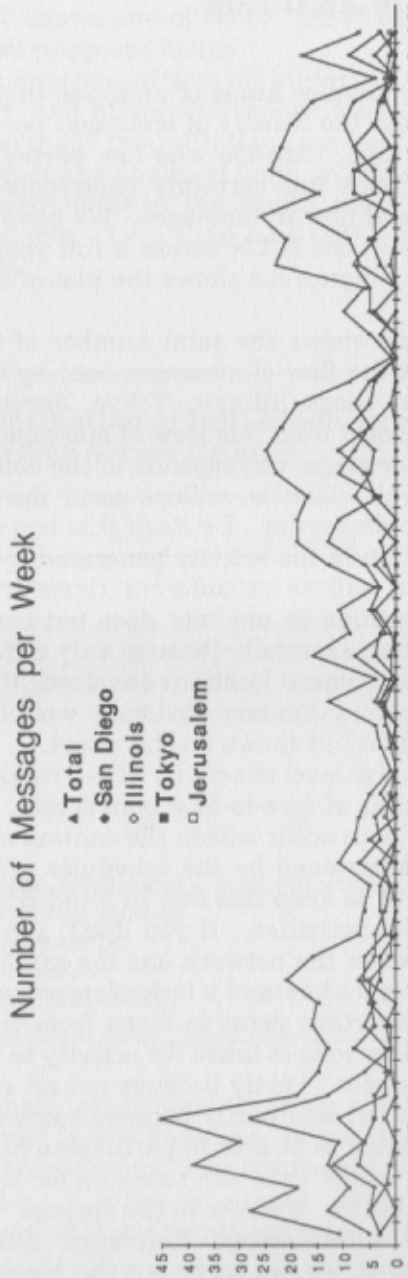
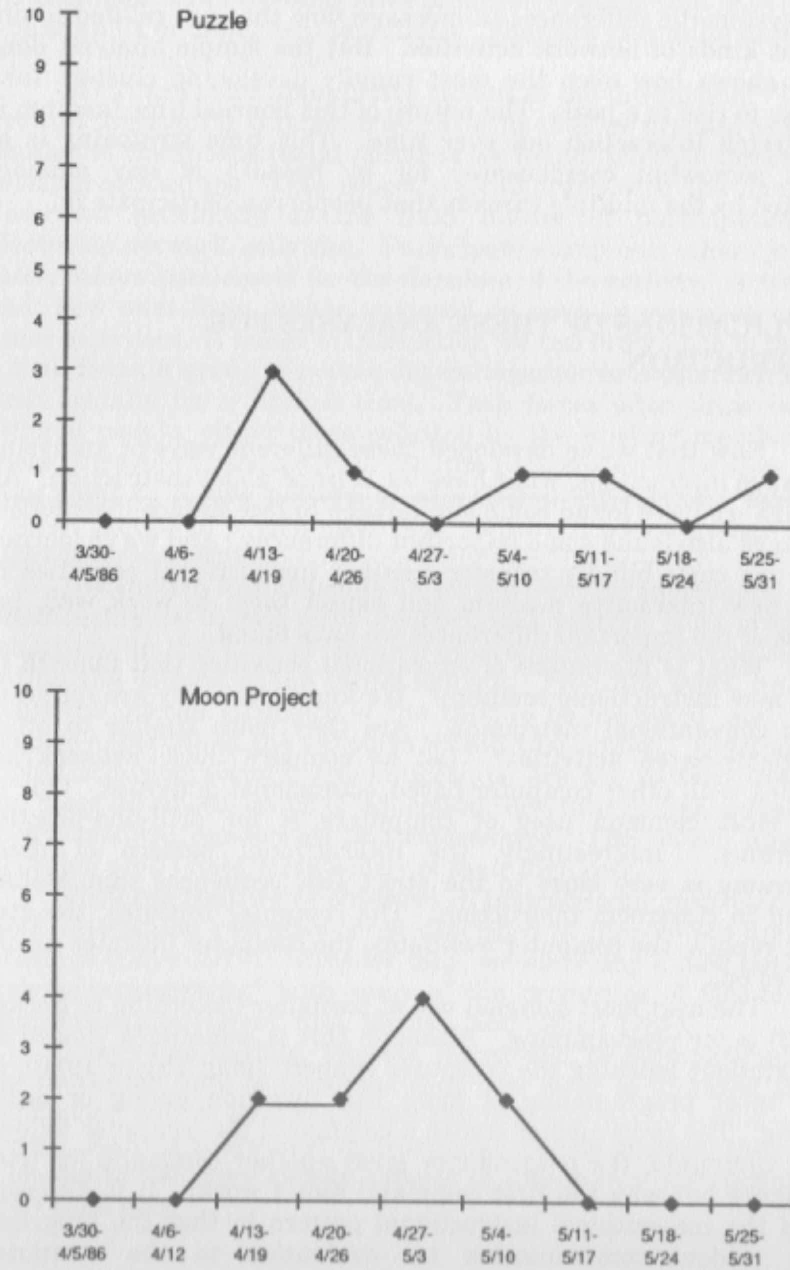


Figure 8.9 Message Flows for Two Clusters



We are currently examining the shapes of these message flow diagrams for different clusters, trying to see whether there are systematic differences in message flow that are related to different kinds of network activities. But the simple analysis done here shows how even the most rapidly developing clusters take weeks to rise to a peak. The nature of this nonreal time medium is to stretch interaction out over time. This time stretching is at least somewhat compensated for by breadth at any moment created by the multiple threads that people can participate in.

IMPLICATIONS OF THESE ANALYSES FOR INSTRUCTION

Now that we've developed these different ways of analyzing message interactions, what have we learned about instruction? Although we have found some similarities to face-to-face instruction, we have also found some important differences. And we've learned that we can't blindly transfer existing instructional activities to this new interactive medium and expect them to work well, because of the important differences we have found.

What is the nature of educational activities that flourish in this new instructional medium? We know that they are different from conventional instruction. Are they more similar to other computer-based activities? Let us compare these network activities with other computer-based educational activities. One of the most common uses of computers is for drill-and-practice programs. Interestingly, the interactional pattern of these programs is very close to the strict IRE sequences that Mehan found in classroom instruction. The computer initiates, the student replies, the computer evaluates, the computer initiates again, and so on.

The next most common use of computer (according to Becker 1986) is for programming. Although this is sometimes viewed as the student teaching the computer (Papert 1980; Taylor 1980), in fact most programming is more like direction giving or order giving. The programmer issues a command, the computer follows that command, the programmer gives another command (or tries to figure out why the first command didn't work). It is different from the conventional instructional pattern in that the programmer seldom communicates an evaluation to the computer (although many programmers issue quite strong evaluations verbally, few computers hear them). The interactional pattern,

however, is quite different from the kinds of patterns we've found through the analyses presented here. Similarly, attempts to develop intelligent tutor systems have produced systems that have more linear kinds of dialogue interactions. They are also quite different from the patterns seen here.

What are more appropriate models of the interaction? There are two functioning interactional patterns that we propose as more similar to the interactional patterns we found: teletask forces and teleapprenticeships. One aspect we can trace with the analyses described previously is the fluid nature of participation in electronic network activities. Participants drop out; others join in later; others participate for the duration of the activity. Activities end; new ones form, either proposed de novo or emerging out of other activities. A model of interaction we can draw upon is that of a task force, a group of people drawn together to accomplish some task, usually for a limited time. Task forces often draw in additional people, either those solicited by the existing members or those attracted to the activity. So, the patterns we have seen here may point to a new pattern of educational interaction, "teletask forces," groups of people of diverse abilities drawn together for a short-term interaction.

Instruction also depends on longer-term arrangements. Apprenticeship is a long-term instructional pattern that predates schooling. In this kind of learning environment, instruction occurs within the context of the target domain. From the start, novices learn the overall structure of the task to be mastered, and then acquire expertise in the subparts within this context. Even in our highly schooled society, apprenticeships are the pattern used at the most advanced levels of education: law internships, advanced study, medical residencies and internships. The reason apprenticeships aren't used more widely is their high cost.

Patterns that we've observed in instructional electronic network interaction resemble those described in face-to-face apprenticeships (Lave 1977). Thus we may see emerging a new pattern, "teleapprenticeships," with some of the properties of face-to-face apprenticeships (Levin, Riel, Miyake, and Cohen 1987).

These two models, teletask forces and teleapprenticeships, are presented here to illustrate that new ways of thinking about instruction will be required to use the new interactive media effectively. And as these new instructional models emerge, they will allow us to see more clearly aspects of face-to-face instruction by their contrasts.

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