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Computer mediated communications and secondary science teachers: Does it work?

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COMPUTER MEDIATED COMMUNICATIONS AND SECONDARY SCIENCE TEACHERS: DOES IT WORK?

by

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of the requirements for the degree of
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Doctoral Committee:

Professor Carl F. Berger, Chair
Professor Loren S. Barritt
Professor Frederick L. Goodman
Professor William B. Stapp (School of Natural Resources)

For Ellie, Kathy and Maia.

Ellie for starting me on the path of enjoying learning.

Kathy for being a fellow traveller along the path.

Maia for taking me back to re-examine the beginning of the path.

ACKNOWLEDGEMENTS

Initial thanks go to Fred Goodman for asking me what I knew about telecommunications when I was looking for work several years ago. Thanks, too, to Carl Berger and Bill Stapp, both of whom encouraged me, and worked with me, to explore the use of computer networks in science classrooms. Thanks to Biff for helping me to tell the story better. Finally, special thanks go to the five teachers who worked with me as collaborators in this study.

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PROLOGUE

This is a story by someone who almost became a "burnt out" teacher. It is about some other teachers who I believe were facing similar feelings - feelings that "there must be something more" to their jobs. Let me explain.

In early 1986, as I began the work that evolved into this study, I was teaching mathematics at Ypsilanti High School, in Ypsilanti, Michigan. Prior to teaching at Ypsi High, I taught Physics, Physical Science and Computers at Key West High School in Key West, Florida for five years. Before that, I spent a year teaching mathematics at Forks High School in Forks, Washington.

In Key West I had enjoyed my job immensely. I felt I had wonderful colleagues, and pretty good students. I was fortunate enough to have a Principal and Superintendent who let me try different activities with the students, and I believe I earned the students respect for the extra time I spent working with them. Most of my professional feelings of accomplishment came from the extra-curricular activities I participated in with my students - the "Physics Olympics", Computer Programming contests, "Mu Alpha Theta" the Mathematics Club, and an annual sailing trip for the physics class on which their final exam was based. These activities all allowed me, as a professional educator, to tailor the activities to my students and local school district objectives, as well as provide interesting and motivating settings for the students - settings that involved their "real world" lives as much as life within the school. All things considered, I felt that I was doing a good job as a teacher, and I was having a lot of fun.

For a variety of reasons, my wife and I moved to Ann Arbor after five years in Key West, and I started teaching at Ypsi High. By February, even though it was only my first year at Ypsi High, I was already bored with the routine. My first class of the day, Consumer Math, was considered a "terminal" math class. The students were enrolled because they needed one more math credit to graduate, and this course provided that credit. Attendance was poor, tardiness high. My other classes - Algebra and Geometry - were more academically oriented, but had large enrollments of low to only moderately motivated students. I spent much of my time with discipline and trying to motivate the students. I was sure I could rekindle the "spark" that kept the job exciting, but when the opportunity to work on an advanced degree surfaced, I knew I was ready for a break.

Through a chance meeting with someone I had known while working on my Master's Degree six years earlier, I began to explore the idea of a Doctorate, focusing in particular on the use of computers in schools.

I had been instrumental in getting computers into Key West High, and was working on a plan to create a lab of Apple IIe's for Ypsi High's math department. I had read a lot of reports on the various ways that computers were being used in schools and, though it seemed clear that computers were highly motivational for the students, it also seemed obvious to me that few people had really *good* uses for them. Most of the uses at the time were attempts to tutorial or drill and practice programs - attempts to do traditional teaching activities by using the new technology. It seemed to me that if the same amount of effort that went into creating the software went into preparing traditional lessons, the effect on the students would be greater. It seemed that this was an inappropriate, and expensive, way of using the technology. I became interested in trying to help teachers learn how computers might be used *appropriately* and *effectively* in the school environment.

In order to be able to afford working on my doctorate, I needed some sort of work at the University. I met with the Dean of the School of Education, Carl Berger, and expressed an interest in organizing a "Physics Olympics" for students in Southeast Michigan, much as I had for the Florida Keys. Carl sent me to see "our man in charge of competitions," Fred Goodman. Fred is anything but "in charge of competitions," but rather, a student of gaming and simulation.

In my first meeting with Fred, I talked about my interest in computers in education. He asked me what I knew about telecommunications, and I told him about the hours some students and I had wasted trying to connect to Compuserve - ultimately unsuccessfully - from Key West. By the time I left his office from that initial meeting, I was in charge of the technical side of the "International Conflict Simulation" (whatever *that* was) and had in my possession a Tandy 200 portable computer with a built in modem.

The premise behind the International Conflict Simulation, ICS, was a large scale, role-playing exercise involving dozens of students who were located at several schools. Each school represented a different political entity involved in the Arab-Israeli conflict. The schools were scattered all around Michigan at the time, and their only form of communication was via computer networks.

Since that fateful day when I met Fred, I have been all over the world working with teachers and students using this technology. My daily communications are likely to involve teachers from Japan, Germany, Italy, Canada and around the United States. I have seen teachers overcome large barriers so that they and their students could continue to participate in ICS activities. I have seen students decide to attend, and subsequently graduate from, The University of Michigan because of their participation in ICS. I have seen undergraduate and other graduate students come to work with ICS and get "stuck" as have I.

My experiences with the teachers and students who have been using this technology over the past seven years have kept me excited about education. I sincerely believe that I was close to loosing that spark that made teaching more than just a job.

This study is an attempt to examine the experiences of five of these teachers. It is not a comprehensive look at the use of computer communications in schools, just a slice that considers five specific teachers involved in three specific exercises. My hope is that it will help others to consider the potential of this technology, and maybe help us to better understand the appropriate ways in which technology might be used in the classroom.

CHAPTER I

INTRODUCTION TO THE STUDY

The purpose of this study is to document the experiences of teachers who have shown renewed vigor in their approach to their professional duties while involved in computer mediated communications based science projects. I will try to determine if there are shared experiences that may have been contributing factors to this apparent change in the teachers' pursuit of their professional responsibilities. This research is important in that: a) It may help us to develop strategies that will keep teachers from losing interest in their students, or leaving the teaching profession, and b) it may help us to understand why teachers are interested in communications based projects - what they see as the benefits and losses associated with these projects.

Computer Communications in Education

There is a "new" technology today pulling a bandwagon that schools and districts seem to be hopping on - telecomputing. The critical need for telecommunications to help us find and use information and communicate with each other is becoming recognized throughout the world. Increasingly, computer mediated communications networks are linking the globe, bringing together people from all cultures. As White (1987) describes it,

> "At a rate and to an extent envisioned only by the most extreme futurists, the world is becoming interconnected by an electronic nervous system over which immense amounts of information flows at nearly the speed of light." (*What Curriculum for the Information Age?*, page 1).

Computer mediated communication is emerging as an educational paradigm that may have the chance to change the nature of the classroom experience. Electronic networks in education have the potential to provide a means for the weaving together of ideas and information from many people, regardless of when and from where they contribute. The educational potential of such computer-mediated activity is enormous. Through computer mediated communications, people can easily contact each other, transfer text and data files, and obtain information from databases regardless of time of day, and geographical and scheduling and coordinating restrictions.

The April 1988 issue of *Technological Horizons in Education Journal* was devoted entirely to Networking and Telecommunications. A brief look at the table of contents shows articles with names such as: *Introducing Teachers to Telecommunications*, or *The Basic Principles of Telecommunications*. Similarly, in March 1991 at the Michigan Association of Computer Users in Learning annual convention there were dozens of sessions where educators from around the state and nation talked about *How We Set Up Our District Bulletin Board* or *Telecommunications: How to Get Past the Hurdles*. The focus of these presentations and articles is on how to set up the computer and equipment and what sort of problems people encounter in doing so. Few people have devoted time and energy into writing or speaking about *what* the networks can do for education, and what elements *need* to be present in activities using this technology.

We are in a quandary similar to one that existed when computers themselves were first introduced: people can see that there is potential, or that there *should* be, but they aren't sure exactly how to realize that potential. A large majority of articles addressing the subject of telecommunications in the classroom deal with the technical aspects of *how* to do it, with very few educators talking about *what* to do, and even fewer addressing the very real issue of *why* should we, if we even *should*, use this technology.

If we agree that one of the major goals of education is to prepare students for their future, then we must acquaint them with the technology they will be using, including telecommunications technology. More and more we will come to depend on computer mediated communications (CMC) to help us manage the complexity of our world. We must prepare our students to be familiar with this technology, to see how this technology can help them, and to inspire them to create new and beneficial uses of the technology. We must also train the teachers who will be working with the students.

Although many leaders encourage the use of CMC and other technology, teachers are not sure about how, when, or even why to use them (Riel, 1989; Lenk, 1991; Wolf, 1990.) This confusion is due primarily to the relative newness of the technology in the educational setting and the subsequently limited amount of information available from practice and research that describes how it can be used in education. Little is known about how teachers actually use telecommunications in their classroom instruction, for professional development activities, or for any other tasks associated with their profession. There are, therefore, few models which teachers and project developers can use to guide them in their efforts to develop effective and appropriate uses of telecommunications in the K-12 school environment.

Theoretical Framework

My intention is to provide a collection of vignettes of the experiences of five teachers involved in three different CMC based projects. This approach is appropriate as I have followed these five teachers through a contemporary set of events and have attempted to illuminate the decisions that were made, how action was implemented, and with what results (Schram, 1971, cited in Yin, 1989).

In this study, I have observed people and events as extensively as possible, attempted to understand the experiences of the participants, and looked critically at the historical and underlying conceptualizations from which those participants have operated. My effort has been to provide interpretations of events from an "insider's" perspective (given my involvement with the participants) and to offer the reader a descriptive account of research conducted in a natural setting.

It is reasonable to wonder if this is an appropriate manner in which to study the effect of computer mediated communications on teachers. Spindler, among others, has observed that educators "are concerned because the tried-and-true methodologies and research designs used most widely in educational research have failed to answer pressing questions" (1982). Thus far, most technology and distance learning studies have focused on changes in students and not on changes in teachers, yet the ways in which teachers approach their responsibilities are integral to understanding any changes that take place in the classroom.

Guba and Lincoln suggest that the following basic principles are found in qualitative research: meaning is socially constructed and context-bound, there is a personal value in the inquiry process and results, and there is necessary and significant inclusion of the inquirer in the inquiry (1988). These principles represent my personal beliefs and my methods reflect them.

I view culture "as a process, recognizing that it is ongoing, elusive, and always being modified" (Wolcott, 1975). It is essential to focus on "educational settings as cultural scenes and on how the individuals directly or indirectly involved in those scenes make sense of and give meaning to what is going on" (Wolcott, 1984). The task of any researcher is to find a lens wide enough to gain a view of the large scale patterns and interrelationships of this process, without losing the focus which gives insight into the "actual dynamics of people's behavior as interpretive, goal-directed, and subject to complex types of influence" (Hansen, 1979)

Ecological Perspective

I have chosen to view the teachers' experiences from an ecological framework, which has been described as:

> the study of the reciprocal influences of socio-cultural organization and the environment, both physical and socio-cultural. Its strength relative to functionalist approaches is that it adds to a functionalist description of how a system works, an analysis of the interrelationships between system and context. This enables a more effective investigation of why the system works as it does. (Hansen, 1979)

"We need to keep in mind the dynamics of educational change as a socio-political process which involves all kinds of individual, classroom, school, local, regional. and national factors at work in interactive ways" (Fullan, 1982). It has been helpful to view the experiences of the teachers in this study as a web of interconnected relationships, where change in one area produces reactions within other areas. Perhaps the visual representation of a Calder mobile most closely captures the way in which the teachers' experiences interrelate, and it is not possible to understand one part of the experience apart from the others.

Goodlad contends,

> Things and sets of things, individuals and groups of people and the relationships among them are seen as one, a unified whole . . . All are part of the same systemic whole or ecosystem. Every person and every thing has consequences for all other persons and things. (1975)

Researcher Bias

The goals of this study were not achieved within a vacuum but were mediated through my personal world view. My assumptions, experiences, and hypotheses have guided the questions I asked, the people I chose to interview, and the way I interpreted each event. Greene suggests strongly that any researcher explicate his/her predispositions so that the readers can "judge for themselves the nature and extent of evaluator bias in the inquiry process and findings" (1990). In this section I will describe my personal experiences and views that have had an impact on this study.

I spent a number of years (1977-1984) teaching secondary school, including mathematics, sciences and computer studies. For almost as many years (1985-1991) I have been working with computer mediated curriculum projects, as well as teaching undergraduate and graduate courses at the

University of Michigan and Boston University in technology in education. I have been an enthusiastic proponent of computer mediated communication used within educational settings to enhance global perspective and teacher collaboration. Based on my personal philosophy of education and experiences, I have come to believe that one goal of education is to encourage the development of active citizens promoting a society of justice and mutual respect.

I have spent the last several years (1985-present) teaching and learning about educational technology. My experiences using technology might bias my interpretation of the events, but, I have a cautious view of the uses of any technology. I have heard computer enthusiasts ask, "What can we do with this equipment now that we have it?" and indeed some computer uses are driven entirely by the hardware. I believe the more appropriate questions are "What are our educational goals, in what ways can technology enhance these goals, and additionally, what are we now able to do educationally using technology that we have not imagined before?" Put another way, "one does not begin with technology in teaching, one utilizes the technology and its capabilities to reinforce the desired curriculum objectives" (McKerlich, 1988)

I am also concerned about economic interests or technological vendors driving educational processes, especially in the delivery of distance education. Many people advocate the use of computer networks and distance education as a cost effective way to deliver traditional instruction in specialized areas to widely dispersed groups - an expensive proposition using traditional staffing and school structures. In my classes and writings I have always encouraged a critique of technological innovations by asking "In what ways does any technology benefit and distinguish us as people?"

Educational innovators, often eager to discover why there is resistance to change, perhaps need to ask themselves why they "are so compulsive about producing change" (Wolcott, 1975).

As a former classroom teacher, I hold the view that knowledge is constructed by learners as they attempt to produce meaning from their experiences. Computer mediated communications in education could become an economical expedient, as evidenced by those who look only to economies of scale, and miss the possibility of transformation in teaching and learning. Traditionally delivered instruction, as well as traditional distance education courses, for example, have essentially predetermined curriculum - the textbook. The control of the curriculum is quite literally situated entirely in the hands of the course designer. Chesterton complained, in the case of traditional distance education curriculum, that the products are "usually inflexible packages to which the students must adapt" (1984). I feel that regular classroom practices fall into this trap too often, too.

Fundamentally, I hold the view that each classroom represents a unique culture in which each individual affects how and what is learned. Groups of learners cannot be researched as corn plants, such that the results are then generalized to all learners. Yet it is important to see how any one classroom or school relates to the larger social system. Computer mediated communications offers a new structure for both affecting and examining these interrelationships.

I have chosen to study teachers in computer mediated communications projects because I have had the experiences and hold the concerns and interests mentioned. I have tried to examine my personal biases and cultural assumptions that have influenced the way I have understood the experiences and comments of the participants in the study.

I welcome insight that readers might offer about biases that they can detect in my account.

Method

I have spent several years working with individuals and groups responsible for a variety of large scale computer mediated communications projects. I have relied extensively on ethnographic tools, for "one does not have to be an ethnographer to avail himself of elements of an ethnographic approach" (Wolcott, 1975). My data sources include obeservations with the five primary informants, informal and semi-structured interviews with the informants, electronic conference, and reflection upon my previous experiences. These techniques were applied in as unobtrusive a manner as possible within natural settings.

Several sources of information were used to assist in describing and examining the teachers' experiences. I participated in the design and administration of the exercises as a colleague with the others involved in creating and exploring the medium. I developed and conducted training sessions for teachers involved in the various projects. I participated as an on-line resource for each of the projects. The informants knew me in this context before I approached them and asked them to participate in my doctoral research. In order to increase my understanding of events I made an effort to include multiple sources and employ multiple techniques of data collection.

Informants

Although I have been out of the classroom for seven years, I remember my disdain for most educational research, especially the research concerned with technology. Apparently many teachers share my former opinion of educational research. Following a review of the research and discussions with teachers, G. Bracey concluded that few educators pay attention to research because it is removed from the realities of the classroom, relies almost exclusively on statistical results, and is usually done to satisfy university publication requirements (1989). D. Hopkins added, "teachers quite rightly regard educational research as something irrelevant to their lives and see little interaction between the world of the educational researcher and the world of the teacher" (1985). There seems to be a paradox here - teachers believe that educational research should be directed towards improving the effectiveness of the educational system, yet most research is written for academic communities. Little attention has been given to the role of practicing teachers' as contributors to research in the changing of education.

It is my belief that teachers reflecting carefully on their use of telecommunications within the classroom would be an effective way to build a body of knowledge useful to themselves, to other teachers and to administrators. This type of effort could tell us a great deal about the uses of technology within the content and process of learning and teaching. Unfortunately, most teachers do not think what they do is real research or that anyone else would be interested in reading it. A small story helps to illustrate this point.

During a recent workshop on telecommunications at a national conference, the discussion turned to the lack of research in this area. A woman in the audience related that she noticed her eight graders eagerly writing, editing their work, and participating in activities as soon as the class began communicating with students in distant locations. She had worked with 13 year olds for 28 years, she told us, and had never before seen such enthusiasm for learning. Then she apologized for giving "just observations" from a teacher, and not having "real research" to report.

Combining these two trends in education, "teachers as researchers" and "educational telecommunications," seems particularly appropriate.

An integral part of this study, therefore, was the collaborative efforts provided by the five informants who served also as co-investigators. These teachers, described in a later chapter, were involved with CMC projects for at least two years prior to this study. In the context of this study and their reflection on their experiences, they worked as a group, both in face-to-face meetings, and in an electronic format, for eight months.

Observations

I have been a participant observer in some situations, and a nonparticipant observer in others; at all times my goal has been to immerse myself in the host culture by being present as well as standing outside it. (Shimahara, 1988). A further requirement has been the development of a "role" for the participant observer (Hansen, 1979). My role was as a resource person for technical questions, as an interested educator with a strong background in computer mediated communications, and as a person who was conducting field research.

I observed several classrooms involved in the various projects. I spent time at the schools where the informants teach, as well as dozens of other classrooms in the projects.

Interviews

I interviewed each of the participants after at least two years of involvement in their respective projects. In addition to my primary informants, other informants include teachers at other schools involved, administrators, curriculum developers at the Technical Education Research Centers (TERC), and other educational researchers interested in computer mediated communications.

Most of my interaction was informal and I encouraged the informants to discuss their experiences with the technology in a variety of ways. I used a tape recorder for all interviews, and then transcribed those sessions.

I used one other method of interview - computer mediated communication. Recently, cases of "electronic participant observer" interviews, which provide a unique method of interaction, have been shown to facilitate significant interactions which might not otherwise occur (Mason and Kaye, 1989; Romiszowski and de Haas, 1989; Schrum, 1989). Respondents in other states and countries were able to contribute to this study in an interactive manner. Without this form of communication, I might not have had access to their insights.

Conference

Following each interview I sent each informant a transcript of his or her interview, along with the initial thoughts I had generated. In late November, 1990, the five informants met each other in a face-to-face meeting in Ann Arbor that lasted for five hours. Prior to this meeting, each participant had had time to review his or her own interview and the thoughts I had send on that interview.

Immediately after the face-to-face meeting, an electronic conference was established for the group to maintain communications. This conference, run on the Confer II software at the University of Michigan, was maintained for the next six months and generated dozens of items of discussion among the participants of the study. Chapter IV of this document describes this conference and the entire text appears in Appendix C.

Documents

Archived documents written and distributed by the participating teachers in their respective projects were retrieved whenever possible. These electronic communications served to suggest and verify the ways in which the teachers used the networks.

Time Line

I spent five years working with and observing teachers in their roles as facilitators in computer mediated communications projects prior to beginning my formal efforts. In the past year (June 1990 through June 1991) my studies have focused primarily upon the participants of this study. I have divided this most recent period of time into three segments which were accomplished in approximately the following manner:

1. From June, 1990 to November 1990, I visited classrooms and conducted interviews with the participants. This represented a set of data used to develop initial ideas for the entire group to discuss.

2. During the second segment, November 1990 through May 1991, the group of five informants and I critiqued and evaluated the concepts emerging from the initial analysis. This began with the face-to-face meeting, and continued with the electronic conference.

3. The last stage of this process has been the final writing and preparation of this manuscript. However, during this time I maintained contact with those involved and continued to use their comments and insights as a basis for analysis.

Significance

There is a noted absence of descriptions of what has happened to the teachers involved in the various projects, or even how the teachers think about and use the technology. In six years of work with teachers in a variety of CMC projects, I can't say that I've ever heard teachers say anything that implies they have thought about how information flows within the network. The practice of describing a project by the flow of information may be completely worthless in the eyes of the teachers who are involved. On the other hand, teachers *may* use the concept of information flow as a primary element in their musing about CMC.

One phenomenon that surfaces over and over is the excitement that teachers express for the projects. Teachers show intellectual stimulation when introduced to the concepts associated with computer mediated communications. They start asking if they can "do this" or "do that," and often generate ideas for their own projects. My specific interest in the context of this study, is that group of teachers who have demonstrated a keen level of interest in this use of the technology in their profession. In particular, those teachers who have shown, through involvement in a telecommunications based project, a renewed interest and stimulation towards their teaching responsibilities.

Limitations of this Study

This study does not offer generalizations applicable to other computer mediated communications exercises and the teachers involved. The three projects studied - TERC's Star Schools Project, The Interactive Rouge River Water Monitoring Project, and the Environmental Decisions Simulation, are all situational. However, there may be commonalties with other projects, and this study may serve to inform them about the nature of the effects on the teachers and the ways in which these particular participants make meaning out of what has and has not occurred.

The group of people involved in this study represent a culturally, socially and ethnically homogeneous group, and as such, are not representative of society in general. The technology that is used may further limit the types of teachers involved.

Ethical Considerations

The participants interviewed and documents collected in this study were essentially public in nature. Anonymity was extended to all informants. I informed each person and group of the reasons and purpose behind my research. At no point in this field work did I intentionally misrepresent myself, or in any way compromise a participant. The primary informants have been offered an opportunity to read their quotes within the manuscript prior to publication so that any serious contextual problems or misunderstandings can be corrected. The conceptual explanations and conclusions, however, are mine alone.

Unfolding of the Story

I have divided this study into six sections to facilitate the understanding of the story. I begin in Chapter II with a description of each of the three projects represented in the study. Within the context of the curricular projects, I introduce each of the five informants of the study and review some of their experiences. Chapter III contains my analysis of the data, including the themes that have emerged. Chapter IV relates these findings to the electronic conference established for this study. Chapter V presents a discussion of existing computer communications projects, the research others have conducted on these projects and relates these others' findings to those of this study.

Finally, Chapter VI interprets and reflects upon the findings, discusses the original questions, and informs the understanding of the outcomes. I have also made suggestions for similar projects and further research.

CHAPTER II

THE PROJECTS AND THE TEACHERS

The teachers in this study were participants in one of three large scale computer mediated communications projects (CMC). These three projects are not typical of the most common telecommunications based activities that are publicized in the United States (for a discussion on the historical development of computer mediated communications projects in education to the present, see Appendix A.) These projects were unique in that they all provided a highly structured set of tasks, involved subject area specialists in addition to the students themselves, and had extensive support structures. Each of the three projects had some affiliation with the University of Michigan's School of Education, though not all were designed there. This chapter includes a description of each of these three projects: the Rouge River Project, the Environmental Decisions Simulation, and TERC's Star Schools Project.

These three curricular projects linked dozens, even hundreds, of teachers and their students for a period of time. For the purposes of this study - to generate a broad understanding of how teachers use networks professionally - I selected five teachers from southeast Michigan who represent a variety of backgrounds and school settings.

In addition to descriptions of the projects, this chapter contains several vignettes that will introduce you to the teachers and their work places that I used for this study. An analysis of the common issues and experiences will be presented in subsequent chapters.

Interactive Rouge River Water Quality Program

William Stapp and Mark Mitchell first published their "Field Manual for Water Quality Monitoring," in 1987. This handbook described how middle and high school students could conduct a series of nine tests developed by the National Sanitation Foundation used to determine water quality in rivers. Stapp and Mitchell developed and tested the curriculum with three schools in Ann Arbor, Dexter and Bellevue, Michigan. Since the three schools they were working with initially were all on the Huron River, the results of the tests were used for comparative studies by the students.

At the same time that the Field Manual was published, I was enrolled in a course on the Global Environment, taught by Dr. Stapp. When I saw the new field manual, I realized that this was an application that could benefit from the integration of computer mediated communications among the schools. As a term paper for the class, I developed a proposal describing a computer network linking high schools within the same watershed, as well as linking various watersheds together. The purpose of the network would be to facilitate the students learning about how to run the tests, exchanging the data the tests generated, and discussing how to address the issues raised as a result of the students' work.

The Friends of the Rouge, a local not-for-profit advocacy group - decided to sponsor Stapp and Mitchell at the University of Michigan's School of Natural Resources in a project similar to that developed in the term paper that would connect schools in the Rouge River watershed - an important watershed which covers most of the Metro-Detroit area. The work that Stapp and Mitchell began with this Rouge River project has stimulated enough interest and spin-offs that the School of Natural Resources subsequently created the Global River Environmental Education Network (GREEN) connecting similar projects around the world.

The purpose of the Rouge River project was to develop a citizenry in the Rouge River basin aware and concerned and able to take appropriate action about the condition of the river. After involvement in the project, it was hoped that students would be able to understand the significance of water quality parameters to overall water quality. They would be able to integrate socio-political factors into their understanding of water quality, and would have acquired the skills and the self-esteem necessary for effective participation in their communities (Mitchell and Stapp, 1990).

Each year, students and educators from the University of Michigan's School of Natural Resources worked with the Friends of the Rouge to plan a two week intensive effort in the schools that coincided with the annual Rouge Rescue river cleanup in late May or early June. This team of resource people worked to develop the skills they would need to help the teachers during the program, as well as plan the logistics leading to the project.

A teacher planning session was held in February to allow the teachers to meet each other as well as the University personnel involved in the program. This session not only served to initiate communications, but also provided a general overview of the project, as well as a source of feedback from the teachers. Based on the input from the teachers, plans were made for a full day teacher and student training workshop. After the first planning session, the computer network was opened. Teachers used the network to discuss subject matter and curricular issues among themselves, as well as maintaining a communications link with the University as a way of participating in the continued planning of the project. This planning and communication area for the teachers and university personnel remained available through the end of the project.

In May, a one-day workshop was held at one of the high schools. The participating teachers, as well as two or three students, were invited from each school. The goals of this workshop were to introduce the teachers and students to the watershed and the central issues, to learn the water monitoring tests, to meet the University students who would be acting as resource people, to distribute copies of the manual and handouts for personalized training, and to learn how to gain access to and navigate within the computer network. This workshop was structured so that teachers worked with other teachers, and students worked with other students to facilitate the development of a collaborative community.

The final weeks before the program started were used for last minute details. Equipment was checked and distributed to those schools that needed it. Wall maps were distributed. Teachers were provided with pre-workshop activities to use with their students prior to the program. University resource people made contact with their host teachers, and ensured that each school was properly connected to the computer network.

When the in-class part of the project began, all schools involved followed the same curriculum for a two week period. The curriculum lead them through an introduction to the watershed, how to run the tests, how to collect and analyze the data, and how to share the results.

Day One:

The first day was an orientation for the students. Students generally viewed a short slide show that introduced water quality issues and the Rouge River. An overview of the 15-day program was covered, and some schools connected with the computer network to initiate discussions, questions and concerns.

Days Two and Three:

Students learned to accurately conduct the water quality tests - including sampling and safety precautions - in the second and third day of the program . Teachers usually structured their classes so that individual students would be responsible for conducting one or two tests, but generally the students were introduced to all nine tests. Resource people from the School of Natural Resources helped explain how the run the tests, as well as the significance of the individual tests to aquatic life and water quality.

Day Four:

Students at each school traveled to their monitoring sites in a coordinated effort to test all parts of the river on the same day. Samples were collected and tests conducted to measure temperature, fecal coliform, pH, nitrate, dissolved oxygen, total solids, phosphorus, biochemical oxygen demand, and turbidity.

Day Five:

The fifth day of the program was devoted to evaluating the raw data. Students performed calculations on their measurements to generate standardized values that allow for the various parameters to be compared.

These standardized values are weighted and combined into the overall Water Quality Index. Once the calculations are made and checked, the results were posted on the computer network.

Days Six and Seven:

Days six and seven were focused on a comparative analysis of all the data collected by all of the schools. The results from each site were posted on the computer network, and received by all schools. Many schools used some form of graphing program - Microsoft Works, Cricket Graph, or Beagle Bros. Graphing Module - to graphically interpret the data. The computer conference facilitated the discussion of discrepancies from location to location that may have appeared in the results.

Days Eight, Nine and Ten:

A brainstorming session was facilitated by the resource people on the eight day. Each class usually came to agreement on a specific water quality problem that had emerged through analysis of their data.

Efforts to find a solution to the identified problem were assisted by developing research skills. A variety of resources were used to acquire needed information, including libraries, parents, phone calls, and extensive use of the computer network among the schools. A typical task may have been identifying the owners of a specific piece of real estate where a given problem had been identified, such as erosion, or leaking raw sewage.

Classes followed the sequence of: identifying a problem, specifying a desired solution, listing the needed resources, individuals and possible obstructions, and finally developing a plan of action for individuals, schools or community groups towards implementing their solution. These plans of action, as well as the associated research was then organized in preparation for a student congress on day eleven.

Day Eleven:

Students, teachers, resource people, administrators and others gathered at one of the schools for a Student Congress on the second weekend of the project. At the congress, students shared their research, discussed the water quality problems they had identified in their communities, and generated recommendations for solving these problems.

Sessions were offered to help develop the skills needed to act on their understandings and commitments. Workshops were offered in radio/public service announcements, video production, editorial writing, public hearings, artwork, letter writing campaigns, and street theater.

For many classes, the student congress marked the end of the project. Many teachers did, however, spend more time in class to allow the students to follow through on their planned action to achieve their goals.

Computer Communications and the Rouge River Project

The computer network was open to teachers throughout the duration of the project each year. Teachers were encouraged to sign-on and participate in the on-line discussion as quickly as possible after the initial meeting in February. Between the February start through the beginning of the two week curriculum, the network was used primarily for coordinating the logistics for the exercise. During and after the two week curricular period, the network was used primarily for exchanging the results of the tests and follow-up questions that arose from the results.

Access to the network was possible using any micro-computer, although participating schools used only Apple IIe, Apple IIGS, IBM PC's, IBM clones and Macintosh computers - depending on what equipment the school owned. Any communications software would work, and support was provided for several different pieces of software on each type of machine. The network was open 24 hours a day, and the schools were free to connect at their convenience. Some of the teachers, those who owned their own computers, communicated from their homes in the evenings. Access was available in all cases via telephones lines and a local telephone call.

Communications were moderated by software at The University of Michigan called *Confer II*®, developed by Advertel Communication Systems, Inc. Confer provided for two forms of written communication among a group of participants: Public Items, and Private Messages. A special forum, or conference, was established specifically for the participants in each year's Rouge River project.

Items allowed for a written discussion by all schools in the conference. Any school could initiate an item at any time. When shown an item, schools were always given the option to respond by adding their own comments to the discussion. Item 55, which was initiated by students from Martin Luther King High School in Detroit, shows this Item-Response structure.

```
Item 55    14:14 May09/88    4 lines    3 responses
Martin Luther King
MAKE A DIFFERENCE

ARE YOU PARTICIPATING IN THIS PROJECT FOR JUST A GRADE, OR DO YOU REALLY
WANT TO HELP CHANGE THE CONDITION OF THE ROUGE RIVER?

    3 responses
May09/88 14:27
55:1) Wayne Mem. Hs: I AM DOING THIS BECAUSE I GREW UP BY THE ROUGE AND I
  FEEL THAT IT IS A SHAME THAT PEOPLE LET IT GET SO BAD.  BRIAN
- - - - -
May09/88 14:31
55:2) Western High School: I am participating in this because I do want to
  make a difference.
- - - - -
May10/88 08:34
55:3) Osborn High School: WE ARE DOING THIS PROJECT BECAUSE ....
```

The other main use for public Items in the project was to share the results of the tests. A special command was created that would prompt for the various data and the results given were formatted and displayed as shown in this Item 3:

```
Item 3    12:28 Apr01/88    4 lines   115 responses
Clancy Wolf
DATA from 1988 Sampling

this item will be used to collect the data from your
testing. To REPORT your data, have the information at
hand, and then type REPORT. Please don't respond to
this item other than with the data.

  115 responses
Apr18/88 13:34
3:1) Melvindale High School:
  Location:  MELVINDALE ICE ARENA
  Date: 05/05/88
  Time: 9:00
  Weather: COOL AND OVERCAST
                                                 Q-Value
  1. Dissolved Oxygen: 92  %Sat                    94.5
  2. Fecal Coliform: 8500  colonies/100 ml         11
  3. pH: 8     units                               85
  4. B.O.D.: 5     p.p.m.                          56
  5. Temperature: -2    C change                   90
  6. Total Phosphorous: .16  mg/l                  97
  7. Nitrates: .54  mg/l                           98
  8. Turbidity:         feet                       73
  9. Total Solids: 83.4 mg/l                       86
   Overall Water Quality Index:      73.7
```

In addition to public discussion, participants in the Rouge River project had the capability to send private messages directly to another participant or school. Due to the cooperative nature of the project, private communications were not encouraged.

Jim

Jim has had his students working on the Rouge River in Southfield for the past 20 years - long before the development of the School of Natural Resource's Rouge River project. He was one of the first teachers to become involved when the school began recruitment efforts. Jim claims his involvement in the project is mainly because it's an opportunity for the kids to do something different and feel important. "And," he said, "*The University of Michigan* is doing this - it gives us a real prestige kick. It's fun to watch the kids, and it's fun to watch the other teachers. It doesn't hurt my career here, either. When the administration is looking around and I'm doing something and the guy next door isn't, you get some positive feedback from the administration." To drive this point home, Jim walked me down to the Principal's office to introduce me to the Principal.

Jim was teaching science at a high school in Southfield, Michigan where he had been teaching mostly biology for the last twenty years. His students had been identified as "at-risk" and were part of a special program to address their needs. Jim worked with six other teachers who shared the same group of 60 students throughout the day. Jim expressed pride in working with these kids - students he believes the traditional educational setting has failed. Jim claimed that the main reason his students haven't performed better is that they had never been asked to do so. Consequently, Jim and his team teachers had great expectations for their students.

A few minutes before the class began two students arrived to hook up the computer and get the new information that had been posted since their last session. The computer was rolled out of the attached office/storage room and plugged in. The modem was hooked up to a wire that ran to a neatly drilled hole in the wall. "I was promised a phone line in here last year," Jim explained, "but I haven't seen it yet. The room next door is a counselor's office, and the counselor is only here one day a week. I asked if we could share the phone line and he said sure. One weekend I drilled a hole through the wall, and now we are all set. I thought the principal was going to raise hell, but he sort of winked when he heard and hasn't said anything since. I doubt I'll get my own line now..."

The students turned on the computer and loaded the software. While Jim and I continued to chat, the students established a connection with the network, recorded all of the "new" information, closed the connection, and printed a copy of the news. They were just about done cutting the printout into individual communications when the rest of the class started arriving.

As the other students started taking their seats, the computer operators handed the communications to the proper recipients. One of the messages was brought to Jim and he was told, "Here's one for you, teach." Jim handed it to me as he started to take attendance. The message was a note from another teacher thanking Jim for posting an announcement about a series of articles that was appearing in the local newspaper.

As things were settling down, I glanced around the classroom. On one wall was a bulletin board with photographs of each of his students. Every one of the students was smiling and sitting upright in their photo.

"They don't like looking like that," Jim had explained. "The *cool* look is to be a solid stud and slouch. We had to carefully select the background color because of the skin colors - this blue seems to work best. They grumble about it, but they *will* bring other kids in to see their picture. I've had parents say they haven't seen their kid look so good in years. It's another way of helping the kids to feel that their life is valuable."

On the chalkboard there were some mathematics where someone had been calculating the standard deviation of a set of values. I asked Jim later who had done the calculations, and he said it was his remedial students. "Other teachers said 'How can they do that if they can't even *spell* standard deviation?' Much of the time the kids can't do something is because they've been *told* they can't do it. With the Rouge River project, the students work with the college kids and think this is college material. My discipline problems go down. My enthusiasm, my children's enthusiasm, goes up. When we finish, they're more willing to read on some other subject that we can relate back this work."

I chose to visit Jim's class during one of the days when University students were present to act as resource people in evaluating the results of the tests they had all run the previous week. Jim's students were working in three groups, each with a different University resource person. Jim moved from group to group, and often walked over to make some comment to me. As we are talking, Jim kept looking nervously at the University students who were working with the groups of his students. I asked him if he was concerned that something would happen. He replied,

> "Not really, I'm incredibly protective of my kids. It's very difficult for me to let the University students come in and take my kids. That's tough, but I think I've been pretty good about it. The kids see that there is someone else out there that doesn't know them at all, yet will come in and work with them - letting them know that they are capable human beings. I work with kids who have been classified as juvenile delinquents. They've been told their entire lives that they are schmucks. Now, someone from U of M comes in and says, 'Come on young man, let's work.' This is heaven."

Throughout the hour, a couple of questions were raised that could not be answered by the resource people. When that happened, the students went over to one of the computers and using the word processor, wrote a paragraph or two explaining the question and asking for help. The same floppy diskette was passed from machine to machine and used to save all of the outgoing questions.

When the class was over, I asked Jim how the files would be sent to the network. "During this two week period things get pretty active on the network," he explained, "so I try to get some students to do the computer work. A couple of the kids will come back later in the day and do the uploading. Usually, though, I try to sign on and send them myself. It gives me a chance during my planning hour to relax and catch up on what's happening at the other schools. It's sort of like going to the teachers' lounge because I can leave or get messages from the other teachers, like the one in that message today about the *Free Press* articles."

Environmental Decisions Simulation

In the fall of 1988, the same term paper that introduced the concept of connecting the Rouge River schools by an electronic network was rewritten as a grant proposal with the help of Carl Berger at the University of Michigan's School of Education. This proposal was submitted to, and funded by, the U. S. Department of Education under legislation to develop new forms of teacher in-service training.

A major difference between the Rouge River project and the Department of Education project was the inclusion of a character-playing simulation in the latter. The simulation, primarily a written communications activity, had students at the various schools using the information they had gathered to address associated social issues. When the funds supporting the Department of Education project ended, the simulation part of the project was offered as an activity by Interactive Communications and Simulations (ICS) - a small group of people working at the University of Michigan's School of Education. ICS offered the character-playing simulation as the *Environmental Decisions Simulation* for three years while encouraging schools interested in the water quality tests to become involved with the School of Natural Resources GREEN network.

The Environmental Decisions Simulation was an exercise both in environmental studies and group decision-making. Students character-played 40 prominent citizens of the world community, drawn from a broad variety of backgrounds and historical periods. According to the simulation's scenario, these individuals had been asked by the World Bank to examine the environmental impact of a huge dam that the government of Zaire proposed to build on the Congo river. They were organized into eight five-person Delegations, each of which represented a particular orientation towards environmental matters. Each of these delegations was portrayed by a group of students located in a particular school.

The 40 Delegates were organized into five Standards Committees, each having representatives from every delegation or school. These Committees were to concern themselves with different areas of possible environmental impact: water, society and culture, agriculture and fisheries, forests, and development. The Committees were to examine the potential positive and negative impacts - social, environmental and economic - of the dam on their particular area of concern, as well as ways in which such impact might be ameliorated. They were also to consider possible alternatives to the proposed project and their possible impacts.

The use delegations and committees ensured that each character, meaning student or group of students playing that character, had reason to communicate with others both within their own class, and in other schools. Any action taken as a member of a delegation required communications with others within the school. Any action taken within a committee necessitated communicating with students in a majority of the other schools in the network.

The three-month-long exercise challenged participants to explore a large range of environmental issues, as well as to consider the consequences of the decisions that they recommend. Participants were involved in decision-making both within the Committees and as members of the entire group. Committees submitted proposals for dealing with their specific areas of environmental concern to the entire body of delegates.

Mentor Group and Team Facilitators

ICS exercises were supported by a Mentor Group based at The University of Michigan and by individual team facilitators located in each participating school. The Mentor Group was composed of university faculty and both graduate and undergraduate students. It organized, administered and "trouble-shot" the exercises, facilitated and stimulated the broadest possible levels of participation, and controlled appropriate degrees of reality and accuracy by providing background information and help to the students to interpret their character-roles. The classroom teachers, consequently, were freed from being either computer experts or highly trained specialists in the subject matter under discussion. The role of the mentor staff allowed the teachers to concentrate on stimulating careful, creative thinking and communications among the students.

The 16 week exercise was divided into three phases, each with a specific set of tasks for the participating students and teachers.

Phase One:

The first phase of the exercise was a three week preparation period. During this time, the students and teachers mastered the substantive and technical aspects of the activity. Within an individual school, the roles were assigned and students began to research the beliefs of their characters. As they learned about their own characters, the students began to develop an agenda that met the needs of their assignments as well as those of the other characters in their delegation. Each student was assigned a few tasks that gradually required more and more knowledge of the simulation structure as well as the operation of the technology.

Phase Two:

The second phase of the exercise ran for seven weeks and had very few specific tasks assigned to the students. The only charge the students had was to pursue the goals of their individual character and their school's delegation as they saw fit. They tried to achieve these goals through private and public communications with other characters in other schools via the computer network. In addition, the students were engaged in discussion and debate within their respective class settings on a face-to-face basis.

For example, one of the characters was a native to Zaire who's family lands would be flooded by the proposed dam. Not only would the dam force the family to move, but it would also mean loosing much of the family history and many of the family relics which were tied to the specific region. A major goal of this character would be to ensure that as much of the family's heritage could be preserved as possible - preferably by not building the dam. Given that the dam *was* to be built, however, this character could raise options for relocating more than just the people, such as moving temples as Egypt did when building the Aswan High Dam.

A task for the second phase of the activity was for the members of each Standing Committee to recommend the most desirable alternatives from their character's point of view.

Phase Three:

Phase Three was the debriefing period of the ICS exercise and was a time for reflection. This final part of the exercise ran for four weeks. In this phase, the students each attempted to express what their perception of the exercise was - what took place in the simulation, what progress they achieved, what assistance had been received, what problems they had encountered, and so forth. The mentors from the university facilitated this activity by posing a few specific questions for each participant to address.

Finally, the debriefing was when the students stepped out of character and introduced themselves to others in the project, stating who they really were, where they lived and their own thoughts on the proposed dam. This final aspect gave them a chance to publicly discuss any difficulties they had encountered in reconciling their personal beliefs with those of their character.

Computer Communications and the ICS Project

Communications in the ICS Environmental Decisions Simulation were similar to those in the Rouge River project as the same host system, Confer, was used. Schools were able to use any micro-computer and software they happened to have. As with the Rouge River Project, the students and teachers were encouraged to use public discussion *items* in Confer as much as possible. The advantages of these public items are twofold: 1) a wider range of readers provides for a greater knowledge base for answers, and 2) other participants who may be less willing to ask questions, or even not be aware that they have questions, may benefit from the discussion generated from an item.

The following shows how a public item generated both types of communication:

```
Item 4    23:51 Feb22/90    10 lines    3 responses
Val Nogues & bailes <Okinawa>
Query about Apple, Zenith, and Mac compatibility

Is there some way to change the Names in the introduction?  We'd
like to correct the "Val Nogues & bailes" to be Val Nogues and Rose
Bailes.  Also, I suppose I already know this answer, but here goes.
When you save in ASCII, you can transmit those files only on the
same kind of machine that you typed them into, right?  E.G., if the
kids used an Apple IIGS, I can't upload that ASCII file from my
Zenith.  BUT if the kids use the Apple, can we upload on a MAC? And if
we can't just put the disk in and do it, is there some way using
some sort of software program?  Seems like I read recently about a new
program that will allow linking of non-compatible computers???

   3 responses
Feb23/90 13:31
4:1) Pat Ridge <Stuttgart>: There is a program that Apple distributes called
 APPLE FILE EXCHANGE that allows you to convert files from different
 machines.  I have used it to move Apple Works files from a IIGS and convert
 them into Microsoft Works files on a Mac.  I'm sure it would be as easy with
 ASCII files.  The main thing is having a 3.5" disk drive on the IIGS.  No
 cables needed.  I will send a copy of the APPLE FILE EXCHANGE in
 Monday's mail - hopefully it will arrive quickly!
- - - - -
Mar02/92 21:41
4:2) Val Nogues & Rose Bailes <Okinawa>: THANKS.
 The copy of APPLE FILE EXCHANGE that you're sending is NOT coming by E-mail,
 is it?  You DID mean Monday's (surface - i.e., snail-mail?
- - - - -
Mar03/92 08:41
4:3) Larry Bebensee <Ontario>: Hey, can I get a copy too! I've been having
 the kids wait for the one Mac connected to the modem.  If they could use the
 IIGS's also in the room, it would really help!

RESPOND, FORGET, OR PASS:
```

In addition to public communications, students and teachers in the ICS projects also used private *messages* within Confer. Messages are electronic mail directed to specific individuals. Messages were used in the Environmental Decisions Simulation both by students in negotiating between characters and between teachers when they had comments or questions that they didn't want everyone to view. The following is an example of the format of a message:

```
Message 18       26 lines       08:59:20 Apr27/92
MESSAGE from: Wolf Vilseck                  04:38 Feb27/90 MABM:MF
HEADER: TO CLANCY J. WOLF?
Please advise as to the meaning of the word retire which
used in sending a message to Theodore Roosevelt and Rufus
King.  Does this mean that you did not allow it to be
uploaded by anyone else and the students need to re-
download it using the function you mentioned, or is
it intended to be a help for their future reference.
To take it off seems to be rather facetious, espec-
ially when you have students who are trying to be active
in the simulation, and when many are not even able
to get on.  This is our first time to use a modem
successfully.  Last year, we could never transmit
and finally gave up (to avoid a nervous breakdown
of yours truly).  This is still a high stress situation
for me, us, with very limited access to the modem,
the instructions seem to be spread all through the
notebook, and we are always bumping into some sort
of problem with no answer. There is no one near by
who is experienced in these simulations to give us
aid.  We had to have a new MODEM SET UP installed
at school because in trying to participate last year
it was discovered that the wrong type of lines had
be placed into the school, etc...Anyway, please advise
as to whether these two characters must re-upload
their files to get them viewed by others in their
committee.p.wolf, Vilseck

REPLY, DELETE, OR IGNORE:
```

There were a few significant differences in the structure and the use of the network, however.

A separate conference, the facilitator conference, was established as an administrative forum for communication among the ICS staff and all participating teachers. This facilitator's conference was used not only as a conduit from ICS to the teachers, but also as a site for the teachers to share teaching strategies, supportive activities, and any other collegial exchange they desired. Due to the uniqueness of the activity, the facilitators seemed to need, and usually provided, extensive mutual support.

Another significant difference between the Rouge River project and the ICS project was the level of dependency upon the communications medium. In the Rouge River project, teachers were encouraged to use the network with the students every day during the two week period, but they were not required to use it at any time. Most managed to gain access during the two week classroom period so they could exchange data, but a few never connected, leaving their university support staff to distribute their results. Few teachers actually participated in the planning that occurred on-line between the February meeting and the two week session in late May. The activities involved - conducting the tests, analyzing the data, and discussing the findings - were all viable exercises even if run within a single school, so in many cases, there was no perceived need to use the network. In the ICS exercise, however, nothing could be accomplished without using the computer network.

In ICS, the schools *must* have connected to the network to learn their character assignments. The network was the *only* form of communication the students had to communicate with their colleagues at the other schools. With this increased dependency on the network, there was a greater frequency and volume of communications than with the Rouge River project.

Because of this increased level of communication, there were additional tasks that the students and teachers needed to learn. Participants in ICS learned how to use a word processing program on their computer to prepare the text of their communications prior to accessing the network. Once the text had been prepared, the students established a connection and transmitted the prepared text. This procedure reduced the length of time they were connected to the network.

Dave

Dave teaches at a junior high in Wayne, Michigan. He taught at one of the district's high schools for thirteen years before moving to Franklin one year prior to this study. He had always taught biology, but now is in his first year teaching 9th grade physical science. It's a one semester course in physical science that he explains may be an end of the line course. "Second semester they take Earth science, then they go to the high school and take biology and complete their science requirements." As such, Dave feels a strong need to get his students to like, or at least not dislike, science.

Dave participated in the ICS Environmental Decisions Simulation twice while at the high school, stopped for his first term at the junior high, then began again during the term in which I visited schools for this study. Dave claims that computers are kind of a hobby, aside from using them as a professional tool. Dave taught computer studies at the High School and had used telecommunications as a part of the program. Dave is the only one of the five teachers in the study who had previous experience with a computer network.

The shelves of Dave's classroom were filled with student projects - models and terrariums - and computer print-outs were posted on the walls. One wall was nothing but print-outs with suggested experiments and background information on a variety of topics such as acid rain and garbage and recycling. There was, however, no computer in the room.

As the students entered the room, they went to a bulletin board with several envelopes and a few print-outs attached which was acting as a post office. Each envelope had the name of one of the characters from the delegation that had been assigned to this class and served at that individual's post office box. Dave had placed all of the incoming message (private communications) into the appropriate envelopes earlier in the day so the students could get their own mail and start discussing it as quickly as possible. The public items had been stapled to the board for all to read.

Dave had been acting as a mediator for his students. All of the computer operations had taken place at Dave's home the previous evening:

> While I was at the High School, I had both an Apple IIe and an IBM PC in my classroom. My students used these machines for data analysis as well as the communications projects. After two years of negotiating and pleading with my Principal, I managed to have a phone jack installed in my classroom. Then at the end of the term, they transferred me here with no equipment and no phone available. After a year now, I'm beginning to get the support from my administration that will allow me to get the junior high students more directly active these projects.

Throughout the hour, the students worked in groups - each group representing one of the characters assigned to the school. As they worked, they made frequent reference to some maps of Africa posted on one of the walls. Occasionally, they would have a question which resulted in a trip to the encyclopedia in the room.

By the end of the hour, each group had prepared at least one communication to be sent out from their character. These communications were all hand written and the papers placed in an envelope on the bulletin board marked for "outgoing mail." Dave explained that in the next couple of days he would type them up and send them over his Macintosh at home. "I tried bringing my Mac into school a couple of times, but it was a real pain. It was a real management problem. All of the kids wanted to work on the Mac at the same time. Consequently, I had one student typing and twenty five standing around goosing each other while they waited. I tried scheduling use by character - the kids representing Chief Seattle would get five minutes, then John Muir, etc. - but that was only marginally better. I think part of the problem was the novelty of a Macintosh for these kids, but I could see that it was still going to be tough with just one machine. With junior high kids I don't mind typing the messages up - they are pretty simple. I'd still like to get them to do it themselves, though."

I asked Dave about some of the printouts on the wall that didn't appear to have been from the ICS exercise. He explained that he also had an account with Prodigy - an information network established by Sears and IBM (see Appendix B). Many of the printouts on the walls of his classroom came from Prodigy. Each week, a different experiment was posted in a science teachers forum on Prodigy. Dave printed them out as soon as they were posted and brought them in for his students to see and conduct.

Similarly, Prodigy has an encyclopedia available for on-line searches that Dave makes available for his students. If they will provide him with the specifics of what they want a search to find, he will conduct the search and give the results to the students the next day.

"I really like the Prodigy Service," Dave explains. "I learned about it from one of the other teachers when I was in the ICS project. I pay a flat monthly rate and can have four different accounts at home. My kids use it about every other night to play games or get information for school. I find it a valuable resource for communicating with other teachers and getting background stuff like the things you see on the wall. I guess I check it most evenings."

Barbara

Barbara teaches seventh grade science in Ann Arbor. Her teaching assignment covers a group of thirty students who she shares with two other teachers. The three teachers together cover all subjects, and are the principal teachers for that group of students. This arrangement continues into the eighth grade with the same students, so Barbara works with the same teachers and the same students for two years in a row.

Barbara's classroom is very organized - everything is in it's place and all of the surfaces are clean. Immediately inside the door is a box with several file folders. As the students enter the class, they grab their folder from the box and head to their seats. Some aquariums are along the wall past the folders, as well as anatomical models of an eye, an ear, and a human torso. The back wall of the room is partially covered by a large map of Africa and another map of the entire world. On the shelf below the maps are a set of the Encyclopedia Britannica and a variety of other reference books - a couple of atlases, an almanac, a few different ecology books and some older issues of the National Geographic.

On the day of my visit to the class, the students were working in several groups. Some were doing background reading, while others were comparing a variety of statistics for some African countries as well as some of the world's more developed countries. One group was comparing the amount of land that was used for agriculture, industry, forests, etc. They were trying to figure out how they could adjust the values to make it possible to compare the numbers between the countries. They realized that saying the United States has 189,915 thousand hectares of cropland compared to Zaire's 6,523 thousand hectares (absolute values) isn't very valuable because of the difference in size of the countries. They decided to convert all of their statistics to percentages (relative values) of the area of the country.

When the group had all the raw data organized, the students asked Barbara if they could use the computer and the spreadsheet calculator. When given permission, they started up Apple Works and loaded a spreadsheet file that had been prepared by Barbara. The spreadsheet was designed so they could enter their raw data and it would perform the calculations and generate some graphs. When I asked the students if they understood what was happening, they said. "Sure. We had to do the calculations ourselves a few times to prove we could do it. This way we don't make any mistakes, Josh (a fellow student) doesn't get bored waiting for us to do the calculations, and the graphs look better than we can draw."

Barbara had heard about spreadsheets before participating in the ICS project, but had never used them. When the students began taking large amounts of time to do the calculations, and made many mistakes along the way, Barbara decided this would be a good time for her to learn about spreadsheets as someone had told her they were good for repeated calculations. It took her two attempts to get the file working correctly, but she was happy, and she thought the students were focusing more on the subject, too. When she mentioned what she had done in a message to another teacher, she was encouraged to share the file with everyone on the system.

> "I met a woman in California, over the network, who wrote back when she got the spreadsheet file. We communicated a lot, and between the two of us, we learned a lot more about spreadsheets. We learned how to create macros that would take the

> data and generate charts for the students. I'm working on a unit now where the students make different kinds of charts from the same data so they can learn what type of chart or graph is appropriate for which type of analysis of the data."

Barbara reported that she hoped her friendship with the teacher in California would continue, but that communications had ended at the end of the term, and she has been unable to contact her friend through the system in subsequent terms. "I guess she was assigned to a different game this time."

One of the groups of students had been preparing a letter from their character in the simulation to another character located at a school in Germany. They used the Apple IIGS in the classroom and saved the file on a disk. The only phone line, though, is located in a small seminar room in the media center - on the other side of the building. Barbara used the school's intercom to contact the media specialist to see if it was okay to send some students to use the computer with the modem. "Often," Barbara says, "I have to take the entire class because she (the Media Specialist) can't watch my students. When we all go, I can only get one group in the seminar room at a time, so the rest work on research projects."

As the kids were packing up to go to the media center, Barbara handed them a disk and asked them to send a particular file on the disk as a message to another teacher. One of the other teachers had mentioned a book over the network that they really liked, but forgot to give the name. Barbara had prepared a message to the teacher asking for the title and author so she could see if it would help her. "I'll get a message back in a few days, maybe...," Barbara said, "*if* the teacher responds, and *if* my kids don't ignore the message as it comes in."

TERC Star Schools Project

At the same time that ICS was beginning to offer the Environmental Decisions Simulation, the Technical Education Research Center, TERC, in Cambridge, Mass., asked Carl Berger to submit a proposal for the University of Michigan to be included as a training center for a grant they were pursuing under the Star Schools legislation. This proposal was accepted, and the School of Education became one of 13 training centers for TERC's Star Schools Project. This project was supported for two and a half years, but was stalled when Congress modified the Star Schools legislation. TERC's approach was to integrate the use of computers for collecting and analyzing data with a wide area communications network to develop a series of activities that allowed students to do "real" science. A total of nine units were developed over the length of the project.

Students created and conducted their own projects, shared data and findings with students and scientists around the globe on the telecommunications network, engaged in large-scale, cooperative investigations, and published reports electronically in TERC's Star Schools network. TERC claimed this approach modeled the way scientists work. Scientific discoveries are more often made by research teams than by individual scientists. Star Schools students, therefore, worked in teams in the classroom and across the country. Scientists use computers to record and display data, and increasingly, are using telecommunications to interact with colleagues around the world. So did the students. When a discovery is made, scientists must communicate and explain its importance to colleagues. Star Schools students prepared reports of their investigations and published these reports on the telecommunications network.

This project was a joint endeavor of the Technical Education Research Centers (TERC) of Cambridge, Mass., the University of Michigan's Office of Instructional Technology, and 10 other nationally recognized educational institutions. The Office of Instructional Technology acted to provide teacher training and ongoing support to the participating schools. A $2.5 million grant from the U.S. Department of Education, Star Schools Program, funded the project.

In Spring 1989, participating schools began pilot testing 6 curriculum modules. In each module students and teachers started with the structure of a central, or core, activity. Hands-on participation, data collection, data sharing on the network, analysis and discussion, and a report to the network were part of each activity. After student teams completed the core investigation, they were offered support and guidance to move in different, or divergent, ways and to design and conduct their own projects.

All classes began with "Intronet", which introduced telecommunications and the concept of collaborative investigations. Classes then selected one or more modules offered on the network and participated in a 6-week investigation.

In the *Radon* module, for example, students were equipped with the tools and materials to conduct a survey of the levels of radon - a radioactive gas - in their area. After conducting the surveys, student teams sent their data to the network. The students' data was combined into a network-wide database, which students could use to pursue additional experiments. In this way, each class had access to a larger data bank which it could analyze and compare with their local data.

All students involved in the Radon module reported their results on the network, analyzed local and national results, and prepared a report for the network. Students then had the option of pursuing one of the issues surrounding radon. Why are radon concentrations so high in certain areas? How much of a health hazard is radon?

Student scientists could proceed in a number of directions, with expert advice available from scientists on the network. The director of the Radon Division of the U.S. Environmental Protection Agency, Margo T. Oge, was one such scientist on the network, as were health physicists from Harvard University and Dickinson College.

The curriculum for each unit was highly structured. The printed materials lead the schools through an introduction activity, a warm up, and the core activity for each unit.

In the introduction activity, each group of students prepared a class profile. The information requested for inclusion in the profile helped to provide a context for the other schools working on the same unit. These profiles were prepared and exchanged with the other schools over the computer network. The introduction activity lead the students through all of the computer related procedures they would need to use to exchange any further communications over the network.

The warm-up activity presented a way for the teacher to introduce the subject matter. These activities usually ran entirely within the class and seldom resulted in a need to communicate with other schools.

The core activity for each exercise involved an investigation within the individual school setting which resulted in a set of data. These data were then sent over the network to all other schools in the cluster or unit. Once all the data was distributed, the students prepared individual reports that either summarized the entire collection of data, or a specific aspect that they found interesting

Computer Communications and the TERC Project

The communication technology for the TERC project was very different from the other two projects. TERC developed their own communications software for this project, so the schools were required to have specific hardware combinations. Initially schools needed either Apple IIe, Apple IIGS or MS-DOS computers. The final semester, TERC released a Macintosh version of the software which allowed a few more schools to participate. The software was designed to de-emphasize the skills needed for computer mediated communication, and help the students and teachers focus on the scientific principles and processes under investigation.

All work on the computer was done within the Apple Works or Microsoft Works environment. Students used standard Works commands to prepare word processing, database and spreadsheet documents. When they had a document ready to send, a keyboard macro would transfer control of the computer to TERC's software where they would specify to whom the file was to be sent. The procedures required to establish a connection, and transfer the files to the host computer were totally automated. Once the file had been addressed and the software had been instructed to send the file, the teachers and students did not need to do anything with the technology until any incoming files had been transferred and the connection terminated.

The following is an example of a message that was sent as a word processing document to all schools scheduled to begin the Radon unit:

```
Posted: Tue, May  9, 1989   5:01 PM EDT                Msg: GGIJ-3566-1550
From:    RADON.DIALOG
To:      radona, radonb, radonc, radond, radone
CC:      all.trainers, radon.dialog, bkurshan.terc
Subj:    welcome

Welcome to the study of radon!  You have chosen to become scientists, for a
while at least; and have been assigned to one of the seven national clusters
of schools across the nation who are also doing the Radon Unit.

We have designed this Unit so that you can learn some science by doing
science.  Learning-by-doing is not a new idea, but using it for a project like
the radon survey is.  In the survey, you will gather radon data, and share it
with your collaborators over the network, to build up part of a national radon
map.

Your teacher, the Resource Center, and we here at TERC are all behind you with
help and guidance; but you are the people this has been designed for, and as
with all learning what you receive will depend to a large extent on your
efforts.

NETWORK NOTES:
    * There are 71 classes participating in this unit.  Your cluster
      assignment has been sent as a separate letter. A mailbox called
      RADON.DIALOG has been set up so that you can send letters about
      the unit to TERC.
    * The deadline for sending your Radon data to the network is Tues.,
      5/23. The compiled national data will be placed in your mailbox
      on Thursday, 5/25.  If you miss the deadline, your data will not
      be included in the national data compilation but you should still
      send the data to your clustermates.

TECHNICAL NOTES:
    * The Star Schools Software disk has very little free space on it.
      As a result, you should delete all unnecessary directories from
      your WORKING disk before you start the unit. If you do this, you
      should have enough room on your disk for the data and letters you
      receive. If you do run out of room on the disk, you should make a
      new working copy of the disk.
    * Make sure when you send in the data that you use the template
      provided for you, RADON.DATA, as described in the unit materials.
    * BUT MAKE SURE YOU USE YOUR SHORT USERNAME in the filename, instead
      of DATA.  This makes it much easier for the network hub to combine
      and organize the data that you send in.

Best wishes to you,    Brian Drayton    Will Sperry
```

Throughout TERC's Star Schools materials, whenever the computer was used, either step by step directions were included, or a note referred them to frequently used procedures.

Linda

Linda was one of the first teachers identified by the Detroit Public Schools to be a participant in TERC's Star Schools Project. At the time, she was teaching at a high school three block s from downtown Detroit. Linda traveled to Boston with the staff from Michigan to be trained by TERC as a teacher trainer for other teachers from the Detroit Public Schools for the project.

Immediately after the training in Boston, Linda was transferred to a different high school located in one of the residential areas of Detroit. She was appointed chair of the science department at her new school - a half-time administrative position and half-time teaching position. Linda continues to teach one or two classes per term.

Although I visited Linda's class many times, I was never present when she used the materials with her students. In fact, due to difficulties in obtaining and operating the equipment, Linda did not introduce the materials to her students until the academic year following this study. Linda's experience with the technology accentuates some of the problems teachers face in obtaining access to, and learning how to operate the equipment needed for computer communications.

The Star Schools Project required schools to have specific computer equipment. Schools needed to have either an Apple IIe (enhanced), Apple IIGS or an IBM PC or PC Compatible computer. Linda had access to an Apple IIe at her new location, so she assumed she would be able to run the project there with few difficulties.

The first task Linda pursued was the installation of a telephone line. The school district had committed to having the lines installed as soon as the teachers were chosen. A line *had* been installed at the school where Linda had been teaching, but none were available at her current assignment.

The principal at this building was concerned about how to restrict use of the phone to "official" business, as well as who would pay for the inevitable long distance calls. Linda assured the administrators that there need be no phone instrument itself - just the modem. Without the phone unit, it would be difficult to place calls. She also explained that the only calls the computer would be placing would be to local or toll free numbers.

The principal agreed to a phone line with a few restrictions. The line itself had to be restricted by the telephone company to allow only local calls. The wall jack where the modem or a telephone would be plugged in had to be located inside a locking cabinet. There could be no telephone unit in the same room. Finally, the line must be installed in an office or storage room - not a regular classroom. As Linda's room was adjacent to the science office, she picked a cabinet in the office that allowed a short line to extend into her room. Due to a work slowdown by the district's maintenance staff it took six weeks for the line to be installed. A total of 12 weeks, or almost an entire school term, had passed before the phone line had been installed in a location where it could be used.

Once the phone line was available, Linda tried running the software. Unfortunately, the disks containing the software were a different size than the drives on her computer. As part of the project, I had several of the correct size disk drives and controller cards, so I took one to her school. The controller card malfunctioned and it was another week before I could get back to her school. With the phone line and proper sized disk drive, Linda was ready to get started - again.

The software worked fine as Linda loaded it and prepared to send a short message announcing that she had finally made it on-line. When she switched to the communications module, however, an error message appeared on the screen telling her that she must have an Apple IIe (enhanced). Apple had upgraded four chips in the IIe computer after about a year of production, and rather than changing the name of the model, they called it the IIe (enhanced). There is no obvious way to determine if an Apple IIe is enhanced or not. Other than running software dependent upon the enhancements, a distinction can be made only by an obscure difference in the start-up screens. When the computer is turned on, the screen on the IIe shows" Apple][e" while the startup screen on the IIe enhanced shows "Apple //e." Even if Linda had *understood* the distinction between a IIe and a IIe (enhanced) when she was told what equipment she needed for the project, she admits she would not have been able to determine what she had. Another week delay and replacement of four chips inside the computer finally provided Linda with the necessary computer configuration.

With the hardware setup complete, Linda was able to connect to the remote system and exchange communications. One of the first communiques she received was from TERC telling her that she was using an outdated version of the software. There had been some intermittent problems with the version she had, so the software had been upgraded. A new version would be mailed to her, and she was encouraged to wait to sign on until it arrived.

The new version arrived after a few days, but it would not let her connect at all! Another round of calls and mail resulted in a second upgrade that worked. It should be noted that the second and third versions of the software were both called version 1.1. TERC was working on a major change for the following year and for some reason decided not to rename the last version. This caused much confusion among the teachers as some had a working form of "version 1.1" while others had "version 1.1" that would not operate!

Linda made sure that everything was fine by using the system to communicate with TERC and the Michigan trainers for a couple of weeks before introducing the technology to her students. I was invited to visit her school the day she was to demonstrate the software and hardware to her class. I arrived at 10:00 a.m. to find an apologetic Linda. Someone had broken into the school the previous night and stolen the computer from her office.

The Univeristy had been provided with two Apple IIGS systems for loan to schools as part of the grant. These two systems had just arrived, so the following day I took one to Linda's school. I left it with Linda to set up by herself. The next day, Linda called to say that this computer had been stolen, too.

Two days later I was able to take the second back-up system to Linda's school. Extra locks had been installed on the office door, and wire mesh had been installed over the door's window. She had solved the problem of "losing" computers.

The software on the new IIGS looked and worked exactly the same as with the IIe (enhanced). Unfortunately, the modem would not respond. Searching through TERC's documentation, she learned that some settings in the IIGS must be changed - settings that do not exist in the IIe systems.

By the time Linda was able to finally introduce the software and hardware to her students two thirds of a school year had passed. She was working on her third computer system, and third version of the software. She decided to wait and start fresh the following year.

Bob

Bob teaches in inner-city Detroit - about three blocks from downtown. He's been teaching in Detroit for fifteen years - most of the time teaching physics. He describes himself as someone who never grew up, and enjoys a playful attitude towards learning. Bob's students appear to share this playful attitude which was evident as the students entered the classroom. In every other classroom visited for this study the students either ignored my presence or looked at me as if to say "Who are you?" but did not say anything. In Bob's room, the kids all said "Hi," or "Hello," and a couple asked if I was Bob's brother. Bob is white and 99.9% of the students at his school are African-American. Bob objected that, just because we both had beards doesn't mean we were brothers. One of the students piped up with, "Yeah, but you know you white folk all look alike to us. It's an honest mistake. No insult intended," with the last directed to me. Everyone had a nice chuckle and without any direction from Bob, the students began getting their materials and setting up the classroom for work. This comment sounded flippant, but it became clear over the course of the hour that the students treated Bob with great respect.

Bob recruited students from all of his classes to participate in the activities associated with the TERC project. Many of the introductory activities were conducted in class, particularly parts that Bob could use to make points associated with the existing curriculum. For example, describing the formation of radon as a product of the natural decay of uranium allowed Bob to introduce several concepts about radioactivity - half-life, decay, "sister" elements, etc. Work specific to the TERC project - collecting raw data, analyzing it, and preparing reports - was run as extra-curricular activities during lunch and after school.

Upon entering Bob's classroom I was struck by the austerity. The room itself was rather large consisting of lecture seating for 30 in the front third and nine four-person lab tables in the back of the room. At first glance, it appears as if there is nothing in the room but the furniture. Shelves built into the walls were empty except for two models of atoms that appeared to be at least twenty years old. All of the counter tops and lab tables were clean and barren. Storage lockers beneath the tables and around the walls were all closed an locked. The one bulletin board was empty, and the chalk board had been erased. All I could see was dark gray from the chalkboard and counter tops and wood.

As the students entered they broke up into small working groups. Some were working on the TERC materials and some were working on completing a lab the entire class had started two days ago. Equipment started appearing out of the storage cabinets. Two students headed to the adjacent storage room and rolled a cart with the computer into the room. About ten minutes into the class, everything was set-up and the students were at work.

The group of students who set up the computer placed a call and retrieved some electronic mail from the network. They were anticipating a response to a question they had sent to Dr. Oge at the Environmental Protection Agency, but instead received only data from other schools in their working group. One of the students complained that the "experts" on the system should be more prompt in answering their mail.

The students then decided to look at the data they had just received from two other schools to see how it compared with their data. Each school tested the radon concentration in a variety of locations within the schools, so there were ten new sets of data to compare. Very quickly the students noted that their school had the highest radon concentration of the three. They also noted that one set reported by another school seemed to have an extremely low level of radon based on the charts they had read in the background material. One of the students retrieved one of the charts and they discovered that the low concentrations reported were even lower than average background radiation. Since the raw data was present, they computed the concentration themselves. They found much more realistic values - values below theirs, but much higher than background levels. Through this process they discovered that if they added two values in the calculations rather than subtracting them, they would achieve the same incorrect results as the other class. The remaining part of the class period was spent drafting a letter to the other school explaining the errors in their report. The difficulty Bob's students were faced with was controlling the pride and excitement they felt for discovering these errors so that their letter was not too arrogant or offensive. As one student said, "They look at *our* work, too."

Bob is a fairly experienced computer user. Before becoming involved in the TERC Star Schools Network, however, he had no experience with telecommunications. The equipment he used for the project was an Apple IIGS provided by the University. A phone jack had been installed in his classroom over the summer prior to his initial involvement. It was a simple matter to move a cart carrying the computer, modem and printer into place and hook it up to the jack in the classroom. Bob's largest technical problem was having a secure location to store the computer. He refused to leave the equipment in his classroom overnight until the door on a storage room had been reinforced and a deadlock had been installed. The first two months the computer was rolled down the hall to the science office every night.

Summary

Although the three projects were vastly different, they all did involve the use of computer mediated communications among the teachers as well as the students. The following chart summarizes the differences and similarities in how the networks were structured and used within the three projects.

Figure 2.1
Differences and Similarities of Network Structure and Design for the Three Curricular Projects

	Rouge River	ICS	TERC Star Schools
Type:	Data Collection and Analysis	Character-Playing Simulation	Data Collection and Analysis
Duration:	2 weeks 16 week prep.	17 weeks 2 sessions/year	6 weeks 3 sessions/year
Computer:	Any	Any	PC or Apple IIe, GS
Software:	Any	Any	In-house/ developmental
Host:	Confer II	Confer II	GTE Telemail, In-house
Role of CMC:	coordination exchange data intra-school questions	coordination student e-mail collegial exchange	administration class descriptions finished reports collegial exchange
Dependency on CMC:	low	high	low

This investigation is not an attempt to compare or contrast the structure, technology or design of these three projects, it is important, however, to have a basic understanding of the similarities and differences when considering the teachers and their individual experiences.

The snapshots of the five teachers in this study suggest patterns in background, participation, and perceptions of the network activities. The background of the teachers was similar in that only one had experience with telecommunications, most claimed that time is a major difficulty for teachers, and they all had fairly limited formal and informal contacts with teachers outside their school.

The next chapter presents patterns that I observed in the ways the teachers participated in the networks as well as their perceptions of the networks.

CHAPTER III

EMERGING THEMES

In this chapter I will describe the common concerns and issues identified by the teachers. These themes emerged both through interviews with them and observations I made in their classrooms. Though the teachers were participating in three very different exercises as described in Chapter II, the themes that emerged were experiences or comments common to all of the informants. There were occasional sub-themes raised that dealt with the specifics of an individual project or exercise, but these were all either procedural critiques or critiques of subject matter specific to that project, and as such, were not applicable to this study.

I will begin with a discussion of the reasons the teachers were interested in participating in the projects. I will then present the the technical issues, followed by observations on how the teachers used the networks and changes observed and claimed by the teachers regard their own professional roles. Though this study is focused on the teachers, I will conclude by reporting upon observations made by the teachers about changes they have perceived in their students as creating changes in the students is a large part of their jobs.

Why Are These Teachers Involved?

With any educational innovation, we should consider how teachers become members of the innovation team. In each of these projects there were twenty to one hundred teachers participating - a small fraction of the number of teachers teaching the same topics in the same physical locations. In all three exercises the teachers were selected as volunteers. They were initially contacted through mailings to school science department chairpersons, or in Detroit, through district level science and computer curriculum specialists. The recruitment materials described the goals of each project, but as all three were pilot projects, the descriptions were based on the expectations of the designers rather than the experience of classroom teachers. Nevertheless, these teachers decided to commit significant energy and time to projects that made a variety of claims, yet couldn't provide specific information about the daily operations and impact in the classroom. The five teachers I examined for this study gave the following reasons for choosing to participate.

Modeling "Real" Science

Both Bob and Jim explicitly stated that they enrolled in the respective projects because they thought it would provide an opportunity for the students to perform what they called "real" science. Their observations were that too often, their students thought of science as what is done in traditional science laboratory exercises - performing a set of pre-established procedures to see if you can obtain the same results as the teacher says you should. As opposed to this "school" science, the results in these network projects have no correct or incorrect results. In many situations, the work the students pursued had not been done before. The teachers felt that this more closely models the work of professional scientists. They considered a significant part of their duty as a science teacher as helping the students understand that "real" science involves, which in their view meant posing questions and searching for answers - without having the ultimate authority of the textbook provide to the "correct" answers.

In Bob's class, for example, the students determined the concentration of radon present in their school. Though the process for measuring radon concentration is fairly well established, nobody had ever measured the concentration at that school. This meant that the results obtained were valid only to the degree that the students could defend their work. The potential to do sloppy work and establish incorrect conclusions exists, but this also models the pitfalls of the work of professional scientists.

Bob also explained that he tries to instill in his students the concept that science is not performed in isolated labs by scientists who never speak to each other. Today, communication using networks is a vital component of doing research in science and engineering. Indeed, some suggest that those researchers without access to such networks are seriously handicapped in their work. The network based exercises provided an opportunity to help the students understand this need to communicate with others performing similar work.

In Jim's class, the students' work in measuring the water quality of the Rouge River led them to find a faulty valve in a nearby sewage treatment plant. If the class had been performing the exercise alone rather than over the network, they would not have been aware that the value they determined for the fecal coliform parameter was significantly higher than that from a school not far upstream from them. The disparity between the measurements from Jim's class and the other Fecal Coliform values reported lead other students from other schools to ask Jim's students to rerun their tests, implying that they had made an error. The repeated tests found the same results. The short distance between these two sites and the greatly varying levels of the parameter led the students to hypothesize that there must be something in that stretch introducing substances into the river to cause this change. A walk along the river's banks found a pumping station that appeared not to be working and was leaking sewage into the river. The information was brought to the attention of city officials, and the pumping station was fixed.

Access to Experts

A second reason the teachers gave for participating in the projects was the access the students would have to experts - both as subject matter specialists as well as role models - via the networks. Each of the projects had subject matter specialists as an integral part of their designs.

In TERC's project, scientists were on-line to answer questions and raise issues that might have been overlooked by the students. In the Radon unit, for example, Margot Oge, the U.S. Environmental Protection Agency's leading scientist for Radon, wrote a letter of welcome to each school, and signed onto the network to answer questions submitted by the students. The presence of these scientists provided a higher, less questioned authority when substantive issues were raised, as well as adding a sense of merit to the projects. One of Linda's students reasoned, "why would this scientist be involved if we weren't doing valuable work?"

In the Rouge River Project, the "expert resources" came in two forms. Students from the University's School of Natural Resources who were trained in the water quality tests and associated issues acted as resource people in the classrooms for the two weeks of the project. At least two students worked with each participating class. Also, a variety of professionals working on water quality issues participated in the electronic conference much as the scientists in TERC's project. These professionals represented government decision making bodies, water quality control districts and interested University personnel.

ICS's Environmental Decisions Simulation included university student mentors who acted to review all communications as well as provide information when requested.

It is important to note at this point that the teachers had mixed feelings towards the success of this aspect of the project. Though the teachers felt the involvement of these scientists was a good idea, they reported having difficulty in determining how to use this resource. In the TERC project, the teachers claimed the communications they received in response to questions asked of the participating scientists were rather general and had the "feel" that they were pre-written as opposed to written in response to their questions. In fact, both the TERC project and the Rouge River Project had difficulty in keeping the outside experts involved after the initial run of the exercise.

These professionals were interested in participating and supporting the project, but the concepts discussed on the network were fundamental ideas and the questions asked of them could have been answered by graduate students. The scientists, however, believed that their professional pursuits were actively expanding the knowledge base in their specific areas, and taking time to answer basic questions, often repeatedly, detracted from their work. It was difficult to maintain the interest of the scientists. It was also difficult for many of these professionals to justify the time needed to participate fully - none of them had education of the general public as a specific task in their job descriptions and felt it was hard to justify continued involvement given the other charges they had.

On the other hand, both the Rouge River project and the ICS activiy included extensive involvement by university students. The use of university students to act as the "experts" was unique to these two projects and may be a key to their success. The continued participation by new groups of university students has been a valuable resource according to the teachers.

Professional Growth and Recognition

Not all of the reasons for participation centered on gains for the students. The teachers felt that participation would be good for their professional record and position. They all mentioned that they had heard about computer mediated communications and how they were being used in both science and educational projects, but only Dave had any first hand experience with using the technology. Participation in these projects would give them experience in a new medium, as well a give them another way to use the computer in their classrooms - something they felt had not been very worth their time in the past.

The other professional reason given for initial participation was the notoriety they gained within the work place for being involved in the new project. Bob and Jim both admitted they chose to participate in part so that their supervisors would have something to note when preparing evaluations. The fact that they were working with "The University of Michigan" gave them a certain status among their colleagues, and, they believed, some leverage in obtaining limited resources from the district or school.

Fun

I have left until last a feature about computer communications which is rarely mentioned, certainly not in published papers, but which may be a primary motivator for continued participation in these teachers: it is great fun! They all claimed that it is exciting to log into a continuing flow, to give and take, to experience the growth of the group creation. The element of surprise, suspense and curiosity is roused - "what has developed since the last time I logged on?"

Many explanations can be offered for this experience - humans desire to communicate, to make contact, to interact. But these don't account for the peculiar, intangible space that membership in an active communication community creates. Freed from the usual constraints of time and distance, a new pattern of interaction emerges, which is far removed from the impersonal, cold contact that computers conjure up in the popular mind. Fellow participants seem, if not tangible, certainly very much alive, recognizable, multidimensional personalities. People discover unknown talents in themselves - such as Barbara's spreadsheet skills - through conferencing and often present themselves quite differently on-line from in face-to-face encounters. I do not believe a description of why teachers continue to use this difficult medium of communication would be adequate without emphasizing that they keep reporting that "it's fun."

Barriers to Participation

Common barriers to participation emerged while speaking with the teachers. Each teacher had their own horror story about getting the equipment together and actually receiving and sending their first communications. The teachers were also concerned over how they were going to be able to maintain their participation in future runs of the exercises.

Technology: Access and Familiarity

The difficulties described in the previous chapter that Linda experienced in assembling a working system are not unique, although the number of problems she encountered may be extreme. A theme that surfaced early with every teacher in this study was this difficulty in obtaining access to, and their lack of familiarity with, the technology needed to participate.

Technical and logistical factors present constraints on the use of a communications network at two points - the machine mediating the communications, and the users in the schools. The design and operation of the software running on the host machine is not under the control of the teachers or students, but rather, in the cases in this study, a function of the organization running the project. Linda's frustration with the constantly changing software in the TERC project demonstrated the need for a robust system that performed as advertised. As a novice user, Linda was busy learning much about the Apple computer in her classroom. When the network software failed to operate properly, Linda did not know how to determine if it was due to her operations or a failure of the system in general. There were times when Linda and the others were not aware that there had been a breakdown in the system until they were informed that vital messages had not been received weeks after a scheduled deadline.

If the teachers had been aware of the problems in the host software for the TERC project, they could have done little to alleviate their difficulties. One might erroneously conclude, therefore, that the teachers should not have input into the design and operation of the host system. However, thoughtful consideration of the experiences of teachers in these and other projects *does* have important implications on the choice or design of systems for use in future computer mediated communications projects. For example, many classrooms have several groups of students working on several computers. The ability to easily combine files from several disks and send them all at the same time from the one computer connected to the modem makes classroom management an easier task. I have included some suggestions regarding these design issues in the "Conclusions" section of this document.

At the the teacher's end, regardless of motivating factors, participation is limited by access to equipment, and ability to use the equipment. The single largest technical problem the teachers in the study encountered dealt with access to a telephone line. In each of the five sites in this study, the school administrators had committed to provide a telephone line run to the classroom of the participating teachers. In Linda's case, the installation was delayed by school district personnel who were to install the line. A labor dispute between the maintenance workers' union and the Board of Education delayed installation of Linda's phone line for six months instead of the promised two weeks. Jim resorted to drilling a hole in the wall and running wires through suspended ceilings and down the hall. Barbara reconciled herself to taking her class to the media center to use the modem. She had to split the class into small research teams to create small enough groups to fit into the seminar room - containing a phone line - where she was allowed to connect.

Participation Fees

One issue raised by every teacher while discussing the concerns they had about becoming involved was the realization that they might not be able to remain involved in the future because of the participation fees. Each of the projects were run initially with no fee charged to the participating schools. If the projects became successful and schools wanted to continue, however, a participation fee would eventually have to be charged to cover some of the operating expenses - primarily the computer and network charges. The Rouge River Project began charging schools $50 for computer time in it's second year. The ICS project began charging $275 for participation on it's second run of the Environmental Decisions Simulation. TERC anticipated charging schools approximately $200 to $300 per unit if the project continued, but since they were unable to secure the needed additional funding, the project died at the end of the two years when it's federal funding ended. The teachers, therefore, were concerned about the cost of participation in the exercises once they were no longer "trial" and, therefore, "free" to the schools.

Each of the teachers expressed concern over raising this participation fee. Their main concern was that with current demands on the school and department budgets, there was a feeling that the schools didn't have the funds to cover existing needs. Jim explained that he had to cut back on his request for supplies so much that in the biology classes he only had one frog for every five students. Bob explained how he had been trying to replace a needed piece of equipment for four years, but it's $200 price made it fall victim to budget reduction year after year. The other three teachers had similar complaints.

The teachers were so enthusiastic about their participation in the three communication exercises, though, that they all said they would find some way to raise the funds. Dave explained how he had success in obtaining money from a small local foundation that he felt would be his "ace in the hole" to keep his classes on-line. Jim and Bob both said they would be willing the pay the participation fees themselves if it came down to it. Jim thought he could claim it as a charitable deduction if he made it a donation to the school. Bob wasn't even hopeful that he would get any form of monetary compensation if he paid for his school to continue, "but," he said, "I don't get any any breaks for giving to my church, either."

Professional Communications

Once a connection was established, the teachers started using the network for it's intended purposes as well as a variety of other purposes. An unanticipated level of communications over the network occurred when the teachers began using the system as a professional communications tool. All three projects were designed with the intent of connecting students and helping them to do collaborative investigations. The teachers quickly realized the power of this medium as a tool for pursuing their professional responsibilities. The teachers used the network to exchange ideas, lesson plans, curricular materials and announcements of upcoming events such as conferences.

The ICS Environmental Decisions Simulation exercise is designed in such a way that when someone signs on to the school's account, the first forum in which they are placed is designated for use by the participating teachers. Once administrative tasks have been accomplished, the user may move to the forums established for the student work. The original intent for this design was to allow the ICS staff to distribute important information to the teachers on-line instead of placing expensive and time consuming phone calls to every participating school. Quite soon after the beginning of the initial run of the exercise, it became clear that the teachers felt this medium was useful for their communicative purposes as well.

Similarly, TERC's Star Schools project was designed to facilitate communications from TERC and others helping to run the the project. There is no place in the TERC material that explains or explicitly encourages individual teachers to contact individual teachers for anything other than issues dealing with the TERC curriculum. The emphasis is on student to student communications. Once again, the teachers quickly learned that they could communicate with the teachers in the other classrooms as easily as their students could communicate with other students.

The Interactive Rouge River Water Monitoring project was perhaps the only project of the three that explicitly encouraged the teachers to communicate directly with their peers. The project was conducted in such a manner that extensive communication among the teachers was desirable for many weeks prior to the introduction of the materials to the students. The preliminary time period was created to encourage maximum participation by the teachers in the planning and coordination of the two week intensive classroom activities. The project directors felt that this would make the teachers feel a greater degree of ownership of the exercise.

Information Resources

Although the initial intent in the design of each of these exercises was to create communication links between classrooms of students, as we have seen, the teachers used the communications for a variety of their own reasons - many unrelated to the project materials and curriculum.

Support for Subject Matter

An obvious use of the network by the teachers is to support the exchange of materials and information associated with the subject matter being studied by the students. Simple points of clarification such as the message Bob received warning about the error in a formula printed in the student materials were common. These communications tended to be for reasons of clarification and coordination of timing, and as such, were the administrative type of communication expected by the project designers.

Soon, however, the teachers began to share information about resources beyond those found in the printed materials. Jim pointed out a series of articles that were appearing in the local Detroit newspaper and explained how he was using them to generate his students interest in issues associated with the Rouge River. Dave informed the network about a book he had received as part of a Book of the Month Club that described a boat ride up the Zaire River - the same location used as a setting for the Environmental Decisions Simulation.

Barbara was interested in learning more about the capabilities of spreadsheet programs and designed a simple file that would allow her students to enter their raw data into a spreadsheet. The computer would then carry out the cumbersome calculations needed to determine the radon concentrations, allowing her students with low math skills to focus on the scientific concepts rather than the mathematical mechanics. Since the students distributed spreadsheets as part of their exercises, Barbara decided to distribute this spreadsheet to all the participating teachers. As a consequence of Barbara's distribution of her spreadsheet, discussions ensued where the teachers discussed aspects of Barbara's design, as well as the general capabilities and uses of spreadsheets in the classroom.

Teacher's Lounge - Professional Development

These spin-off discussions regarding spreadsheets in general are an example of what the teachers described as participating in a "virtual" teacher's lounge. Here was a tool they could use to exchange ideas, tips and tricks with other teachers who had similar interests and curricular responsibilities. Linda explained - "If I could have as successful exchanges and learning take place at the professional development workshops I arrange for the teachers at my school, I'd have the best teachers in the city."

A variety of tips and bits of information regarding professional skills and professional development were exchanged over the network. Barbara reported that she had attended a conference she would not have known about otherwise. Bob claimed to have "broadened my own ideas and the background which would effect my teaching." Dave reported learning where to get additional information, such as lesson plans. A "what-to-do-in-the-classroom-before-vacation" idea had "saved his life," by giving him ideas on how to keep the students interested on a day when they were preoccupied with the upcoming holiday.

Electronic Sense of Community

All five of the teachers felt that the professional communications they exchanged during the course of the exercise were extremely valuable. "I'm sure that we could have accomplished a lot if we were only allowed to exchange student generated communications, " noted Jim, "but the exchanges among the teachers above and beyond the curriculum was what hooked me, personally. I felt like I was finally a member of a community of professional teachers - people interested in teaching and improving their ability to teach. Here was a place where the adage *those who can't, teach* doesn't apply."

Creating this sense of community, though, seemed to be more by luck than by design of any of the three projects. Discovering who was participating, building the courage to initiate a discussion, and fear of losing contacts were aspects of the projects that even seem to have hindered the establishment of this collaboration among the teachers.

Who's Present

The nature of the computer mediated network is such that people using the network may seldom, if ever, actually meet each other in face-to-face settings. One cannot simply gaze around a room to see who is present, or how many people are attending a particular meeting. In a computer mediated environment it is more difficult to find out who is participating. In addition to finding out who is present, it is also difficult to determine who of those present are interested in particular information, and what expertise they may have to offer. It was difficult in all cases to find out exactly who was on the network, and what their interests were. Each system provided a list of user names, and short descriptions, but the usernames are often cryptic, i.e., BELLIES.MI, and the short descriptions included full name, and addresses.

In TERC's project, each school was provided with a list of the other teachers in their cluster. A cluster consisted of roughly ten schools assigned to the same unit at the same time. The only information associated with the list was the name and location of the school. Any further knowledge would have required a message from each participant to every other participating teacher. An additional restrictive feature was that the teachers were only told the addresses for others within their cluster. There may have been 300 or more classes working on the same topic at the same time, but each teacher was limited in their access to only a handful of the others.

The design of the software running the ICS exercise and the Rouge River project made finding the list of participants a bit easier. As the teachers signed on the first time, they were prompted to provide a short introduction. This information was available at any time to any user by a simple command. The ICS project was organized in clusters, as was the TERC project, to make it easier for schools to learn more about those in their cluster as well as limit the amount of incoming information to a manageable size. The fact that each account first went through the common teacher's lounge, however, made it possible for the teachers in the ICS project to obtain a comprehensive list of all teachers in the project, and communicate with them easily. In the Rouge Project, there was only one forum, so there was no problem in finding a comprehensive list of users.

Hesitation to Speak

The various electronic communities, therefore, were rather vague in nature. A member could get a sense of who was participating and what they were like only after a long period of use and regular logging in. This type of ill-defined community may intimidate some users. David described his feeling when writing messages as similar to the "mike fright" experienced by ham radio operators as they begin to send their first message. He found that not knowing who was listening was quite unnerving.

Jim, although an experienced computer user and one of the informants with technical knowledge of telecommunications, said:

> "you're always worried that your messages will seem ignorant or you will misspell something. In the Rouge, I know who's on the network. I can send things directly to the appropriate person. When I use a national bulletin board, or when I started on the Rouge, I don't know who's available, what they know, and what other resources are there. Having a way to find out what resources are available would be great. If I have a problem in AP biology, say I want to do this or that, I can

> put a question up and get responses from all over the country. If you can help them, you do the same. I just had a problem saying 'I have a problem' that would be worthy of this group. It's embarrassing to say, but I know once I make it over that hump, I'll be an active user."

The teachers in this study all managed to overcome the difficulties in finding others on the network to communicate with, and the reservations about posting material for public consumption. The need to accomplish specific tasks designed into the projects may have been a catalyst to encourage this activity. Each project had two or three initial activities that require the schools or teachers to learn how to send communications. The activities are designed to help people learn the specific steps for functioning within the electronic environment. Generally, the schools are to prepare a small introduction about themselves and send it to one or more others on the network. This initial activity requiring the teachers to learn the system by sending something appears to have been a catalyst in generating teacher use of the network.

Barbara, Jim and Dave all were participants in an electronic forum hosted by the Michigan Science Teachers Association prior to becoming participants in the various projects. This forum does not require specific tasks, but rather is an open place to post questions or information. None of the three report having been active in this forum for the reasons stated above - fear of appearing ignorant. In the curricular projects, however, they felt is was easier to get started because they were forced to do some simple things right at the beginning. "I was freed from lurking in the depths of my computer, waiting until I could bolster my courage enough to jump into the fire," Barbara said. "I was pushed out into the fire, where I found out it wasn't so hot anyhow."

Loss of Contact upon Completion

The ironic part of these network-based communities is that regardless of how hard or easy it was to establish collegial exchanges, they were doomed from the start. In every project, the teachers signed up to participate for a semester at a time. When a specific "run" of an exercise was completed, the network managers recycled the accounts for the next term of participants. Even if schools continued to participate in subsequent semesters, none of the projects allowed for keeping specific schools or teachers within the same working group in subsequent terms. As Bob reported about TERC's network, "There was one woman the first year in California who I had some communication with, but the next year, she wasn't in my cluster and it was hard to get in touch with her."

End of Isolation

Regardless of the difficulties of creating the sense of community, the teachers stated over and over how valuable it was to be members of the network. "Once I started talking openly, I found out I wasn't the only one with specific questions and ideas," says Bob. "In my school, I'm the only one teaching Physics. There's nobody else there to exchange tips and tricks of the trade with. With the network I had regular access to dozens of physics teachers - all teaching roughly the same topics I was trying to teach. We were able to exchange all sorts of lesson plans, demonstrations, and other tips." Jim mentioned this reduction in isolation with "... also, I, and colleagues, noticed things others were doing that we didn't previously know about."

This sentiment rose over and over. "I am the only Chemistry teacher in my school"; "I am the AP Physics teacher at my school - not many meetings to attend"; "a method to contact other teachers ... a very diverse group I couldn't otherwise come in contact with"; "I felt I had broken out"; " ... get beyond your own system ... good to see how things are with other teachers." These phrases appeared in every interview or visitation I made to classrooms. The teachers honestly felt that their professional isolation - real or simply perceived - had diminished as a consequence of their involvement in the communications network.

While the networks may have been intimidating, there is evidence on two important points: 1) lack of interpersonal familiarity was not insurmountable in the projects, and 2) the network appealed to teachers who felt professionally isolated.

Observed and Reported Student Effects

Closely associated with the distinction between *school science* and *real science*, the teachers reported that the students had a greater degree of pride and ownership in their work. As there were no "correct" answers, the students did not feel like they were doing "make-work". The results they obtained may be important. The design of the projects - to have the students examining parameters in their own communities or the real world at large - also helped the students to feel that there was value to their work. The teachers reported that the students were much more positive towards performing the work.

There was also a reported change in the social structure within the classrooms themselves. The teachers became less expert sources of information and more guides to what might be needed, where to get it, and how to get the desired information. As Dave said, "This allows me to be the teacher I want to be instead of the enforcer I have had to be in the past. The students see a value in their work that is hard to appreciate when performing a lab experiment that has been done since their parents were students."

Not only were the students more motivated to do the work, they produced higher quality work. Each of the five teachers reported instances like that described in Bob's classroom where there students were critical of the work of others. As Barbara explained:

> My students had spent several minutes criticizing one of the reports that they received over the network. The students preparing the report had made a careless error with a minus sign, creating an impossible result. Just as I started to kick into "Teacher mode" to reinforce previous lessons about examining your own results to see if they made sense, the students raised the issue themselves. The incident helped to reinforce the idea of thinking about your results, something the students seldom do since the "answers" are already known. They also realized that they were fair game, too, and that others were examining their results with as much scrutiny. The time spent preparing reports, and the quality of the reports jumped dramatically.

The fact that there was a real audience appears to have motivated the students, as well as instill a sense of pride regarding their work.

Social Interactions

Teachers reported changes in the interactions among the students within the classroom, in addition to the changing student-teacher relationships. Students who had been social outcasts due to their facility with computers and interest in learning - the computer "nerds" - quickly became valuable resources. These students could provide assistance in operating the machines and software, and often were able to "make things work" when nobody else, including the teacher, was successful. The teachers believed that the social openings created by this supply and demand for computer expertise allowed the students to begin to understand each other better. The liaisons created out of need led to greater acceptance of the social outcasts by the remainder of the class - and this carried over into activities unrelated to the specific communications project.

The teachers all mentioned that their observations had forced them to reflect more on how participation in class is affected by the student's gender. They reported that their female students became more involved in the network based activities than other classroom activities. The idea of communicating with other students in other classes was considered to be the motivating factor for these girls, albeit the goal of these girls was more social than scientific. As a consequence of the desire to communicate with others, these students acted to keep their working groups on task so they could get to the message writing stages as soon as possible. The teachers explained that while they were initially concerned over this mis-directed motivation, they felt that the girls had rewarding experiences which strengthened their self confidence in their ability to "do science." This self confidence reportedly transferred to other activities in the classroom, even after participation in the communications project ceased.

While the teachers all commented on how their female students were highly involved in the communications aspects of the exercises, they also mentioned that their male students seemed to be interested in the technology and operating the computers. Barbara explained, " I usually don't have much of a problem getting my boys working on their projects. In this project, though, I had both the boys and the girls equally involved in the work, with much less effort than normal." The variety of tasks each group had to accomplish in a collaborative manner provided interest and an opportunity that appealed to nearly everyone.

The Network as a Tool - Not a Subject

In each classroom there existed several students who showed interest or skill at operating the computers and the communications software. Two of the projects - TERC and ICS - suggested using this interest as a way to involve these students in the cooperative projects as well as a resource to help keep the teachers from performing all of the technical tasks themselves. The underlying assumption was that these students would become contributing members of the class even if they were not interested in the subjects under investigation. Based on these suggestions, and the fact that I was serving as a technical troubleshooter for all of the schools, I was prepared to be approached by these students when I made my visits to observe and interview the teachers. Much to my surprise, I was not approached once in any of the trips I made to the schools.

The teachers had spent considerable time in mastering the hardware and software *themselves*, even though all three projects suggested involving students in the initial stages of learning the technology. They reported an internal need to make sure they could do everything necessary before introducing it to the students. This often meant learning more about the specific computer systems and software than any individual student would ever need.

The teachers had not, however, chosen to spend time on explaining all of the specifics to their students. The students were introduced to the basic premises of the exercises and how to get started with the software, but none of the teachers chose to use the technology as a subject of study itself. The message the teachers presented regarding the technology was that it was just another tool used in the pursuit of knowledge. The students learned how to operate the software, but they didn't need to know how it worked, or even all of the potentials of the software. As Linda said, "The software changed from year to year - sometimes week to week - in the project. I can't justify teaching my students everything about that technology. I didn't even want them to spend much time on it on their own. The next time they need to use something similar it will be a different system, probably on a different computer. Who knows how these things will change by the time these students are using them again. The important thing to me is that they are doing the science, and this is a tool that lets them do better science. I don't teach my students how a microscope works in biology class - why should I teach them how this technology works?"

Summary

This chapter has presented the common experiences and issues that surfaced while observing and discussing the various projects with the five teachers. The following is a summary of these themes:

Reasons The Teachers Chose to Participate:
- The projects offered the teachers a way to model "real" science in their classrooms.
- The projects offered access to experts and scientists to act as information resources and role models.
- Participation in the projects promised to develop the teachers' professional capabilities as well as improve the way they were perceived by their supervisors and colleagues.
- The projects looked as if they were going to be fun.

Barriers The Teachers Experienced:
- Obtaining and running the equipment was often difficult.
- The teachers were concerned about procuring the necessary participation fees.

Volume of Professional Communications:
- Unexpected volume of communications dealing with professional concerns.
- The network was used as a resource for background information.
- There was much communication in support of subject matter both related and unrelated to that of the projects.
- The teachers used the network to exchange ideas and information for their own professional development and growth.

Sense of Community
- A strong feeling of community developed in all cases.
- It was difficult to find out about the others involved.
- There was an initial hesitation to contribute to public discussions.
- The teachers no longer felt intellectually isolated.
- There was an unfortunate loss of contact with others upon completion of the units.

Observed and Reported Student Effects
- Social interactions changed in the classroom, particularly within and between Gender groups.
- Female students became move active in the projects.
- The network was used as a scientific tool - not a subject of study.

An electronic conference was established to seek support for and clarification of this classification scheme of the themes I have identified in the teachers' experiences. It was my belief that the manner in which the teachers used the conference established for this study would be similar to the ways in which they used the networks while associated with the curricular projects. The next chapter describes our experiences with this new conference.

CHAPTER IV

THE ELECTRONIC CONFERENCE

As stated in the opening chapter of this document, the nature of the educational projects in which the teachers were participating and the skills that the teachers had developed in operating the technology offered a unique way to involve the teachers as co-investigators in this study. As part of the study, an electronic forum was established for communication among the informants so they could continue to discuss issues with me and each other. This conference was run on the same system used for both the ICS and Rouge River projects, Confer II, so four of the five were familiar with the system. The fifth teacher, Linda, who was only involved in the TERC project and had no experience with Confer, received hands-on instruction in Confer and claimed to be comfortable after a follow-up visit I made to her school.

Saturday morning, December 8, 1990, the teachers all gathered in Ann Arbor for a face-to-face meeting. At this meeting they were introduced to each other for the first time. This was also the first time they learned who the other teachers in the study were. A few had heard of each other through various projects in their school districts, and several mentioned that they were glad to place a face with a name they had known over the network for a year or more.

The purpose of this Saturday morning meeting was threefold. First, I wanted to present a preliminary set of generalizations about their experiences based upon the class visitations and interviews. The second purpose was to have the teachers meet each other in a face-to-face situation to create a greater sense of community in the ensuing electronic conference. The final reason was to establish an agenda to guide the initial discussions on the electronic conference.

Throughout the morning session, the teachers kept mentioning how excited the were that they had met each other, and that they were anticipating many interesting discussions over the new conference. Jim, in particular, was involved in restructuring student to teacher ratios and team teaching strategies at his school. He exchanged a few ideas with Barbara and Dave, both of whom worked in setting much like the one Jim's school was trying to create. There were promises from each to send specific pieces of information to each other over the network. Similarly, Bob was interested in following through on some comments regarding using toys to teach physics concepts. Linda and Dave were both planning to send Bob some information they had back home.

The final hour of the meeting we moved to a computer lab and spent the hour on-line, talking to each other over the network even though we were in the same room. The teachers felt this would help them to set the stage and get the on-line discussions started while they were still excited. When the meeting ended, everyone had an active account, knowledge of how to use the system, and at least one task they had assigned themselves regarding the exchange of information within the group.

In the previous chapter I described a variety of reasons the participating teachers used the network that were not intentionally designed into the projects by their respective staffs. The teachers' comments on how useful it was to be connected with other teachers lead me to believe that they *would* continue to use this new network based conference after this face-to-face meeting. Their stated intentions reflected the uses outlined in the previous chapter:

Professional Communications:

- The network was to be used as a resource for background information, in this case, on the use of toys in physics.
- There was to be much communication in support of subject matter both related and unrelated to that of the projects. They were excited about discussing a few of the points I had made about how I saw them using the network.
- They intended to use the network to exchange ideas and information for their own professional development and growth. The structure of the programs in which Barbara and Dave taught was a particular point they intended to discuss.

Community

- Some had recognized each other's names from their work in the projects, but none had met in person before. Due to the face-to-face meeting, everyone had met each of the other participants.
- They no longer felt intellectually isolated. They each had one or two others they wanted information from and with whom they wished to maintain contact.

The conference was emptied and restarted with no text in it on December 8th, the day after the group meeting. A copy of the full text appears in Appendix C. The only editorial changes made were to change the names of the participants to the same names I used throughout this document.

Frequency of Use and Usage Patterns

Confer II maintains a set of summary statistics on each conference. These statistics are minimal, but they do provide some useful information:

```
On Jan16/92 DSC:TELECOM has
    22 items, and
6 participants.
Since Dec08/90 there have been
    80 uses which have lasted
250 minutes total.
There have been
    18 messages sent,
    80 items displayed,
    56 responses made,
    74 sets of responses seen, and
250 DO NEXT? commands issued.
```

This summary would indicate that the six participants were active over a period of a year (December 1990 through January 1992.) With six participants and 80 uses, one might also conclude that each one signed on twelve to thirteen times.

In reality, activity in the conference ended after four months and most of the communications were exchanged within the first two months. Also, only two of the teachers were active participants. These two teachers signed on approximately 50 times between the two of them in that two month period.

A more complete image of the dynamics of this conference is provided by examining which participant signed on, and what form of communications they initiated in each session. Due to the design of the Confer system, I was not able to collect data on sessions in which no communications were sent, as well as when private communications -

messages in Confer terminology - were sent. The public communications are summarized in the following table:

Figure 5.1
Authors of Items and Responses in the Electronic Conference

Item #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
8-Dec-90	c	c																				
11-Dec			c																			
12-Dec	d		d	d	d	d																
13-Dec			c	c	c																	
15-Dec						c																
15-Dec			d	d	d	d																
16-Dec				c																		
19-Dec				d			d	d	d													
20-Dec				c																		
30-Dec				d																		
31-Dec	b	b	b		b			b														
1-Jan-91								c														
2-Jan								b	b													
3-Jan	d		d		d			d	d													
5-Jan										d												
9-Jan					d						d											
10-Jan										c	c											
13-Jan	b		b		b				b													
13-Jan											d	d	d									
16-Jan														b								
17-Jan												c		c								
17-Jan	d		d		d							d			d							
20-Jan															b	b						
20-Jan									d						d	d						
21-Jan			b		b																	
22-Jan																c						
23-Jan					d											d						
24-Jan																c						
27-Jan					d											d						
3-Feb																	d					
10-Feb																	d	d				
10-Feb																	b					
17-Feb																	d					
10-Mar																			d			
16-Mar																				d	d	
20-Apr																						d

c=Clancy, d=Dave, b=Barbara

In Figure 5.1, each row represents a single session in which one of the conference participants contributed text to the ongoing discussions. Each column represents a single discussion, or item. The letters in the matrix represent the author of each particular communication. The first letter in each column indicates the person who initiated that item or point of discussion. Subsequent letters indicate responses, or comments associated with the initial item.

Content of the Discussion

Shortly after starting the conference after the Saturday morning meeting, I entered an item dealing with one of the issues we had discussed in the meeting. I was cautious not to create too many points of discussion as I was interested in how active the teachers would be - including which topics they would raise for discussion. I made a point to respond quickly and positively to anything that was entered by the teachers.

The purpose of the conference - to talk about their common experiences using the various networks - was clear from the start. I did not, however, discourage or encourage the teachers from using the conference for other purposes at the start. Throughout the next two months a total of 22 items were created. Three of these items dealt specifically with the themes and issues we had discussed at the face-to-face meeting. There were, however, many items entered that fit into the categories I identified as *Professional Communications* in the previous chapter.

Three items were created in which the teachers discussed background information and resources to be used in their teaching duties. One item discussed the use of Science Fiction writings in the classroom, one dealt with the use of magic in a science classroom, and one discussed roving shows used at school assemblies such as "Mr. Wizard." In these cases, the teachers were asking and sharing information about specific resources used to support their role as a teacher.

Three other items dealt with more general educational issues. These issues wouldn't necessarily help the teachers in the daily performance of their jobs, but they might help the teachers to clarify the philosophical basis on which their beliefs are formed. One discussion - constituting two of the items - addressed low-ability students and the relative merits of a tracking system within schools. A second line of comments dealt with the question: "What should be included in a 9th grade physical science curriculum." Neither had direct impact on the daily lesson plans of the teachers, but asked them to think about what they believe to be the nature of learning, the nature of the subject matter and the nature of their students.

A third group of items dealt with professional development and acted as a set of pointers leading participants to other resources dealing with both sets of issues previously identified. One item announced a workshop Dave was beginning to attend and he offered to share what he learned over the network. Another item mentioned the upcoming National Science Teacher's Association meeting to be held in Houston.

Finally, one item helped verify the sense of community the electronic networks seem to nurture. Dave evidently saw a reference to Bob in the *Detroit Free Press*, a local newspaper. The next time he was on-line, Dave posted a short item stating that he had seen the article in the newspaper, and left a supportive comment for Bob.

The low number of active participants in this conference severely hampered the length of the discussions in many cases, items had no responses. If there had been more participants, there probably would have been longer and a greater number of discussions. It is important to note, however, that even with the limited participation in terms of both people and volume of communications, the teachers used this network for the same type of activities as when directly tied to a curricular activity.

Observations

Three important points are raised by reflection on the usage figures. First, not all of the teachers participated, even though they each left the meeting highly motivated and excited about the continued discussions. Second, for those who did participate, they often simply joined the conference to see if anything was happening without adding any comments of their own at that time - a phenomenon I call "lurking." Finally, even though the teachers knew each other, there was still a degree of apprehension towards initiating new discussions on the part of one of the teachers.

Lack of Participation

A total of six people had participated in the Saturday morning face-to-face meeting as well as the on-line session at the conclusion of the meeting - five teachers and myself. Over the next days, weeks, and months, only two of the teachers actually connected with the conference.

I contacted the three teachers who had not yet been on-line on at least two occasions to offer technical assistance. In every case, the assistance was declined. The teachers explained that technical difficulties were not the problem. Each mentioned that with a semester ending shortly after our meeting, followed by the Christmas holidays, they had not had the time to sign on, though they *did* desire to do so. Each restated their interest in participating, and said they would sign on and try to catch up within a week. None ever did.

Lurking

According to Confer's records of participation, there were 80 uses of the conference, or sign-ons, over the year after the face-to-face meeting. Yet at the same time, there were only 39 sessions in which text was entered by the participants. In over half of the instances in which the participating teachers used the conference, they simply joined the conference, read any new information, then signed-off without leaving any comments.

If all the participants behaved the same, they would have signed on an average of 14 times each without contributing to the discussions. The number of sessions in which a participant lurked - looked in but did not contribute - is actually higher as I was one of the participants, and I made an effort to respond to something that had been submitted each time I joined the conference.

The "lurking" behavior may be important for a couple of reasons. First, if an analysis is to be performed on a system used in an educational communications project, the analysis must *not* be based specifically on the messages sent. If it was based only on the logged communications, all of the sessions in which nothing was sent have the risk of being overlooked. Most of the studies that conduct this form of interaction analysis - discussed in the next chapter - focus on the dynamics of the communications. The dynamics behind those who tend to sign-on and be passive participants as opposed to those who are active participants may help to inform us about group of teachers who have been ignored to date.

Apprehension to Contribute

A theme that emerged in the previous chapter was that of hesitation to initiate a discussion. In this conference, Barbara did not actually initiate an item of her own until January 16th - her fourth session. Though she had contributed by responding to previously existing items, I called her on the phone after she entered her item of January 16 to see if she there had been a hesitation to start a discussion. She admitted that she did feel a bit overwhelmed by the number of items that Dave had been entering, but she had finally decided that the group was small enough, and that she had, after all, met everyone, that she should feel comfortable in starting her own discussions.

Summary

The electronic conference among the teachers in this study helps to reinforce many of the observations and generalizations I made based on their participation in the curricular projects. The teachers used the network for the same types of purposes as they had in their previous involvement - those associated with becoming a better teacher.

The low level of participation is also important. The fact that only two of the five teachers actually participated in the conference supports the argument that the teachers tend to use the network only while their students are using the network for some reasons of their own. Even though there is a perceived value to the network, it is apparently not enough to gather the equipment and establish a connection unless the equipment is set-up for some other reason already.

In the next chapter I will present findings from other studies that tend to support the uses and behaviors I have identified in this and the previous chapter.

CHAPTER V

CORROBORATION FROM THE LITERATURE

Literature associated with computer mediated communications in the classroom usually comes from academics, often project developers, and seldom from practicing teachers. A plethora of articles exist describing the "physical" and conceptual elements of a successful project - from hardware and software to lists of suggestions for how long an activity should last and specific curricular points. A recently emerging set of articles are beginning to report research conducted on the effects on students, specifically on writing skills (Riel, 1989), science achievement (Lenk, 1989b) and learning styles. Little, if anything, has been published that discuss what happens with the teachers associated with network-based educational projects.

Why should a classroom teacher who is already overburdened with large classes, numerous preparations, mandated course requirements, and state tested reading objectives be interested in computer communications based projects? When so many districts place an enormous emphasis on standardized test scores and our public critics cry out for "back to the basics" curricula, should district and building administrators buy into these programs? When money in education is tight, why should a principal or parents pay for a modem, telephone line, or participation fee for a school to engage in one of these simulations?

One major implication of these projects is the dynamics of information flow in the classroom. No longer are the teacher and textbook the main sources of information and the student the receptacle. Ideas, data and information can come from anywhere now, and likewise, they can be directed to a number of locations with a variety of audiences.

In addition to changing the dynamics of the information flow, these projects have other implications. Technology is used as a tool rather than a subject of study. Indeed, many parts of the activities *cannot* be performed without the use of the technology.

In the previous chapter I presented a variety of issues, concerns and phenomena common to the five teachers in the study. This chapter presents research findings from a variety of published reports which lend corroborative support to, or challenge my observations and arguments. I will examine research findings regarding the use of computer mediated communications for group decision making in industry and higher education, and then consider what the sponsors of the previously mentioned projects claim, and what research there is regarding these claims. As I present these research findings I will relate them to my own.

Computer Conferencing

A small research experiment began in 1968 and was delivered to the Advanced Research Projects Agency (ARPA) in 1969. This network, known as the ARPANET, demonstrated the viability of computer networks.

In the beginning, ARPA, an arm of the U.S. Department of Defense noticed that its contractors were tending to request the same information resources and decided to develop a network among the contractors that would allow sharing these resources (Roberts, 1974). In addition to the original goals of networking research and resource sharing, researchers almost immediately began using the network for collaboration through electronic mail and other services. The network worked so well that it had developed into a research utility by the end of 1975.

Although researchers in all disciplines benefit by collaborating using networks, Jennings *et al.* (1986) indicate that today, communication using networks is a vital component of doing research in science and engineering. Indeed Jennings *et al.* suggest that those researchers without access to such networks are seriously handicapped in their work.

The major lesson from the ARPANET experience is that information sharing is the key benefit of computer networking. It even may be argued that many of the advances in computer science and artificial intelligence are the direct result of the enhanced collaboration made possible by ARPANET (Jennings *et al.* ,1986).

The primary effect of heavily used computer mediated communications is increased human interaction (Hiltz, 1980). Not only work related communications and contacts increase, but informal communications of all kinds usually increase an order of magnitude in volume. Murray Turoff and Starr Roxane Hiltz named this phenomenon *superconnectivity* (Turoff, 1985; Hiltz and Turoff, 1985). The unexpected volume of professional communications by the teachers in the three projects of my study are an example of this increased interaction.

Increased connectivity quickly leads to *information overload* (Hiltz and Turoff, 1985), which is the receipt of too much unwanted information, and was encountered early in the history of computer mediated communications (Hiltz and Turoff, 1981). The particular system can, itself, provide ways to avoid the additional factor of *information entropy* - that is, lack of organization or labeling of pieces of information (Hiltz and Turoff, 1985).

This information overload may be a contributing factor to the relatively low level of communication in the Rouge River project. Many of the teachers did not actively review the electronic communications until a few days prior to the student participation. By that time, however, there were dozens of communications, and pages of text in the conference. A tension appears to have existed in the minds of the teachers between the desire to search the conference for the meaningful information embedded in it and the time needed to access that same information. Trying to "catch up" with the discussions may have been an intimidating task.

In addition to changing the structure of an organization, more people are starting to work from their homes because of this technology (Brand, 1987). This may in some cases cause problems of isolation having to do with the lack of work related social contacts (Hiltz, 1977), management difficulties, etc. But there may also be increased confidence from feelings of independence, and use of the technology often causes the development of better communications skills (Mills, 1984). It also often leads to a greater number of acquaintances, co-workers, and friends, who may in turn lead to more long distance travel (Hiltz, 1980). Effects on families are also a concern. Some people find working at home very useful in managing domestic and work requirements (Hiltz, 1977). But quite a bit of self-control on the part of the worker and cooperation from the family may be necessary to make sure that both kinds of tasks get done.

In summary, the research on computer mediated communication systems in general suggest that it is a good medium to increase human interaction and access to information - and to do this in settings which may be more comfortable for those people involved. This increased interaction and access to information is the premise on which the designers of the three curricular projects in this study structured the *student* activities. My findings in the previous chapter, however, indicate that these changes in access and interaction were more valuable to the teachers themselves, than to the students.

Computer Mediated Communications in Education

Much of the research on computer mediated communications evaluates its effectiveness in higher education and business. This literature has been quite consistent: when used in business, military training and adult learning, there is no significant difference in effectiveness between computer mediated communications and traditional instruction methods but student attitudes are generally positive about using computer mediated communications (Moore, 1989.)

Viewing computer mediated communications as different from other means of educational delivery focuses attention on the "value added" by the system. This view has lead to proposals for new educational systems (Feenberg, 1987), to suggestions that computer mediated communications will have "a penetrating influence on established systems" (Meeks, 1987), and to the suggestion that the new technologies will erode the "geographical monopoly held by many institutions of higher education" (Hiltz and Turoff, 1986).

These conclusions, however, do not necessarily extend to the K-12 setting. Little research exists that specifically addresses K-12 computer mediated communications, and what does exist is limited in scope. Few long-term evaluations have been conducted, partly due to the newness of many of the systems. One review of the literature, for example, found 503 documents related to delivering education via computer mediated communications, of which only 46 examined K-12 applications. In addition, there were ". . . no studies comparing effectiveness of instruction across types of population (general K-12, exceptional students), and no effectiveness data comparing different subject areas (Eiserman and Williams, 1987.)" The literature regarding the effectiveness of teacher in-service and staff development is similarly lacking (Moore, 1989.) The literature that is available, however, is enlightening for the present and suggests future directions for research and evaluation in the field.

There are four major categories in which most of the observations can easily be classified: effects on the institution, effects on students, effects on teachers, and effects on others associated with the exercise.

Effects on the Institution

As with most new tools, computer mediated communications has had an impact on the mechanics of running educational activities. The physical setting and communications dynamics are aspects of our current educational institutions that are being effected by the use of computer mediated communications.

Physical Setting

If students and teachers do not have access to the necessary equipment, they cannot participate in computer mediated communications activities. The fact that equipment is available in a school or workplace, however, does not mean that access and participation will follow. Studies with university faculty and scientific researchers show that a greater frequency of use of communication systems occurs when the computer is located in the individual's own working environment (Solomon, 1989.) This would imply that computers and phone lines need to be conveniently located. In the Science Teachers Network, network use increased and remained the greatest among those teachers who had home computer and modem access (West, Inghilleri, et al, 1989.) Harasim (1989) finds that those teachers with computers in their classrooms communicate more often and regularly than those who must walk to a shared computer - even if it is located in an adjacent room. In a recent survey of teachers who have participated in the Interactive Communications Simulation, one of the most frequently offered reasons for not continuing with the project was difficulty in getting regular access to the equipment (Wolf, 1990.) On the other hand, those teachers who had administrative support and the necessary equipment located in their classrooms continued to participate in the project, and at high levels of involvement (Lenk, 1991; Wolf, 1990.)

Accessibility to the equipment is just one aspect of the ease to using computer mediated communications systems. The user interface also appears to be a significant variable. Many of the projects have attempted to develop software that performs many of the mundane tasks in an invisible manner while assisting the user in attending to the purpose of the communications rather than the process. Two notable examples are "The Thought Box" under development at The Open University, and the ALICE developed for the TERC Star Schools project. Both sets of software use metaphors such as Electronic Rooms as groups of communications having some logical grouping, and offering a graphical representation that allows users to "walk" through the information on the system. Both projects are in early stages of development and no evaluation has taken place to see what impact these interfaces have on student and teacher activity.

A final factor that seems to contribute to the level of involvement in a computer mediated communications project is the perceived needs or benefits gained from using the system. When information can be obtained or exchanged using more traditional and/or familiar techniques, there may be no perceived need to use the system. The use of the communications in the Interactive Rouge River Water Monitoring Project suffered because of the daily presence of university students (Though online communications were affected by the presence of the University resource people, the project in general did not suffer.) The students were present as resource people to help conduct tests and focus on the issues, but they inadvertently acted as an alternative conduit for reporting results and posing questions (Mitchell, 1989.) Similarly, when the goal or task is not clearly defined, communications tend to drop off as interest wanes. Several of the projects offered by companies running networks have attempted to create pen-pal environments. Those projects that did not provide a structure or set of tasks for the participants to pursue suffered from low participation and either terminated or began imposing tasks or activities for the students (Rogers, 1989; Wolf, 1990.)

Although the research is scarce, it appears that those projects that have had the highest level of participation are those where: 1) the equipment is located in the classroom or place of work, 2) the software is easy to use and focuses on the content of the project rather than the process of communicating, and 3) the participants have a clear purpose or goal that requires using the network.

Communication Dynamics

The evaluation of on-line records of various projects is one of the few aspects of research on computer mediated communications projects that have been published. Researchers have focused on the dynamics of interactions occurring over the computer mediated communications system.

Whereas in the face-to-face classroom environment up to 60-80% of the verbal exchange during class time comes from the teacher (Dunkin and Biddle, 1974), the pattern seems to be different with activities run on-line. Analysis of various courses conducted on-line indicates that the instructor contributes only 10-15% of the message volume (Harasim, 1987b) Analyzing the actual transcripts indicates that the interaction is highly student centered with over 80% of the messages being between students.

Inter-message reference analysis (IRA) of electronic seminars developed by Levin, Kim and Riel (1989), looks at references to previous notes in each message within a conference and draws a *message map* of inter-referenced messages. This allows the identification of organized groups of messages and the representation of the influence that a given message has on the interaction. This message map analysis shows a complex web of interaction composed of many interconnected linkages.

The two main problems with this line of research are that it deals with one type of communications environment - messages only - and it is considering only the on-line components of the communications. Most of the projects described are based on commercial e-mail or bulletin board systems.

These systems are relatively unsophisticated in their ability to organize information. The main result of IRA is in identifying groups of messages, "threads" or streams of topics within messages, and other forms of referencing between and among messages. More sophisticated conferencing systems such as Confer II, the system used for both the Rouge River and ICS projects, allow for these different communications structures by allowing a variety of types of communications. Perhaps the most useful results of IRA work will be in developing newer conferencing software.

The second failure in this line of research is that it ignores the off-line components of the projects. Depending upon the project, each communication is the result of hours of work by one or several students. Focusing on the exchange over the network ignores the dynamics that are taking place within the classroom. A proper analysis of the dynamics would include the information flow within the classrooms as well as between them. These changes have significant impacts on the teachers as well as the students.

Effects on Students

Today's students are in the midst of a technological society in a time that has been called the technological revolution, or the information age. While many people are overwhelmed by the changes, the students in most computer mediated communications activities are using the technology for their own purposes, not being swept around by it. The students are usually not in a computer room, studying computers as a subject, nor are they using disks of software to study parts of speech or facts about their subjects. They use the computer as a means of preparing and transmitting these ideas to their peers.

> "I knew nothing about computers - very little about computers - and I feel computers are important and *can* be used in subjects like social studies. This (simulation) gave us a chance to learn how to use the computer, interact with it, and use it to our advantage which otherwise I would not have done" (Wolf, 1990).

Individual student roles can abruptly shift, usually assigning much more status to those who have knowledge or expertise in areas where most of the students have little background. Overnight the "computer nerd" becomes someone who everyone likes and wants to work with. While this may be insincere at first, motivated by a need to get something done on the computer and this person possesses the skills that allow that task to be accomplished, once the students work with each other, they often lose track of the previous prejudices (Wolf, 1990).

Writing Styles

The primary mode of communication between schools in these distance learning projects is, by definition, textual. Students and teachers prepare reports, requests for information, articles, etc., using their computers as word processor, and then send these communications to other students and teachers via the computer networks. Not surprisingly, one of the first areas of research on these projects has been on their impact on students writing skills.

Researchers interested in writing have studied skills displayed by expert writers. The importance of the writer's audience analysis repeatedly appears in their studies (Berkenkotter, 1981; Flower and Hayes, 1980). Verbal protocols indicate that experienced writers develop a strong mental image of their audience during all phases of writing, whereas less skilled writers tend to be topic bound, paying little attention to audience (Flower, 1979).

Unlike real world writing situations, school writing usually requires that the student write for a single authority, the teacher. The student must demonstrate his/her authority on a given subject. Berkenkotter (1981) claims student writing is topic bound because the tasks it addresses preclude the need for audience analysis.

Writing to communicate ideas to someone other than the teacher is not an activity that is commonly found in schools. Applebee (1981) found that there are very few instances (less than 12% of all secondary school writing) where the writing is addressed to someone other than the teacher. Even when communication situations were created by researchers where students were to *imagine* that they were writing to a particular audience, it was found that students responded without paying much attention to this imaginary audience.

Computer network based activities provide an increased range of audiences for students' writing. Many of the projects described have developed environments in which students write for specified audiences on topics about which they want to communicate information and ideas. Hudson (1985) finds more attention to audiences, writing purposes, and genres in self-sponsored writing than classroom-assigned writing. It is reasonable to expect, therefore, that network based activities will help to improve student writing skills.

In one of the few studies published about effects of network activities, Cohen and Riel (1989) showed a clear improvement in writing when students wrote to communicate with their peers over a network as compared to when they wrote to demonstrate their skill for their teacher's evaluation. The expectation of a cultural gap between the writers and their peer audience prompted them to write better organized and more formal compositions. When writing for their teachers, the compositions were less complete. Assumptions were apparently made by the students about shared background information which was left out of the compositions, and the writing was more informal and often included colloquial expressions.

A majority of these network projects create learning environments where students can experiment with audience and writing purposes. By placing the writing in a communicative setting, students may be more likely to utilize skills learned in the classroom outside of school.

Working - Learning Environment

Many communications projects are designed to help teachers expand upon what the learner knows. An early step in this approach is to exploit conferencing to help students discover what they already know and what they need to find out. Next, through the conference dynamic, students can get direct experience through peer leaning. Assessing and reflecting on the ideas and opinions of fellow students is a valuable extension to reading the materials of a text. Conferencing has been shown to support a more active and involved style of learning on the part of students.

The nature of the on-line domain contributes to developing active learning environments. Students actively present ideas and respond to one another's work, facilitating higher levels of understanding (Harasim, 1989)

The idea behind many of the communications projects, for example, is to enable students to be scientists (or engineers or mathematicians), to experience the creative excitement of discovery, and to construct their own science concepts.

They *can* make an amateur science contribution. There has been the tradition that amateur scientists can make a valuable scientific contribution through their observations. Throughout the 19th century talented amateurs contributed to the vast amounts of data assembled by the National Geographic Society. In this century the National Geographic Kids Network involves students in this tradition. In the weather unit, for example, there are thousands of students observers who measure temperature and rainfall in their environments

Instead of attempting to cover several content areas, this approach allows students to master one area thoroughly and to experience the joy of participating in the process of science. Tinker (1989) claims that students come away from these experiences liking science and seeing themselves as future scientists.

"We have chosen to use technology to get kids involved deeply in discovery, in the art of science itself. We expect your students to discover something new by themselves, no matter how trivial. In so doing, they will learn a topic in great detail in a way that will last a lifetime. More important, we expect them to gain deep insight into the conduct of science and technology, an understanding that should be important to them whether they select a technical vocation or participate as citizens in decisions that involve technology" (Tinker, 1989.)

On-line projects designed around collaborative learning approaches generate more active and interactive learning: it appears that a more equitable pattern of communication among class members also occurs. Analysis of usage data suggests that communication among class members in on-line courses is relatively equitably distributed (Harasim, 1987b).

An analysis of user rates and patterns as well as student reaction again strongly indicates that computer conferencing has the potential to offer both qualitatively and quantitatively different, and in many cases better, learning experiences that that of the classroom. Students reported more active participation and interaction and more effective learning in the on-line course than in classroom courses. (Harasim, 1987)

Anonymity from Stereotypes

An interesting aspect of computer mediated communications in education that is beginning to gain the attention of researchers is the faceless character of the medium. Since communications are written, and at a distance, much of the non-verbal information that is present in face-to-face exchanges has been removed. Prejudices against sex, race, age, physical or emotional handicaps, and any other attributes normally discernable through visual assessment do not immediately arise. There is some evidence that, in the ICS programs at least, students invest much more effort and time into the collaborative aspects of the project than they would if they had some of their collaborators early into the project and allowed their initial stereotypical assessments to prevail (Wolf, 1990.)

During the Fall 1988 field testing of *Our Air*, the weather unit of the National Geographic Kids Network, it was often difficult to spot a group of mainstreamed special education students. They were as actively involved as their regular education peers in this hands-on science curriculum and telecommunications network. The unit's wide variety of features stimulated the mildly disabled students to apply their *abilities* to study weather problems. The students were able to learn content by functioning independently, interacting with small cooperative learning groups, and participating in the larger classroom discussions (Mischio, 1989.)

Anonymity from the attributes that are often used in forming first impressions shows some positive potential as stated. We must be careful to also examine the opportunities for abuse that also arise. Some of the questions that we must start to ask about the faceless aspect of this technology include: Are the dynamics of discussion different? Are questions asked and left unanswered intentionally? Do people talk past each other? We now have the ability to ignore questions and/or students. What percent of questions are left unanswered? These questions can only be answered by a concerted effort to examine what is happening both within and between classrooms.

Effects on the Teacher

Many teachers experience frustration in their initial involvement with computer mediated communications activities. There is a large amount of new information and skills that need to be acquired. If the teacher is to maintain the tradition role of complete control over all aspects of the educational environment, they must master three computer systems (word processing, local communications system and the remote communications system), as well as the subject matter. The following was provided by a teacher facilitator in the ICS programs describing their daily routine:

> At our school the Social Studies teacher handles the student portion during her regularly scheduled class time. The TAG (talented and gifted) teacher prepares the items for uploading during her regular duty day, sometimes having to put in a few hours after school to prepare the items. I, as the computer teacher, do the uploading, downloading, editing and printing for the classroom teacher before I start my regular duty day and after school. This is my second simulation and I know I have gotten faster at it but it still can take up to two extra hours outside of my regular day. I come it a 6 am to take care of my portion of the simulation to have it ready for the teacher. Then I start my regular day at 8:00 (Wolf, 1990.)

Even with schedules and time commitments as indicated, teachers keep repeating the exercise. They see how excited the students become, and they see some of the changes in the students that we have described. While this example indicates that the group this teacher works with at her school is still trying to control most aspects of the process, veteran teachers generally learn to involve the students in an increasing number of the processes.

Computer mediated communications can add new human resources to the traditional classroom. These resources can be other teachers or contributions from interesting and unique people from many walks of life. These resources will change the design of courses and how teachers conduct their classes. In fact, many teachers develop new skills and insights that carry over into their regular classrooms (Barker, 1989)

One area of change is the teacher-student relationship. The new medium does not replace the teacher but provides an alternative way for teachers and students to meet. A feeling of group membership developed in on-line classes at the university level, and students frequently were able to learn as much from each other as from the teacher (Feenberg, 1986.) Students sought out faculty more often at the University of Guelph, provided more mutual help, and opened clubs to recruit each other on the undergraduate system. Faculty are having to invent on-line activities and discover the means for evaluating or giving credit for contributions made there. Some technocratic staff have noticeably improved their ability to help and communicate with the technically illiterate when they are approached and can respond with the necessary time lag via computer mediated communications. (McCreary, 1989)

Collegiality

No Educator should be an Island. When educators want information and they're looking for ways to enrich their classrooms, they may turn to colleagues for help. Computer mediated communications provides the opportunity to link teachers who might normally be isolated from their colleagues. At many schools, a teacher is the only person in that school teaching their particular courses. Even at large urban high schools, it is unlikely that there will be several teachers teaching the same subject.

The Science Teachers Network and Lab Sites Networks were developed specifically to address the perceived problem of teachers isolation. The network was intended to create opportunities for collegial exchange of specific information, and more personal and general "reflections" about teaching and curriculum. Teachers only sometimes offered views or discussion of more abstract points, and the general conclusion was that teachers will use collegial computer mediated communications systems to the extent that it is directly tied to their immediate classroom priorities (West, Inghilleri, et al, 1989.)

Summary

Though most of the existing research on computer mediated communications in education does not directly deal with teachers, there are sufficient findings to lend support to the themes that emerged in this study.

The critical role of teachers in effective learning means that all must have training, preparation, and institutional support to successfully teach with technology. Networked communications have dual impacts on teachers: as a tool for teaching and as a means to upgrade their own skills and professional development.

Although it is the technology that removes the barriers and expands opportunities for learning, it is the teacher who teaches. In network based activities, teachers find that they are required to change their methods of teaching. Many teachers report that the experience has improved their teaching skills. It has forced them to become more organized and has challenged them to become innovators.

Teachers who work with colleagues via distance the network are finding opportunities for new relationships: sharing parts of a course, sharing resources and lesson plans, and learning from master teachers. The technology itself could be a mechanism for boosting the professionalism of teachers by fostering access to experts and making high-quality training and professional development available to teachers wherever they are located.

In the following chapter, I will use these findings, and the findings from my study, to discuss a variety of implications and suggestions regarding the design and use of computer mediated communications projects in education.

CHAPTER VI

ANALYSIS AND REFLECTIONS

A researcher who looks at innovation and the implementation of change must attempt to walk a fine line during his/her analysis and recommendations for action. It would be easy to focus only on the forces which passively or actively interfered or hindered the process. It would be just as easy to ignore all conflicts and setbacks, thereby announcing the innovation fully implemented. My goal has been to strike a balance. Throughout this study I have woven observations, interviews, documents and personal experiences into the story of five teachers using computer mediated communications projects in their science classrooms, and have endeavored to present the situation from my perspective, while also allowing the reader to draw his/her own conclusions.

In this chapter, I will review the questions with which I began this study, identify factors which have played a significant role in the experiences of these teachers, and suggest areas for further research. Last, I will offer conclusions and recommendations which will summarize what I have learned.

Research Questions

The structure of our educational system appears to be based on the strong belief that something significant happens when teachers meet students in classrooms. For several years there as been a continuing interest in determining those teaching practices which most promote student learning. Most of the studies on classroom practices have related to the learning and development outcomes of students rather than the learning and development and quality of professional life outcomes for the teacher. I began this study with an interest in the experiences of teachers involved in the three computer mediated communications projects in which I was involved. I was particularly interested in the way that some of them had shown a renewed vigor in their approach to their professional duties.

Are there common factors among the teachers who participate in this type of project?

The teachers who participated in this study had varying backgrounds. They represented both inner-city and suburban schools. The teachers were of varying age, gender and race. The three factors all five teachers had in common are that they: 1) taught science, 2) were interested in the use of computers in their classroom, and 3) had volunteered to participate in one of the curricular projects.

The fact that the teachers are all science teachers is not surprising in that all of the projects were designed for science classrooms. That all of the teachers were interested in using computer technology in their classroom may have a bit more import. The teachers all claimed they had colleagues who had no interest in using computers in school for any reason. The approach the teachers in this study took seemed to be that the computer is just another tool in their array of professional tools, and they wanted to explore ways in which it could be used. This shows that these teachers have an interest in developing and exploiting a variety of resources. Similarly, each of the teachers were volunteers. The fact that they were aware of the new projects - even if only by reading a letter to them from a department chair, shows that they were interested in self improvement.

> *What are the technical considerations the teachers had to address? What equipment was needed? What did the teachers have to do to acquire the equipment? Where was this equipment located?*

In each case, the teachers mastered the technology relatively quickly. In some cases they delegated the operation of the technology to students who had previous experience. In other cases, they invested the time in mastering the technology themselves.

The only technological challenge that was not overcome by any of the teachers was when the TERC software didn't perform properly. TERC had attempted to design a system that would minimize the time a school actively used the networks by automating each of the steps a user might normally perform manually. When difficulties with the TERC software arose, there was no recourse to pursue for those teachers who had no knowledge of the individual steps of the process.

A larger problem with the technology was not in it's operation, but rather in the administrative task of obtaining access to a telephone line for use by the students. In each school this was an administrative hurdle - even though every teacher had prior verbal approval from their administrator.

How can the integration of "expert participants" be enhanced in the operation of these network based activities?

Each of the three projects in this study were distinctive from other communications based science projects in that they included subject area "experts" as part of the network of participants. In the Rouge River project, these experts were drawn from university students and faculty as well as industry and regulatory officials whose job responsibilities included aspects of the Rouge River's water quality. TERC recruited scientists for each of it's units, such as Margo Oge of the U.S. Environmental Protection Agency for the Radon unit. In the ICS activity, the university undergraduate and graduate students acting in the role of "Mentors" provided this expert base.

There were mixed perceptions reported by the teachers and students as to how effective this participation was, as indicated in Chapter III. In many cases, the teachers and students felt that the answers they received to questions they sent to the experts were "canned" or prepared ahead of time. The complaint was that the experts were either too vague or generic in their responses, or didn't address the specific issues raised by the students or teachers. Worse yet, in other cases, questions or requests sent to the participating experts never resulted in responses received by the schools.

To be fair to the people acting as expert resources, there has been little, if any, evaluation as to what their role is in these projects. There are several aspects of this participation that should be investigated - time demands, rewards, and intellectual stimulation to name three.

The time commitment is unknown for a new project, and many of these people have little time to devote to answering the requests from the schools. If the TERC project had been as successful as anticipated by it's designers, there would have been over 2,000 schools participating in each of it's curricular units every term by the end of the project's third year. This means that the EPA's lead scientist on Radon, for example, would potentially be answering questions and requests for information from a pool of roughly 50,000 new students every four months!

If the experts were able to find the time to thoughtfully respond to all of the requests, it is not clear that they would be rewarded properly for their participation. It may even be argued that they could suffer professionally as a consequence of this participation. In the TERC project and the Rouge River project, the experts were either academics or professionals participating because the activity matched their professional interests. In all cases, these experts were volunteers. In current academic settings, there is little reward to faculty who participate in this type of activity - it doesn't result in juried publications nor the generation of new knowledge in the subject area. In the case of professionals, unless their job description specifically includes education, many felt that they may have a hard time justifying continued participation.

Regardless of the time and ability to justify participation from a job description point of view, many of the experts discontinued participation from a lack of intellectual stimulation. Each of these experts had been identified as such because of the level to which they had risen academically or professionally. They would not have been "experts" if they had not spent a considerable amount of time studying the subject matter. The questions presented by the students, though, were relatively simple, and often repetitive. The experts lost intellectual interest after explaining the same basic concepts or details repeated times.

The model for expert participation presented by the ICS activity, and in some ways by the Rouge River project - that of using university students - may help to overcome some of these difficulties. Indeed, by using university students as the subject area experts, many of these difficulties are not only eliminated, but turned into advantages.

The "expertise" of the university students does not reside in their demonstrated capabilities, but rather from the resources at their disposal from being a member of the university environment. The work they must perform to research and answer the questions in a manner that is acceptable to the secondary school community may facilitate a better understanding of the basics premises of that discipline by the university students themselves. If this is correct, then the "rewards" could be institutionalized by awarding academic credit to the participating students. The annual addition of new students at the university level also provides a constant pool of new "experts" to replace those quitting because of graduation or loss of interest.

What are the professional responsibilities of the organizations running these projects, and how can appropriate levels of competency be maintained?

It should be clear to the reader that I was involved in the operation of these projects to a much greater degree than just an observer of the experiences of the teachers. I worked on the development and implementation of each of the projects. I invested a considerable amount of time towards helping the teachers understand the concepts and overcome difficulties they encountered. Much of my experience has lead to my beliefs and concerns as stated in this document. I believe that, to a certain extent, the successful experiences many of these teachers had was due in part to the efforts I was able to invest in working with them to be successful.

My experience in working with these projects leads me to believe that my ability to invest the needed time and energy is perhaps unique, and surely uncommon, in network based projects. For example, the University of Michigan was one of twelve centers working to recruit and train teachers for TERC's Star Schools project. Each center committed to recruit and train 100 teachers by the end of the first year of the project. At the end of that year only 200 teachers had successfully participated. Almost half of these successful participants - 95 - had been recruited an trained by the Michigan center, while the other eleven centers pretty much equally contributed to the remaining 53% of the successful participants.

In discussions with the directors of some of the other centers they complained of a variety of factors that made adequate support difficult to provide. It was difficult to hire someone with appropriate technical skills for a limited - one year - contract with the funds available to the project. On the other hand, if someone was hired for a fractional position, they had other demands and could not meet all of the demands. If university students were involved, they introduced a lack of continuity and a need to retrain the trainers from year to year. In essence, there was no professional place for the people needed to run the project. Finally, the computers used by the public schools were usually older and simpler than those present in the University environments. It was difficult to locate people within the university environment who had the technical expertise to support the public schools' older technology.

The success, I believe, of the Michigan center in training and supporting teachers for TERC was due to the fact that I was working on two or three projects at once. In fact, Michigan had participated in the TERC project as a way to pay my salary for supporting the ICS project. I was also intellectually interested in a variety of aspects of using this technology in education - the subject of this dissertation being just one. I had created my own niche, had developed expertise with the technology, and was able and willing at that time in my life to commit full time resources to supporting the activities for a salary that would not support someone at a professional level.

If TERC's Star Schools project had continued, it would have been difficult to provide the same level of support much longer, with the same level of funding. If these types of educational activities are to become institutionalized, they must not depend upon the energies of graduate students. Overcoming this challenge may be one way in which the projects validate themselves.

How did the teachers use the network? What did the teachers see as essential elements that encouraged or discouraged their participation their participation?

It became apparent through this study that the teachers involved in computer mediated communications exercises view the network connections as more than just a tool to connect their students with students in other schools. The teachers used the network as a tool for the students, but, possibly more importantly, they also used the network as a tool for their own professional growth. They used their participation in the various projects to raise their own status among their colleagues and by their administrators. They used the network to exchange subject matter and professional information. They also used the network to communicate with other teachers dealing with similar issues and subject matter in other locations.

Even though the teachers in the study had used the networks for professional growth and felt comfortable with the technology, three of the five failed to participate in the electronic conference established specifically for the study. They all agreed that there was a real reason for them to participate, and they all acknowledged that they had plenty to gain personally from participation, yet over half never did connect.

A similar phenomenon appeared in the Rouge River project. In that project, all of the teachers were trained in how to use the technology several months prior to the two week intensive curriculum at the schools. As with this study, most of the teachers who had gone through the training did not participate in the network discussions until their students were also active on the network during the two week period.

Similarly, in both the TERC and ICS projects, there were occasions when two or three teachers who had been working closely together during the curricular phase of the exercises asked if their accounts could be kept active so they could continue to communicate. In the four cases that I was aware of, none of the groups of teachers actually used the extended accounts.

It appears that the teachers consider this as a professional tool as well as a curricular tool, yet choose only to use it in a professional capacity while actively using in a curricular capacity. Future investigation is needed to gain a better understanding of this phenomenon.

How did participation effect the teachers sense of empowerment?

Teachers are expected to act as professionals, but they are told to take on tasks that are assuredly nonprofessional and decidedly demeaning. "Two years ago, I spent the beginning of each school day watching people park their cars, making sure students didn't park in the teachers' spaces," said Bob. "The year before that, I stood in the courtyard watching students smoke. For another 45-minute period, I watched students study and signed corridor passes to exciting places like the lavatory and the library."

More than altruism is involved in trying to alter the circumstances of teaching. If the job is so undesirable that not enough qualified people want it, then there may be an awful lot of kids without anyone to teach their classes in the next few years. The reality is that teacher shortages are already developing and are expected to grow worse in the next decade, when the higher birthrate of the 1980's will push enrollments back up, though there are serious differences over how critical the shortages will be.

There is a paradox in discussions of teachers and power. On the one hand, teachers ostensibly have more freedom in their work than do those in many occupations. When the classroom door closes, the teacher typically has enormous latitude in deciding how to teach a lesson. Teachers spend most of their working time out of sight of any supervisor. Granted that students and the parents of teachers look over the shoulders of teachers, but they do so no less than patients and clients who keep their eyes on physicians and lawyers. Journalists have a reading public and business people have customers. So the fact is that aside from infrequent observation by a principal or some other administrator the teacher is essentially on his or her own. It is true there are lesson plans to file and reams of forms to fill out, but, despite the complaining by teachers, accountability by paperwork is not unique to their craft.

What is it then that makes the situation different for teachers? For one thing, teaching, more than any other occupation, is practiced in isolation, an isolation that is at times crushing in it's separateness. Is power conferred on someone simply by leaving him or her alone? Collegiality is nonexistent for many teachers, unless hurried lunches over plastic trays in unkempt lunchrooms are viewed as exercises in colleagueship, rather than the complaint sessions they are more likely to be. Knowledge is the currency in which a teacher deals, and yet the teacher's own knowledge is allowed to become stale and devalued, as though ideas were not the lifeblood of the occupation. The circumstances of teaching, exacerbated by the relatively meager salaries, add up to a status so low that often teachers do not respect themselves or each other.

"Perceptive researchers have told us for years that teachers are treated as if they have no expertise worth having," the Carnegie Forum's Task Force on Teaching as a Profession said (p. 39). "An endless array of policies succeed in constraining the exercise of the teacher's independent judgement on almost every matter of moment. There may be some who believe that all this is fully justified by what they perceive as teachers of inadequate ability. But the plain fact is that the many good teachers we have are being driven out of teaching by these conditions, and it will be impossible to attract many new people of real ability to teaching until conditions are radically altered."

Giving teachers power is a major way to make them more professional and to improve their performance. Professionals usually have a sense of authority about what they do and are recognized as experts in their fields. They feel good about themselves and are respected by others. The empowerment of teachers has to do with their individual deportment, not their ability to boss others. The kind of power I mean is not of the strutting, order-issuing variety. It is the power to exercise one's craft with confidence and to help shape the way that the job is done. This is the teacher empowerment I saw with the teachers in this study. The "confidence" to which I refer is the confidence teachers have in themselves and the confidence others have in teachers.

Teams organized to conduct interactive research on schooling found that what enabled some teachers to maintain positive attitudes about their jobs were the freedom to be creative and innovative, the capacity to influence students, opportunities for feedback, recognition and support, and the chance to share with peers (Lieberman, 1986). Such is the stuff of which empowerment is made.

Empowerment does not necessarily mean being in charge though that is possible; more than anything else it means working in an environment in which a teacher acts as a professional and is treated as a professional. The inevitable result is empowerment.

There surely is no single way to empower teachers and to improve the circumstances of their employment. One effort to empower teachers was the Rockefeller Foundation's program to strengthen arts and humanities education in the secondary schools, CHART. It began in 1983 in Philadelphia and then expanded with grants for projects in Atlanta, Los Angeles, New York, Pittsburgh, St. Louis, Saint Paul, Seattle, and a group of rural school districts in South Carolina. Other teacher enhancement programs include the teacher enhancement program of the National Science Foundation, and the elementary and secondary schools program operated by the education division of the National Endowment for the Humanities (NEH). Three guiding principals have been identified as central to all of these projects:

- Boosting status is fundamental to the process because those who have lost the will are not likely to find the way. Teachers themselves make it abundantly clear that the ability to look at themselves and their colleagues through new eyes has liberated them from self-imposed shackles of self esteem.

- Making teachers more knowledgeable is an obvious step in enhancing their power. Francis Bacon said it long ago, and it has never been said better: "Knowledge is power." Part of the reason why teachers have not exerted more authority is because they are not sufficiently well informed to do so. A teacher not versed in history must assuredly depend on others to supply a curriculum for a history course. A teacher intimidated by mathematics is not likely to be able to critique a textbook. Teachers shaky in their academic pedagogical backgrounds must repeatedly defer to the judgments of supervisors, who are given the time to be the supposed experts.

- Finally, allowing teachers access to the lofty towers of power means building psychological ladders they may climb to escape their isolation and gain the overview that few of them usually attain. It also means connecting teachers with each other and with principals, building a kind of collegiality that has been all too unusual in elementary and secondary schools. (Lieberman, 1988).

Recommendations

The following recommendations are offered for consideration in the design an development of future computer mediated communications projects based on the findings of this study.

Technology

The three projects presented two extremes towards the consideration of what technology should be used in the project. TERC started from scratch and built a system that was partly run by the schools' computers and partly by the host machine in Cambridge. An advantage to this approach was that the software could be designed to do exactly what the project staff wanted, and represented a potential economic savings in the future when the software could be distributed at little cost rather than paying for commercially priced software.

As second advantage to this approach was that much of the interaction between the two computers would be anticipated and pre-arranged resulting in less actual connect time, often an economic constraint. TERC's software was programmed with full knowledge of every interaction that would occur between the two systems. Minimal information was exchanged, and any unknowns, such as the names of files to be exchanged as well as what to do with the file, could be specified before a connection was established, also reducing connect time. The participants did not need to understand, or even know, what decisions and processes were taking place.

One disadvantage of TERC's development of their own software was the short development period forced by the funding schedule. Becuase the software needed to be in use within months of funding approval, it was not as robust as most commercially available software. The teachers kept experiencing bugs and glitches that blocked their participation. Questions could be called into the centers who were supporting the teachers, but in most cases the centers had to refer back to TERC. Longer development time prior to distribution may have helped, but the development staff felt that they had tested the systems adequately anyhow, so the same problems, or others, may have surfaced anyhow.

A second disadvantage was that all schools were required to obtain specific hardware for this project. The initial software development for the TERC project was on Apple IIGS computers, followed by MS-DOS computers the second year. Many schools not represented in the context of this study purchased the equipment specified so teachers could participate. The third year of the project, TERC released their "final" version of the software - ALICE - which they had been working on for the previous two years. This "ultimate" software was NOT available on the Apple IIGS and had very specific demands in the DOS environment - much more specific than the previous versions. As a result, several schools invested thousands of dollars in computer hardware based on TERC's requirements, and were unable to use that hardware for the final version of the software.

ICS and the Rouge River Project, on the other hand, made no specific demands on hardware or software used by the teachers. Any hardware the teachers had available was appropriate. Teachers were encouraged to use any software they or someone at their school was familiar with, or specific suggestions were provided by the project staffs. This made it economically more feasible for the schools to participate, and in many cases provided local expertise by someone at the school who had previous experience using a computer for communications.

A disadvantage to the approach taken by ICS and the Rouge River Project is that the support staff needed to be familiar with dozens of pieces of software. Common directions and descriptions of general procedures were distributed by the projects, but specific details - which keys to press, etc. - could not be distributed for every type of software in use. In practice, though, supporting the various forms of software was not very difficult. When a new piece of software was introduced by a school, the support staff would prepare suggested routines and a set of answers to the most commonly occurring problems.

The host software used by ICS and the Rouge River project, Confer II, had been in use at the University of Michigan for many years prior to the initiation of the exercises. This software had been sufficiently tested over the years that no problems occurred with it during either of the exercises.

A disadvantage was that the teachers had to understand the commands and processes needed to operate within the Confer environment. They had to manually tell Confer what to do, and they had to do this while actively connected to Confer. This required them to make more decisions than with the TERC project, as well as using larger amounts of connect time.

The two approaches represented narrow down to: 1) Developing software that is highly automated and customized to a given project, or 2) Allow the participants to use any software available, but spend more time in training them to understand the software and processes so they can manually perform the necessary tasks.

As the main support person for both exercises, I would recommend a more flexible approach, along the lines of the Rouge and ICS projects. I give two reasons for this suggestion:

1. When a participant runs into difficulty with highly automated software, there is little they can do. In most cases, even if they understood the processes, they did not know the specific commands to allow them to manually override the problem.

2. Computer and software technology is evolving so quickly that it is difficult to predict what will be available in the near future. TERC's software evolved so quickly that within two years, the required hardware was obsolete.

Curricular Design

One of the most significant findings of this study is the extent to which the teachers used the network for professional growth. All three projects had assumed a small amount of communication would occur between and amongst the teachers, but none expected the volume of use and the variety of tasks the teachers accomplished with this network.

Future curricular projects should include specific aspects that help the teachers to use this medium as a professional tool. Resources are needed to help the participating teachers discover the names and interests of the others in the network. Similarly, resources need to be provided to help the teachers access and utilize more of the features and built in resources of the networks. Many systems, for example, are not designed and operated in isolation specifically for these educational projects. In many cases, other resources are available on the same host computer or through the same network. Future exercises should take these existing resources into consideration and provide help to the teachers in accessing and using these resources, even if they don't specifically address the curricular topics of the projects. As we have seen, the teachers may use these resources for a variety of professional purposes.

Finally, the experiences of the teachers in this study leads one to believe that teachers will not use communications networks except when their students are actively working on projects using the same technology. Yet at the same time, the non-curricular uses of the network by the teachers are exactly those processes and activities recommended by advocates of increasing teacher empowerment and job satisfaction. Efforts have to be made to extend teacher professional activity beyond the time limits of the curricular projects.

Suggestions for Future Research

During this study I found two discrete foci of previous research studies. Some studies looked at the effects of participation in computer mediated communications projects on the students involved in these projects. Others described the "physical" and conceptual elements of a successful project - from hardware and software to lists of suggestions for how long an activity should last and specific curricular points. Five further areas of study are recommended for research to advance our knowledge and inform our practice.

1. Studies have indicated that teachers with more overall work satisfaction are likely to experience less stress than teachers with less overall work satisfaction (Kyriacou and Sutcliff, 1978; Menlo, *et al.*, 1987).

Stress, in turn, has been related to teacher burnout and its consequences of teachers either leaving the profession or remaining in it in an unhappy, self-shackling manner (Cedoline, 1982; Dworkin, 1987). It has also been suggested that a high quality of professional life for the teacher contributes to an increase in student achievement (Chapman, 1983; Duke, 1984). Perhaps the most important finding of this study is that the teachers used the networks for a variety of purposes that have been identified in these and other studies as ways to increase teacher empowerment and improve the quality of their professional life. Continued study into specific details regarding the teachers involved in these projects - their perceived quality of professional life, and their feeling of empowerment - would help to understand if the potential apparently offered by the network to improve these factors is achieved in reality.

2. Studies of innovations in education fill volumes. Still, innovations are frequently ignored or rapidly discounted after the implementation stage; in other words, research does not necessarily as the questions educators would like to have answered and education does not always learn from past difficulties. Fullan says, "The educational system should turn its knowledge about learning inward on its own problems of change. It is truly ironic that the usual ways of introducing and supporting change violate so many of the principles of learning" (1982, p. 296). Microcomputers and other interactive technologies have been available in classrooms for over ten years. It would be useful to ask what factors inhibit the adoption and implementation of technological innovations by teachers.

3. There is little research on the cultural and social implication of technological innovations within schools. In this study, the teachers reported a variety of changes they felt in their own social status as well as

the dynamics within their classrooms. The formation of inter-classroom, geographically dispersed, many-to-many communication links is a phenomenon that is perhaps unique to this type of project. The careful study of contextual changes of a school as computer communications technology is implemented would constitute an important addition to this literature.

4. It has been reported that only one-third of newly graduated teachers feel comfortable with computers (U.S. Congress, 1988, p. 100); even less have an understanding of the issues surrounding computer mediated communications. It would prove valuable to follow a cohort of teachers as they move through and beyond a teacher education program that includes a specific body of knowledge about communications and electronic technology. What influence would their familiarity with the technology have? How would they use the technology in their classrooms? What attitudes would they hold toward the technology, cooperative projects, and the adoption of technologically based innovation in their classrooms?

5. Computer Mediated Communication affects the educational process in a number of ways. Teachers report students having a greater responsibility for their own learning and that their experience helps them make the transition to higher education. Teachers also report that students benefit from exposure to a greater range of ideas, peers, and teachers made possible by the expanded community. Whether computer mediated communication works equally well for all students is yet to be determined. Most applications to date have been with academically advantaged high school students and independent adult learners - those who already possess strong study skills and high motivation. Whether the medium works as well

with young or academically weak students - and under what conditions - needs further study.

Contribution of the Study

This study has presented a look at the involvement of five teachers in computer mediated communications exercises in their science classrooms. It has been my intention to describe the common experiences of these teachers and the uses to which the put the network. In addition I have described the similarities and differences between the projects, and the variety of ways in which the teachers used the networks for professional growth.

Findings are that: 1) Teachers need support from someone with detailed knowledge of the hardware, software, and pedagogical expectations of the systems at hand. 2) Support for the person(s) expected to provide such services must be placed on a more rational basis than is the case now. 3) Professional development and curricular activities appear to work best when they are integrated, not treated as components of computer mediated communications to be delivered separately. 4) Teachers value greatly learning things from one another that bear directly on the teaching of their present instructional responsibilities. 5) Teachers will work very hard if they see their students learning as a result of their efforts. 6) Computer mediated learning can be "fun" despite its time and energy consuming nature. Indeed, if the teachers, students, "mentors," and technical systems support personnel do not enjoy their participation, there is little evidence that this line of educational development will continue to exist.

Wide interest exists in the potential of computer mediated communications projects in education as we approach the twenty-first century. This study has offered an understanding of five teachers involved in three of the first large scale computer communications projects created for science education. Although most educational innovations do not produce much impact in their first year or two, it is important that researchers continue to observe and analyze them. This study has identified areas of concern and difficulty, and should contribute to the implementation of future educational innovations.

EPILOGUE

The original title of this document was to be: *The Use of Computer Mediated Communications Networks by Middle School and High School Science Teachers for Curricular and Professional Development Activities.* After struggling his way through the first draft, one of my committee members asked: "How can you say this works?" pointing out all the teachers' frustrations and difficulties I have reported. He argued that I should change the name to: *Computer Mediated Communications and Science Teachers: It Doesn't Work!*

On the other hand, the reason I undertook this study in the first place was my casual observations that many of the participating teachers showed renewed interest and excitement about their profession. At the very least, I was excited about what I saw happening in the participating classrooms. How, then, does one reconcile the views that computer mediated communications projects create almost insurmountable hurdles, yet also accomplish a great deal towards changing the educational setting?

First, I must state that I don't see a conflict. The structure of our educational system has stayed essentially the same for over sixty years. Any changes will encounter significant resistance in a conservative environment. It is this resistance to doing things differently than the established, traditional way that creates the feeling that we may not be able to "get there from here."

The bureaucracy was apparently defeating the attempts of these projects to create change in a few almost predictable manners:

- ***"We don't have the necessary equipment."*** Computers are still somewhat new in schools. In some cases, sufficient equipment was sitting idles in the school, but it belonged to a different department and was just as unavailable as if it didn't exist.
- ***"We don't have a phone line."*** It was difficult to obtain permission for, and installation of, a phone line in an accessible area. The main concern here was monetary - who would pay for the cost of the phone. Even when a Science Department was willing to commit money to pay for the phone line, it was difficult to budget money for a variable cost.
- ***"Who will pay for the participation fees?"*** In an era of cost cutting and efforts to go "back to the basics" it is often difficult to secure the participation fees needed to provide the support structures provided by the project staffs.
- ***"It doesn't fit into the curriculum."*** It is not clear exactly which course the various projects "belong." Indeed, the three projects described in this study were intended to be able to fit into a variety of courses. Since none of the materials state that the projects belong specifically in this course or that course, the schools seem to have a hard time placing them in any course. My impression is that this objection would not be raised if the materials were clearly labeled with phrases such as "This is designed for an introductory physics class."
- ***"Teachers don't have time to learn how to run the equipment."*** The ICS staff likes to answer when asked how much time does this take: "Imagine spending more time on this than anything else you've ever done while teaching. Now double it." There is a large time

commitment to these projects. On the other hand, it doesn't have to be as much as many teachers make it. In many cases the teachers have delegated all of the technical responsibilities to students, eliminating the need to master the technology themselves. In other settings, the administrative tasks have been delegated to the students. The most successful teachers seem to be those who don't feel as if they have to know about, and approve, everything detail of every activity associated with the project.

- ***"How can we keep the participating 'visiting experts' interested enough to return?"*** Each project has had difficulty in keeping the visiting experts interested. There is little motivation for these people to participate other than altruism. If rewards could be established such as recognition, money, research opportunities or other rewards, we could expect increased participation from these people. We should also consider the ICS model where participation is not from the experts directly, but rather from their students.
- ***"We'll wait until the hardware and software is easier to use."*** Linda's experience shows us how difficult it may be to operate the computers and software. Even when she had things right, the machine at the other end of the line wasn't working correctly. In most cases, the projects are using technology that has been around for years, but in use for business or higher education purposes. The difficulties that the teachers have experienced were mainly due to adapting these existing systems to the special needs of the educational environment.

With all of these barriers to running these projects, and more, discussion at the oral defense of this dissertation included whether or not the title of this document should be: *It Doesn't Work!* As one committee member argued, I had documented dozens of instances where the teachers had faced these difficulties that proved that it doesn't work.

On the other hand, I have shown that in many instances it *does* work. I have not addressed issues associated with student outcomes in this document. It would seem to me that a careful evaluation of what the students get out of these projects would be needed before we can say whether the projects "work" or not. Anecdotal information from the teachers leads me to believe that the students *do* learn quite a bit from these projects, but documenting these outcomes would be a completely different study. I believe that the value of these projects lies as much in their capability to meet the professional needs of the teachers as in their direct impact on the students, and this is where this document has focused.

I believe I have shown that an area where the technology of computer mediated communications does work is in reducing teacher isolation and increasing professional skills. I have documented how these teachers have used the network to contact others with similar interests and job responsibilities to share ideas and materials.

The purpose to any medium is to send messages and information. Since we live in an information-saturated world, any new messages compete for a scarce resource: time. Messages compete for time in two ways: salience and production value. Salience is the relevance of the message to the individual's personal or professional interests. Production value is the amount of attention getting "heat" embodied in the message.

Television commercials are high in production value with fast cuts, lots of action and fancy graphics, but their salience to most people at the time of viewing is low. The production value of a three line newspaper classified ad for a used sailboat is very low, but it's salience to those who purposely turn to that column in the newspaper is high. I believe that I have shown that the networked communications, while low in production value, are highly salient for the teachers, and as such, are valuable tools to *do* work.

I have not argued here, or elsewhere, that this technology is useful or valuable to every teacher. This is *not* a panacea. Some teachers will meet their professional and personal communication and resource needs in other ways. I argue, however, that this is a valuable medium, and as such, should continue to be explored and made available to those teachers who wish to use it.

In conclusion, the title on the cover remains: *Computer Mediated Communications and Science Teachers: Does it Work?* Instead of ending the title with a question, I could make it a statement: ***It Doesn't Work! (For everyone) (Yet!)***

APPENDICES

APPENDIX A

COMPUTER MEDIATED COMMUNICATIONS TECHNOLOGY

Rapid advances in technology are creating distance learning systems that are powerful, flexible, and increasingly affordable. Many systems are hybrids, combining technologies such as satellite, Instructional Television, microwave, cable, fiber optics, and computers. New developments in computer, telecomputing, and video technologies continue to expand the range of choices, and new strides in interconnecting the systems are being made regularly. These essays are focused upon digital telecomputing, a technology that is currently available in almost every school in the U.S., in an attempt to examine issues and ideas which may be implemented quickly and inexpensively.

"What do I need?" is the most common question from educators interested in telecomputing based projects. Simply put, there are four main elements: Microcomputer, Communications Software, Modem and Phone Line.

The Microcomputer may be a work station. Connected to a modem and communications software, a user may communicate with another computer. Most schools already own several microcomputers, the vast majority being Apple II's, however Commodore 64's, IBM PC's and Macintosh computers are also in use. Generally, any microcomputer found in the U.S. can be used for telecomputing.

The Modem is a device that connects a microcomputer to the phone line. It converts computer signals (digital) into phone signals (analog) and vice versa so that information can be sent and received. Depending on the microcomputer available, schools may use either internal or external modems. Modems range in price from under $99 through mail order companies to well over $300 if you go to a local store.

Communications software is the "brain" of the schools' telecomputing system. It tells the modem and computer what to do, including dialing, sending and receiving text and files. There are several versions of communications software available for almost every computer, many of which are distributed through the "shareware" concept.

Finally, the phone line is the conduit for the communications. It carries the signals from the modem to another computer. It also carries the signals back to the schools' computer where they are converted and printed on the screen or paper or saved as a file on a disk. Access to a phone line is critical. The line and the microcomputer need to be present in the same room at the same time for parts of the day. In some schools the computer is wheeled over to an outside phone line. Many times the media center has an outside line that could be accessed.

While not essential, several projects recommend the use of word processing programs. This allows students to prepare and edit their communications prior to sending them into the network. Most schools already own some sort of word processing software, and as long as it can save the documents "unformatted" or as a "text" or "ASCII" file, these software packages will all work. Many projects provide the needed software, or require that everyone uses the same system.

On the other end of the phone line is a "host" computer. This remote computer runs software that allows it to act as the communications center for the network. Traditional descriptions classify these computer communication systems into four major categories: Bulletin Board Systems, Electronic Mail, Computer Conferencing, and On-line Information Services. Each system is briefly described below.

Bulletin Boards

The term "bulletin board" usually suggests a cork board where important pieces of information are posted. These segments of text are one-way in the sense that readers have no means to respond. A reader could, of course, use a two-way communication device such as the telephone to call the person who posted the bulletin for more information.

Electronic bulletin boards often function the same way as physical bulletin boards. Information is posted on them (i.e., a text file is stored on disk), and the system users access the text via their computers.

There *are* advantages to having such an expensive communication system when a phone, a letter, or posting on a "real" bulletin board may appear to suffice. First of all, a wider audience can be accommodated. A message typed into a bulletin board system (BBS) can readily replace mass mailings and telephone calls, with their attendant expense in both time and money. Time zone and distance problems can also be resolved with bulletin board systems.

BBS systems offer several advantages: information can be posted and received at any time; text - both sent and received - can be saved on microcomputer disk or printed out for permanent records; information is instantly accessible to any member of the communication network.

Electronic Mail

Use of the computer to deliver messages offers all the advantages of one-way bulletin board systems with the additional abilities of seeking clarification, giving comments, and sharing information.

In electronic mail, the host computer actually coordinates or keeps track of discrete bits of information. Electronic Mail (e-mail) is very much analogous to the "real" mail. The host computer stores all of the messages, directs them to their intended recipients, and reproduces the text or graphics for the appropriate receiver. Some sophisticated systems also allow for the forwarding of mail to another user on the network or for the archiving of a letter by sending it to the disk under a specific file accessible by the user only. Some systems also allow messages to be sent to specified groups of people on the network. This allows a message to be entered once and sent to all those identified by the group name.

Conferences

Computer conferences offer all of the functions of bulletin boards and more. They are usually capable of both shared information and e-mail, but, like the real conferences they emulate, they are designed to elicit more discussion. Sometimes conference topics and membership are broadly determined - at other times they are narrowly focused.

Participation in conferences is usually characterized by having members present public statements which are then followed by a series of public responses. Some conferences may also allow private messages (analogous to e-mail) and voting on issues. Real-time conferences are supported on some electronic conferencing systems. In this case, the discussions occur on the screen similarly to in-person conferences with vocal responses.

The benefits of computer conferences are that the conferees need not be present in one geographical location. This can save significant time, effort, and cost. Furthermore, such conferences can continue for hours, days, months, or years. They can be used to speed up (relative to a normal conference proceeding) or slow down the normal pace of discussion.

On-line Information Services

On-line information services are sophisticated hosts that provide a wide variety of services. Most of them have forums for conferencing and electronic mail. Their services extend far beyond these two capabilities. UPI and AP wire services are often available. Medical information services, bibliographic retrieval systems, and airline reservation systems. Some systems have consumer services, such as e-mail ordering from major department stores and small sales companies.

Any microcomputer owner with a modem can access such systems. Subscription fees and on-line time charges are usually involved. Most systems offer local telephone numbers in larger cities which allow users to avoid long-distance telephone charges. In small cities and rural areas, however, the expense of long-distance telephone time adds substantially to the cost.

Many on-line information systems exist. The most well-known of these are CompuServe and The Source. Others include: GEnie, BitNet, and Quadlink (for Commodore). In addition, there are several systems which are designed for obtaining bibliographical information on a specific topic. Among these are Dialog, SDC, and BRS. Some offer special low rates for service provided at night. Those who can delay their searches until low-traffic nighttime hours can use BRS After Dark or Dialog's Knowledge Index and realize substantial savings.

An interesting example of an on-line information service is NASA's Spacelink. There is no charge for the use of Spacelink itself, but you do have to make a long distance call to Alabama to connect with it. While NASA understands that people from a wide variety of backgrounds will use Spacelink, the system is specifically designed for teachers. The data base is arranged to provide easy access to current and historical information on NASA aeronautics and space research. Also included are suggested classroom activities that incorporate information on NASA projects to teach a number of scientific principles. Unlike other conferencing systems, NASA Spacelink does not provide for interaction between callers. However it does allow teachers and other callers to leave questions and comments for NASA.

Merging Capabilities

At the present time, these types of services tend to be seen as separate, discrete elements, partly because they have developed in different markets, serving different clientele. Most bulletin board systems began on microcomputers and are still run by individuals or small organizations, catering to localized populations. E-mail grew from large corporate needs, and usually involves wide geographic coverage. On-line services offered information retrieval and e-mail services to companies not large enough to support their own systems.

The documented applications of computer conferencing shows it to be valued amongst communities of research workers in both commercial and academic environments (Hiltz, 1984). It is interesting to note that although computer conferencing technology was first developed at about the same time as electronic mail, its use is far less widespread than one-to-one e-mail. Recently, however, an increasing number of companies have started to use conferencing as an aid to group decision making (Johansen, 1988).

The point to be made is that the evolution of the hardware and software is merging the traditional groups mentioned above. The latest generation of computer mediated communications incorporate the better features of all four categories. The software is being written to provide conferencing, e-mail, and database searches all in the same program. The hardware limitations of small microcomputer based systems have been met through connecting the micros together and creating "distributed" systems. A recent product, CC:Mail by CC:Mail, Inc., provides all of these features, is available for several brands of microcomputers, and provides an invisible interface with the well established, large user based, commercial e-mail systems.

With advances in hardware and software technology the various formats for handling information have been applied to almost every type of system. Highly sophisticated conferencing packages, such as Caucus, now exist for microcomputers as well as the large mainframes where they began. Relatively unsophisticated bulletin board systems are no longer limited to basement hacker systems with systems like IBM's Isaac emerging in the international networks. NASA, one of the earlier driving forces for both hardware and software in the American computer industry, maintains

Spacelink on a minicomputer located in Alabama that can only handle eight callers at a time.

Dr. Roger Hart of the University of Victoria suggested that electronic mail will not become a commonplace until such time as any user can sit at their terminal, connected to their bulletin board or mail system of choice, and send mail to others regardless of the mail system the other user frequents. This is no small request because it seems that those who develop mail/conferencing systems always want to be noted for developing the "best", and seem to always choose to ignore any form of standardization, believing that in time the others will see the light .

UUCP is a network which links unix/xenix based computer systems. It is very common on university campuses, and in more recent years has become popular on some of the more advanced micro computers. Of particular interest to educators is the comp.education discussion which focuses on computer education, and to a lesser extent discussions relating to the different kinds of hardware such as Apple and MS-DOS. Users may post articles to these "news groups", and the postings get circulated or echoed around the network. It offers its users opportunities to dialogue with other users across the world.

FidoNet got its beginnings in the early 1980's as a popular, public access bulletin board system which supported distribution of electronic mail. At some time later, the concept of "echo mail" was added which supported the same kind of distributed conferencing capability as had been available in the UUCP news offering. This was a significant step forward because it represented the first public bulletin board system which supported distributed mail. Its popularity was instant, and nodes sprung up across North America and the rest of the world to a lesser extent.

FidoNet did not become a major force in educational telecomputing and conferencing however, because it is based on MS-DOS computers, and as most educators know, MS-DOS is not the most common computer to be found in educational circles.

FrEdMail was a later arrival on the e-mail/conferencing scene. Based on Apple IIe computers, FrEdMail was a natural solution for telecomputing between schools because of the popularity of the Apple IIe in education. Educators can send electronic mail, participate in educational discussions and send files between sites on the network. Example:

> We are a 5th grade class at Thomas Paine School in Urbana, IL. We are looking for other classes from primary through H.S. to participate in a science project on acid rain and ground water contamination. We would like to receive water samples from as many different locations around the country as possible. The attached file explains this project in more detail. Classes, small groups, or individual students that participate will have several levels of participation open to them ranging from minimal to more in-depth. All materials and costs will be covered on our end. If you are interested, read the attached file for a better understanding of the complete project.

The McGraw-Hill Information Exchange for Educators, MIX, was a commercial system, operating with a "for profit" motive. It was a large capacity system, with a an estimated subscribership in excess of 4,000. While MIX provided conferencing/mail capabilities, it did not provide for communication with those who are not subscribers. The Minnesota Educational Computing Consortium is currently attempting to give MIX a new lease on life with the name of IRIS.

APPENDIX B

COMPUTER MEDIATED ACTIVITIES

The number of Computer Mediated Communication (CMC) projects operating or being planned in the United States has grown from only a handful to many. Today, virtually every State is interested in using telecomputing to serve education. A few States have coordinated plans, while others are just beginning. Some efforts involve only local schools and districts, others involve institutions of higher education, while still others bring in various governmental agencies. States are also beginning to look beyond their borders and share resources as well as respond to various national programs.

The following profiles represent an attempt to outline the range of CMC projects unfolding across the nation and around the world. Because the efforts in CMC, particularly in K-12 education, are so recent, this should not be considered a complete list of projects.

I have grouped the projects into three categories: Information Retrieval, Information Exchange and Collaborative Projects. In the first category, *Information Retrieval*, students access data that has been professionally collected, generally for some other purpose, and use it for various activities. The flow of information is usually from the outside world into the classroom. What I will call *Information Exchange* projects are highly structured and coordinated activities that produce data and or ideas at the various schools involved. These data are then exchanged and differences between locations are examined. The flow of information is between and among the classrooms. The final group, *Cooperative Projects*, are projects where students and teachers begin to communicate *and then* develop ideas as to what data will be collected and how it will be shared. In this category, data and ideas are shared among schools as well as the responsibility for deciding upon a topic, method and even overall design of the investigation. We could include Information Exchange as a subcategory of this final group, but the implications for the teachers involved are significantly different.

Information Retrieval

There are hundreds information retrieval systems available to the general public. Databases are offered by several commercial networks that cover any topic one can think of from Ikibana to Sports Medicine. It should come as no surprise, then, that there are several projects that promote the use of on-line databases and other information retrieval services for use in the classroom.

Commercial Databases

The Weather Machine, a multimedia software kit and telecomputing service from the National Geographic Society, is a good example of how an isolated classroom can reach out of the building to access commercially available data for curricular purposes. The kit includes computer disks, a filmstrip, student books and a comprehensive teacher's guide. Students learn about weather by using actual weather data, including data from recent droughts, hurricanes, and other phenomena. The optional telecomputing service provides up-to-date National Weather Service data from over 100 weather stations across North America.

DIALOG Information Services, Inc. offers a more typical on-line database service with it's *Classmate* program. Classmate includes access to databases covering: Agriculture, Biology, Bio-sciences, Biotechnology, Books, Business Information, Chemistry, Computers and Electronics, Corporate News, Economics, Education, Engineering, Environment, Government Publications, Legal, Magazines, Mathematics, Medicine, News, Psychology, Reference, Social Science and Humanities. A Student Workbook includes an introduction to on-line searching, activities on planning the search, practice in using Knowledge Index search commands, and help with performing the search.

Other database and news services include:

- *BRS Instructor* with access to seventy databases such as Magazine Index, newspaper index and others,
- *Dow Jones News* allows access to 44 databases of business and financial information. General news, movie reviews, and an encyclopedia are also available as are a tutorial and educational materials,
- *Einstein - Learning Link* by the Educational Broadcasting Corporation provides secondary schools with access to 70 databases, including an encyclopedia, ERIC, abstracts and MLA Bibliography,
- *News Access* is a joint project of Cable Network News and the National School Board Association. The project is centered around the TV program, "Week in Review" on CNN. An electronic bulletin board allows for dialogue between the viewers and designers of the program.
- The *Learning Link* National Consortium is a network of information systems which operate from individual PBS stations and state

departments of Education. Most of the data is customized for regional use and generally is in the form of information supporting educational uses of upcoming broadcasts.

- *Accu-Weather*, the largest private weather service in North America, offers a complete weather database. Available data includes: hourly surface observations, digitized radar pictures, upper air data, National Weather Service hourly reports, forecasts, severe weather bulletins, marine data, and more. Curriculum materials as well as a special software program for Macintosh computers is available.

These commercial databases are not only used by students. Perhaps the most beneficial use of these systems is for the professional growth and development of the classroom teacher. NASA's Spacelink, described earlier, was set up specifically with science teachers in mind.

EdLINC, a free electronic information service, offers education professionals access to an on-line database of educational products and services. The service is funded through ad sales to companies and organizations listed in the database. Teachers and administrators can request searches on the phone, or directly via computer modem. In addition to the on-line service, EdLINC also offers a monthly newsletter, membership directory, and annual convention.

Information Exchanges

Perhaps the most common type of activity developed to date for the classroom are ones where students use CMC to exchange data or communications in pursuit of some pre-establish goal. Generally, a set of coordinated activities result in the generating of the need to communicate for each school or student involved. By selecting activities that produce differing results, these projects entice the students to begin thinking about why the differences exist. Phenomenon that vary over a geographical location - such as the boiling point of water at various altitudes - were the first to be adapted for this type of activity.

Kids Network

The goals of the National Geographic Society's *Kids Network* are to increase active learning, to improve problem solving, and to encourage cooperative scientific investigation. The curriculum consists of a series of units with printed materials and software for use with Apple IIGS computers. Topics include acid rain, weather, water quality, and an introduction to telecommunications.

In the National Geographic Kids Network Acid Rain unit, students learn about the effects of acids, design a rain collector, collect rain, measure pH, share these data with other student investigators throughout the U.S., analyze their nationwide data, share their conclusions with scientists and then consider the significance of their measurements. Scientists professionally involved in acid rain research collaborate with students in this activity, giving students an opportunity to participate in and gain a personal view of the process of science.

Pollution Surveys

In Great Britain, ten schools are involved in the *Northamptonshire Pupils' Pollution Survey* project. The students are examining four of their local rivers: the Avon, Greta Ouse, Cherwell and Nene. The techniques they are using entail taking samples of the rivers from different points and looking at what forms of life are present. After the survey, students put together graphic representations of their findings and send their reports and data to the other schools.

In southeastern Michigan, a network of schools has also been running water quality tests in their local rivers and streams. Originally on the Huron and Rouge Rivers, the network has been growing and is now referred to as the *Global River Environmental Education Network*, or GREEN Network. This network grew out of the work of Bill Stapp and Mark Mitchell at The University of Michigan's School of Natural Resources. The students conduct tests that provide values for nine parameters used to determine the National Sanitation Foundation Water Quality Index. The data is exchanged over the network, and students generally follow up with questions, suggestions and a face-to-face meeting.

TERC Star Schools Project

TERC, the Technical Education Research Centers in Cambridge, Mass., received funding from the U.S. Department of Education to develop the *TERC Star Schools project.* Each of the ten curriculum modules begins with a shared investigation and leads the students through the development of reports and the exchange of data and conclusions over the computer network. Hands-on participation, data collection, data sharing on the network, analysis and discussion, and a report to the network are part of each activity.

The Polling module introduces students and teachers to data analysis and basic statistical tools. After conducting a poll in their classrooms, student teams send their data to the network, where results are pooled and returned to all classes. In this way, each class has access to a larger data bank which it can analyze and compare with local data.

Design challenges students to develop different strategies for solving design problems. One core problem is to design a solar house. Each team constructs and tests a prototype of its design and shares its results on the network, so that teams can compare and critique designs and suggest new models.

In the Radon module students are equipped with the tools and materials to conduct a survey of radon levels in their area. As in Polling, students' data are combined into a network-wide database, which students can use to pursue additional experiments.

In Weather students study the physical principles behind weather phenomena. Students use Microcomputer-based Laboratory (MBL) probes to monitor temperature, sunlight intensity, and humidity over a 24-hour period in order to better understand heating, cooling, and other weather processes.

In three "Patterns from Iteration" units students investigate the patterns that emerge when geometric transformations and algebraic functions are iterated repeatedly.

Finally, in the Probability unit, students explore probability and design algorithms that implement their own strategies for a probability game proposed by the mathematician Koetke.

Three additional modules, Astronomy,Trees and Tides, are under development.

Interactive Communications and Simulations

The *Interactive Communications and Simulations* (ICS) program of The University of Michigan School of Education offers a variety of large scale, highly structured activities connecting schools from widely dispersed geographic and social settings. The ICS exercises are large in scale: each of them engaging many hundreds of students in dozens of schools for typically term-long periods of time. A major goal of the individual activities to to create environments where students communicate about a variety of issues.

The Arab-Israeli simulation is an international politics exercise focused on one area of the world. Participants are organized into approximately twelve five-person teams, the number varying with current circumstances in the Middle East. Teams, each generally located in a different school, represent the principal political entities involved directly or indirectly in the conflict. Students assume the roles of the actual presidents, kings, ministers, and others who form the nucleus of leadership in each country. The goal for the students is to pursue their own character and country goals as they see them.

The United States Constitution simulation is an exercise in both American History and United States government. Secondary school students role-play prominent American public figures drawn from the past

200 years of American history. All are delegates to a hypothetical constitutional convention held in the near future with the task of developing a new constitution. These characters are organized into Delegations, each of which represents a particular orientation toward constitutional matters. Delegates are organized into Drafting Committees which address particular areas of constitutional concern.

The Environmental Decisions Simulation is an exercise both in environmental studies and group decision-making. Students role-play individuals who have been asked by the World Bank to examine the environmental impact of a huge dam that the government of Zaire proposes to build. The students are to concern themselves with different areas of possible environmental impact: water, society and culture, agriculture and fisheries, forests, and development.

The Thinkers League is designed to facilitate the learning of mathematics as well as scientific reasoning. Participants are organized into teams and receive weekly research problems. Teams submit their solutions, and conduct experiments on a regular basis - the results of which are published for all schools.

MIX

The McGraw Hill Information Exchange (MIX) conducted a variety of collaborative activities before being closed due to a lack of revenue. In the *Growing Corn* activity, MIX sent participating schools seeds, maps of the US, and charts to monitor growth. Students researched soil types, planted, watered and fertilized their crops. Then they watched the seedlings grow and recorded the amounts of water, fertilizer, light and location. Most important they charted the size of the corn. They posted this data regularly on the MIX "Plant" electronic conference. They monitored and compared seedling growth around the country, plotted and interpreted maps, produced charts and graphs, and rote to one another on-line to compare notes.

Cooperative Projects

The third and final category for CMC projects in existence today are best described as Collaborative Projects. Groups of teachers and students work together to develop investigations to be run cooperatively at each school. These projects have usually been initiated by someone or some group interested in CMC who have established a network and then suggested that the medium might be used for education. In some instances the sponsor has provided extensive support for the activities the educators have developed, in other instances they have not. This category is different from the previous one in that the "Information Exchange" group has relatively structured activities that provide a basis upon which the classroom teachers can build, while this category merely provides the medium. On the other hand, in the collaboratively defined projects, students or teachers must, by definition, interact closely with the other classes. There are many projects, but they usually take much longer and produce less sophisticated results than with the predetermined projects.

AT&T has created the *Long Distance Learning Network* (LDLN) - a learning environment that "helps students develop the cooperative skills and tools necessary to build the 21st century." LDLN links teachers who share common interests and helps each teacher design telecomputing projects that will enhance educational practices. The LDLN gives general interest titles and then matches teachers who have expressed interest in similar activities, acting much like a dating service. One category offered has been "Energy Works." In this learning circle, participants explore what energy is, how it is produced and transported, how it is used and what environmental consequences result from it's use. Students have studied regional and national differences in energy consumption and pricing. Student projects might explore environmental issues related to energy production or use (acid rain, the greenhouse effect, nuclear wastes, mining, drilling effects and spills or leaks) or they might center on comparisons of alternative forms of energy for similar tasks weighing positive and negative factors of nuclear, solar, coal, gas or water.

Other organizations that have established these "learning Networks" include Apple Computer, Inc. with the *Apple Global Learning Network*, Tandy Corp., with *Project 2000*, Epson Computer, Inc. and it's *Computer Pals Across the World*, the San Diego County office of Education's *FrEdMail Project*, and most recently the Minnesota Educational Computing Consortium with IRIS, the latest incarnation of the McGraw Hill Information Exchange, MIX.

Projects proposed and conducted via MIX include studies of weather, the sources of drinking water, the temperature at which water boils, and "Twisted Science." In the weather project, students all over the country measured the outside temperature at 9:00 am local time every day. They also downloaded weather data provided by the US National Weather Service through the local UPI news wire. In "Twisted Science," Captain Flathead, a science teacher, stated that the earth was flat. He presented arguments to prove his point. Students were challenged to come up with arguments to prove that the earth is round.

The Scottish Council for Educational Technology (SCET) created the "100 Schools' Network Project by the pairing of schools in the United Kingdom and Europe with "twins" in the US via MIX. The computing studies departments of the schools tended to view the project in terms of their own requirements: word-processing, preparation of files, communications, electronic mail, and, to that extent, the content of the messages was peripheral; although it is only fair to note that all computing studies teachers in the study were aware of the value of the project to other curricular areas. There were two approaches to using the MIX system. One was process specific in the terms of using and learning about the system and the other was curriculum specific.

One school, Vale of Leven Academy, twinned with North Pole High School, sent:

> Geography classes would like you to give the following information:
> 1. Perception Study
> Please ask a sample of students to write down the first 20 things that come to mind when they hear the word "Scotland". From the sample, please work out the 10 most common.
> Here in Scotland, the ten most common things thought of in one class with the "United States" mentioned were:
> Hot Dog, Fancy Caps, Pepsi, Rich, Gangsters, American Football, Hamburgers, President, Films, Ronald Reagan.
> 2. Climate Survey
> How do temperatures of -30 to -40 degrees centigrade affect your everyday life? eg transport, clothing, sport, home life, work, school.
> 3. Wildlife
> What are the main types in the vicinity? Are some troublesome? eg Do bears in winter go garbage raking? Do wolves approach the community? Do insects cause difficulty in summer?

In Northern Ireland, the "Joint Work in the Environment" project is an example of this collaborative atmosphere. The aim was to encourage teachers and pupils from both sections of the community to work together undertaking project work in their local environment. Forty-eight schools throughout Northern Ireland have been taking part in the project and have carried out a wide range of environmental studies, both rural and urban.

Several attempts to create this type of learning network have been made by governmental bodies, too. In 1986, The University of Michigan's School of Education was given a grant to develop a network of schools performing Water Quality testing on Local Rivers and Streams. This project was modeled on the work of Stapp and Mitchell and the Rouge River Project mentioned before. In contrast to the Rouge River project, this one established the network, gave the teachers the tools and training needed to operate the computers and the tests, but left the discussion and analysis to the teachers and students. The focus was to develop a set of tools including testing skills and equipment, communication skills and equipment, and analysis tools using the computer, then let the teachers use these tools as they felt appropriate in presenting the existing curriculum.

One of the longest lasting learning networks has grown in the Southern California area with the work of Al Rogers and the FrEdMail network. Approximately eighty electronic bulletin boards make up this system, which links multiple locations in the U.S., Puerto Rico, and Argentina. Participants have included teachers in first grade through Senior High classrooms and educational researchers from school districts and universities. The network is organized by the people who run the individual bulletin board systems. Two network-wide conferences - IDEAS and KIDWIRE - are available for teachers and students to exchange ideas and work, and to obtain technical assistance. Over a recent three month period, over half of the messages were sent by eight users with thirty four additional users sending only one message.

Teachers volunteer to moderate particular discussions or projects, and many project initiations go unanswered. With a few notable exceptions, activities lacked project time-lines or the expectation of a finished product from each of the classrooms. Generally, students are asked to participate in a project by providing some information or writing which is then either sent directly to the teacher proposing the project, or to the KIDWIRE conference.

In one typical implementation, students at one school sent electronic letters to a teacher at another school asking questions about daily life in Africa. The teacher, who had lived in Africa as a Peace Corps Volunteer, would prepare responses and send them back. In a similar project, sixth grade students at one school answered Christmas mail to Santa Claus from the second graders at other schools.

APPENDIX C

THE TEACHER-INFORMANTS' CONFERENCE

Index for DSC:TELECOM

Causes of Learning
  3 What's Easy vs. What causes learning

Chit-Chat
  7 Congrats!!!
  8 Happy Holidays

Confer Tips
  1 Welcome to the conference
  2 Submitting text anonymously

Curriculum
  6 Science Fiction and Science
  9 Curriculum
  10 Exploration

Demonstrations
  4 Toys in Science
  5 Assemblies

Students (and their nature)
  11 Low ability/low interest students

Teachers (and their nature)
  11 Low ability/low interest students
...items not categorized
  12 Magic in Science
  13 Cooperative Learning
  14 Clancy where are you?
  15 Peace
  16 Clancy and the Desert
  17 Conceptual Planning
  18 Conversation
  19 Weather
  20 Conceptual Change
  21 NSTA
  22 Hi
  23 Pistons

On Jan16/92 DSC:TELECOM has
  22 items, and
  6 participants.
Since Dec08/90 there have been
  80 uses which have lasted
  250 minutes total.
There have been
  18 messages sent,
  80 items displayed,
  56 responses made,
  74 sets of responses seen, and
  250 DO NEXT? commands issued.

Item 1 17:38 Dec08/90 11 lines 5 responses
Clancy
Welcome to the conference

I want to welcome you to this conference as co-investigators in the study I'm doing for my degree. I want to say "welcome" and thanks for agreeing to help.
There will only be six or seven people in this conference - those who have been interviewed. I tried to get everyone together for a meeting, but there may be one or two holdouts.
NOTHING in this conference will be attributed to anyone, so PLEASE feel free to say what you want. I suggest that most things be as items, which are public so the others can comment. To start an item, type ENTER at a Do Next? prompt.
Once again, welcome and thanks for participating.

5 responses
Dec12/90 22:07
1:1) Dave: Thank-you Clancy for the opportunity to work on this project. It was a pleasure meeting everyone and I hope we have a good opportunity to share worthwhile ideas. Dave
- - - - Dec31/90 08:50
1:2) Barbara: I am hoping to learn as much, if not more than you, Clancy!
- - - - Jan03/91 22:48
1:3) Dave: Welcome aboard Barbara!
- - - - Jan13/91 21:55
1:4) Barbara: Thanks- and howdo we get the rest of the crew on board?
- - - - Jan17/91 17:39
1:5) Dave: Well that's a good question. It is probably just a problem becoming acquainted with the equipment. Dave

- -

Item 2 17:41 Dec08/90 7 lines 1 response
Clancy
Submitting text anonymously

In case you want to say something and don't want anyone else to know who you are, there is a command in Confer that lets you say things anonymously. Just add PSEUDO to any command and you will be asked for a pseudonym. For example ENTER PSEUDO or TRANSMIT PSEUDO will work.
This is *NO WAY* that we can look through the computer records to see who wrote things attached to a pseudonym, so please feel free to use it as you see fit.

1 response
Dec31/90 08:51
2:1) Barbara: I didn't know we were going to get into those kinds of discussions!!

Item 3 10:58 Dec11/90 4 lines 8 responses
Clancy
What's Easy vs. What causes learning

One of the points that we left the meeting on was dealing with how do we as teachers decide what are things that are easy to do versus what are things that cause learning. Any opinions? (Type R at the prompt and enter your comments. PRESS RETURN AT THE END OF EACH LINE!)

8 responses
Dec12/90 22:10
3:1) Dave: I remember talking about this a little bit. I am a little foggy as to the direction of the question. Do you mean that we as teachers have certain skills that make teaching easy yet these may not lead to "real" learning for students? I need a little clarification. Dave
---- Dec13/90 09:15
3:2) Clancy: I was thinking more along the lines of "ease" and "fun" for the teacher. The telecom projects, for example, are definitely not easy for most people. In same cases they are downright frustrating. On the other hand, without too much effort you could probaby find so "fun" projects that are also easy to run. (Movies, for example) Many of the easy/fun things are somewhat trivial. I wont go as far as saying that *all* easy and fun activities don't cause learning, and all hard projects do, as there are many types of activities that do cause learning and many that don't. I'm a bit curious about how we as teachers decide what *does* cause learning, and based on that (If it is based on that) how do we decide what to take on out of the numerous activities available.
---- Dec15/90 22:32
3:3) Dave: I believe that it is important to stay in touch with the research in our field. We know that some things are overdone and others are not. I believe that we know the kinds of things that are important for students because of the research and the impact that society has on us. For example, we all know that we can learn from movies, but everyone has movies at home, so why have them in school? We know in science that it is important to get involved and not be passive learners. We know the impact of the computer and that we have to get students involved. Thus, I think that we take on the activities that will be best for our students. Dave
---- Dec31/90 09:01
3:4) Barbara: Im my philosophy course this fall we got a discussion of "Can you have a real experience by reading books, or must you personally experience sometime to know it? Movies/ journal articles/textbook readings kind of fall into this category. I try to have a "real" investigation as a focus for each of my units- thus- the radon study and modem as a way of students actively experiencing the science-not juct reading about what others did. (forgive all my typos..) There is certainly a place for reading in science- that of gthering background information. However- I must throw in a parental concern here. My 5th grade daughter would not go to a move with the family because she had to read her 250 page s of science (electricity and magnetism!!) that she was assigned over vacation. She hates science, but always does her homework!! She says the stuff she has to read is boring. Now this certainly is easy for the teacher- the students keep a reading log- they do the reading- he has "covered" the material??!! I couldn't teach that way. I have to be learning, too. That's the way I am also- you must get the student's ATTENTION!- generate some excitement. enough on this for now- sorry for getting long winded.
---- Jan03/91 22:56
3:5) Dave: Over the vacation, I was able to watch a series of physics demonstrations by Julius Miller. They were shown on the M-Star Network. They are a series of 15 demonstrations that take anywhere between 10-15 minutes. I am meeting with a person at the WCISD on Friday to find out more about these videos. I have them on tape. I believe that they could be shown once a week or every other week to stimulate the thinking process. His philosophy is not to teach physics but to stimulate. I was fascinated by these programs. He is wierd enough to be considered "camp" by the students, or so I believe. These programs could stimulate me to bring

in some of the same materials, so that after viewing the students could try them. Or they might be used as extra credit, whereas students could bring in their own examples of the demo's and explain them to students. As I gather more information about this series I will share it with all of you. Dave

---- Jan13/91 21:57

3:6) Barbara: Sounds great- Tell me more about the name of the program- wonder if my media center taped them?

---- Jan17/91 17:45

3:7) Dave: The program series is entitled, "Science Demonstrations". The series deals with heat, thermodynamics, and physics toys. They can be found on the M-Star channel on cable frequently. You may also get the series from your county ISD. Find out who is in charge of the television aspect. This is funded by the State Board of Education. They will supply you with the tapes, you can make a copy, and then return them. The person that I spoke with from Wayne County was Beth Todd. The series was produced in 1967, but it is old enough and weird enough to get kids attention. Let me know how you do finding it. You would be welcome to my copy if all else fails. Dave

---- Jan21/91 22:32

3:8) Barbara: thanks, Dave!

Item 4 22:10 Dec12/90 9 lines 6 responses
Dave
Toys in Science

We talked about toys and science on Saturday and I wanted to share this activity.
I had two "snappers", also called "poppers", in my desk that another teacher had given me. I didn't know what to do with them. Well Monday it all came together in a lesson. I used them to illustrate buoyancy, Newton's third law of motion, projectile, and free fall. Thanks for the stimulus on the toy idea. The kids really enjoyed it (I think they did, they paid attention.)
Any other ideas?

6 responses
Dec13/90 09:15
4:1) Clancy: Can you describe what the "poppers" are and how you used them?
---- Dec15/90 22:36
4:2) Dave: The poppers are sold in drugstores, science stores, etc. They are made out of a soft plastic and look like a small mound on the table. When you push the popper in the mound is depressed and after a period of time, the mound pushed up and it explodes into motion. (boy, it's harder to describe those then I thought) Projectile--Put it on my finger and watched it "pop" off. Buoyancy--Determined whether it would float. 3rd Law of Motion--Action is pushing; Reaction is going upward. Free Fall--Let it drop. I have also been getting a lot of mileage out of juggling lately.
Dave
---- Dec16/90 18:01
4:3) Clancy: I have seen some plastic ones that have a suction cup on the bottom and a spring powered psiton that pushes it up. Are these them? I have soem bi-metalic ones from Edmunds Scientific that sound like what you describe, byt they are metal and work on varying rates of expansion - like a thermostat.
---- Dec19/90 21:31
4:4) Dave: These are not the same ones. The plastic ones that I use can be found at "Science and Things" in Livonia for 39 cents. This is a neat exercise, trying to describe a simple object over the modem. This is when I need a fax. I could stick the popper in the xerox machine and then fax it. Boy, wouldn't technology do some great things?
---- Dec20/90 09:16
4:5) Clancy: The problem is, there is not yet such a thing as "store & forward fax" We've talked about fax for some of the eductional projects, but that involves each participant calling the other places rather than calling a local number to access the data network. We're looking at some graphics packages that are interchangable between machines, but that increases the on-line time and, to a certain degree, the expertise needed to operate.
---- Dec30/90 21:51
4:6) Dave: Great News getting back to the "poppers". I received a great book for Christmas called, "Turning the World Inside Out" by Robert Ehrlich. On page 64 of the book, they are called "hopper poppers" and can be purchased from Jerryco, Inc. But you can also use a half of a hollow rubber ball, like a racquetball. The demo that they use it in is called, "Energy storage in a rubber hemisphere". The transformation of elastic potential energy to kinetic energy is shown by the extreme height to which a hollow rubber hemisphere jumps when it is turned inside out and dropped from a low height. Dave

Item 5 22:13 Dec12/90 4 lines 10 responses
Dave
Assemblies

Can anyone give me any ideas regarding traveling science shows that come to schools? Our district has Academically Talented Money available and would like to use it for assemblies in science, etc. Any ideas?
Thanks, Dave

10 responses
Dec13/90 09:16
5:1) Clancy: I saw something last year recruiting for the Mr. Wizard travelling show (they were looking for teachers to run the shows.) I'll see what I can find for you.
- - - - Dec15/90 22:36
5:2) Dave: Thanks Clancy. Dave
- - - - Dec31/90 09:09
5:3) Barbara: Last year we brought 2 "traveling shows" to Clague- One was the Living Scisnce Foundation- They have several program- er used The Ocean's Edge in which they brought many marine invertebrates, a shark, etc for children to pick up- we used i t with our Voayge of the Mimi unit- Novi, Mich- phone (313-478-1999) Excellent The other was out of Saline , Michigan on Tropical Rain Forest Reptiles I think it was "Pets and Things"- will check- also EXCELLENT! Also-- the DNR has a program using endangered species- call Lansing- have fun- wish we had some money this year!
- - - - Jan03/91 22:57
5:4) Dave: Thanks Barb for the ideas. I am still open to more ideas. Please share as many as you have. Dave
- - - - Jan09/91 21:43
5:5) Dave: I have had a request for a laser light show. Does anyone have any ideas? Thanks, Dave
- - - - Jan13/91 21:57
5:6) Barbara: ow- sounds great- no help here
- - - - Jan17/91 17:47
5:7) Dave: I have found a person who does assemblies on tops, yo-yos and juggling. He then ties it in with Physical Science. If anyone is interested, let me know. By the way, the guy lives in Ann Arbor. Dave
- - - - Jan21/91 22:33
5:8) Barbara: I am! Name please, if you would..
- - - - Jan23/91 22:48
5:9) Dave: I'll send it out next time. I thought I had the name at home, but I guess I have it at school. I'll remember to get it tomorrow. Dave
- - - - Jan27/91 22:27
5:10) Dave: I have the name for the assembly. His name is Yo-Master Zeemo. He does assemblies on yo-yo's, tops, juggling and their relationship with science. His phone number is 313-994-0368. By the way, does anyone know anything about Magician Doug Scheer. I saw a coupon in my Gold C Saving Spree book. It says that he does science assemblies. His phone number is 313-357-6615. Dave

Item 6 22:15 Dec12/90 4 lines 2 responses
Dave
Science Fiction and Science

I would like to pursue the idea of the interrelationship between the humanities
and science. We were talking about science fiction and science.
Any comments?

3 responses
Dec15/90 16:22
6:1) Clancy:
There is a book I really like - I think I mentioned it at our meeting. it is:
Hollister, Bernard (1987). "You and Science Fiction" National Textbook Company, Lincolnwood, Illionois. 350 pages.
It is a collection of short SF stories. For each short story their is an introductory section desribing some issue, then a set of questions called "Projections" with three or four questions that are great for discussions and getting kids to think about the issues.
The story follows looks like an average of about 5 pages, then a section called "Probings" with some more great questions.
For example, one section is called 'VALUES. There is about 1.5 pages talking about trends, advice columnists, "Future Shock" and a lead in to the story. One of the three "Projections" is merely a newspaper headline that you may want to talk about: "Teachers Strike for Less Pat, More Working Hours"
The story is 4 pages long. Itr is by Ray Bradbury and is called "The Smile" In the story a kid in a future society is present for a mob's destruction of an "ancient" art work that is left over from previous time. He is intrigued by the painting, but get's into the destruction and ends up with a scrap of cloth that, when he lloks at it, is the Mona Lisa's smile. There are 4 follow up questions dealing with societies w/o values, or having the kids rank a dozen things about a future society in order of importance.
The book is divided into 4 sections:

WHO AM I?
Topics:
Finding an Identity
Occuational Roles
Leisure Roles
Sexual Roles
Values

HOW DO I RELATE TO OTHERS?
Topics:
Family
Friends
Generations
Conformity
Nonconformity
Conscience

WHAT KIND OF SOCIETY DO I WANT?
Topics:
The Good Life
Status
Technology
Justice
Bio-Ethics I
Bio-Ethics II

WHAT KIND OF WORLD DO I SEEK?
Topics:
Ecology I
Ecology II
Population I
Population II

Survival

Authors:
Kurt Vonnegut Jr., Isaac Asimov, Ray Bradbury, Frederick Pohl,
Robert Silverberg, and others.
---- Dec15/90 22:38
6:2) Dave: Thanks for all of the information. I will digest these
and respond back later. Dave

Item 7 21:31 Dec19/90 4 lines No responses
Dave
Congrats!!!

Congratulations to Bob. I was pleased to see his picture in the
Detroit Free Press this week. He was working with his students at MLK.
The Free Press is doing a series on Blacks in Detroit. Keep up the good
work Bob.

No responses on item 7

Item 8 21:33 Dec19/90 1 line 4 responses
Dave
Happy Holidays

I want to wish everyone in our group a very happy holiday season.

4 responses
Dec31/90 09:11
8:1) Barbara: Thanks, Dave- if more people log on -- this could be a
great conference!
---- Jan01/91 14:47
8:2) Clancy: I never got in touch with everyone before the holidays. I
will make some calls in a week to get everyone on.
---- Jan02/91 19:41
8:3) Barbara: Great-- Happy New Year!!
---- Jan03/91 22:59
8:4) Dave: Happy New Year everyone! Happy New Year everyone!Happy
New Year everyone!Happy New Year everyone!Happy New Year everyone!Happy New
Year everyone!Happy New Year everyone!Happy New Year everyone!Happy New Year
everyone!Happy New Year everyone! I thought I would try out my cut and paste
with this program. I never thought about using it before.

Item 9 21:33 Dec19/90 11 lines 4 responses
Dave
Curriculum

Does anyone have any recommendations regarding what should be covered in a Ninth Grade physical science class? This course is one semester before they go to a semester of earth science. A few students will take a Physical Science II class which goes beyond the basic course. Does anyone have any suggestions as to any public domain software that can be used with Apples that deal with physical science? How are people dealing with the technology in these general courses? I believe that these ninth grade courses are important because most will take biology in tenth grade and that will fulfill their science requirement in high school. I will be doing the Rouge River study with my Physical Science II class this spring.
Thanks, Dave

4 responses
Jan02/91 19:44
9:1) Barbara: What kind of students take this course-- college prep or average and below average students- are you expected to PREPARE tham for further courses- or would this be their last physical science class? I would tend to focus on practical applications to real life- such as what I do with my heat unit- we build/construct model "Hot Houses" that are insulted structures and have a competition- which one retains the heat of a beaker of hot wate r, for example. More later...
---- Jan03/91 23:02
9:2) Dave: The students are composed of all of the ninth graders, with the exception of maybe 60 students who take a lower level course. Some students will take Chemistry in high school and even fewer will take physics. Could you give me an idea about the units that you use? Thanks, Dave
---- Jan13/91 22:04
9:3) Barbara: In my 8th grade physical science class I cover the usual physics and chemnistry units- right now we are doing chemical reactions/ elements and compunds-this week we are doing a mystery powders (qualitative analysis) type lab in which they i nvestigate several white subtsnaces: sugar, salt, baking soda, etc, etc and using different test (iodine, water, pH, etc- gather data- and then determine unknown identity Later I will do a food chemistry unit- Units during the year include sound,heat,light/waves/magniticsm/electricity/motion, etc.-again with much emphasis on applicationm labs. Technology includes using videlaserdisc; some computer MECC programs- using temp and sounds probes in the Bank Street MBL lab kit, etc.
---- Jan20/91 22:07
9:4) Dave: I take it that you mean you use the basic physical science units? How many can you cover in one semester? Are the activities based on the unit or are they conceptual? Can you give me more information about the MECC programs and the Bank Street programs? Thanks, Dave

Item 10 20:28 Jan05/91 4 lines 1 response
Dave
Exploration

How do we explore the confer system? Is there a command to determine the other conferences? I look forward to hearing from our group during the new year.
Dave

1 response
Jan10/91 09:12
10:1) Clancy: HELP will give you help on CONFER commands at any point. VIEW CNFR:CONFERENCES will give a summary of some other conferences avalable. Not all conferences are listed there, however, and by design there is no way to know about all the conferences. I strongly suggest: MSTA:FORUM I also suggest you use/learn the commands: MARK ALL (when going into a new conference this marks all items as seen so that Confer can tell you about new info from that point on, without the need for you to look at all of the old stuff.) Also, learn INDEX so you can find stuff.

- -

Item 11 21:43 Jan09/91 10 lines 2 responses
Dave
Low ability/low interest students

I received a letter today from Dick Braun, Science Coordinator for the Livonia Schools. He is putting out a call to help him solve a problem and I would like to share it with all of you.
He feels that they are not meeting the needs of low ability/low interest science students at the high school level.
What do you think?
My gut feeling is that tracking leads to problems and we also run into problems because we don't really deal with science but with textbooks. Any ideas?
Dave

2 responses
Jan10/91 19:11
11:1) Clancy: These are the kinds of kids I had in mind when creating the Odyssey curriculum. It has some science that they can do, and enough other things to keep them excited. I *DO* think that these kids miss out a lot. I know when I was in the classroom, some of my favorite students were from my academic classes. Is this, I wonder, a function of the fact that we were probably somewhat academically motivated ourselves, evideneced by the fact that most teachers have college dergrees?
- - - - Jan13/91 11:56
11:2) Dave: Is this curriculum project still available for school districts to subscribe to before you begin your journey? If so, I would be happy to pass this on to the Livonia Schools. Dave

Item 12 11:56 Jan13/91 7 lines 2 responses
Dave
Magic in Science

Does anyone use magic in their classroom? I had a good time visiting Romig Magic and Book Co. in Ferndale yesterday. There were some good ideas for use with the scientific method. I purchased the needle through the balloon, the magic water suspension cup, tops and a gahoogala stick. Is anyone knowledgeable about a person by the name of MacDonald who wrote a book on magic and science?
Dave

2 responses
Jan17/91 09:11
12:1) Clancy: I used to have a book on Magic for Sci. Clubs. I got it at a second hand store. It was from the late 40's. Sort of goofy, but it had a few nice things. I'll look in my attic and see if it's still around.
---- Jan17/91 17:49
12:2) Dave: Thanks Clancy. I just met with a teacher today regarding magic and science. It was a good way to get together and share teaching ideas. The ideas just kept flowing out--Just like Magic! (that was weak) Dave

- -

Item 13 11:59 Jan13/91 4 lines No responses
Dave
Cooperative Learning

I went to a good conference on Friday dealing with Cooperative Learning in the Science Curriculum. Would anyone like to discuss the differences between the John Hopkins model and the Johnson Brothers model?
Dave

No responses on item 13

- -

Item 14 22:05 Jan16/91 1 line 1 response
Barbara
Clancy where are you?

Clancy are you out there??

1 response
Jan17/91 09:12
14:1) Clancy: I'm here, but I've been rather preoccuopied. I will be trying to get Bob, Linda and Jim online soon. Bob has been trying, but I think his modem is bad.

Item 15 17:49 Jan17/91 7 lines 2 responses
Dave
Peace

This has been a historic couple of days for our planet. It is really some thing how we can look at our planet from space and see such a beautiful and peaceful sight. Yet a closer look shows such violent disagreements. Let's keep working for peace on our planet.
This makes me think that science can play a role on educating our students on this topic. Any ideas?
Dave

2 responses
Jan20/91 14:29
15:1) Barbara: Funny, you should put up this item. I was thinking along the same lines, then saw your item. I think that helping children to be stewards of the earth is one way we can focus them on peace. Also becoming aware of world geography and biomes - for example I have been wondering the last few days how I might integrate the Gulf War sitution into studying chemistry!- More later when I can think up some stuff!
---- Jan20/91 22:05
15:2) Dave: When the bombs hit, I heard the discussion of waves. This is what got me thinking about it. Projectiles, waves, motion, I wonder about a unit which includes it all? Dave

----

Item 16 14:29 Jan20/91 2 lines 5 responses
Barbara
Clancy and the Desert

Clancy, where are you?- I was just wondering how the world Gulf situation might affect you desert telecomm. project this Feb?

5 responses
Jan20/91 22:05
16:1) Dave: By the way Clancy, when are you leaving? Can you give us a little more detail about your teaching trip?
---- Jan22/91 14:42
16:2) Clancy: Yes, this *HAS* been a hectic few weeks. In addition to the world blowing up, I've had a brother-in-law as a house guest. I've been entertaining as well as completely changing the itinierary of a three month long trip! I keep telling myself "Tonight you need to spend some time on Confer. (Ha!) We are NOT going to Africa any more - 12 months of planning down the drain. We can not get across Morocco right now, and the US State Department suggests not going there unless absolutely necessary. We looked into shipping our vans to central Africa, but that costs more $$ than we have. So... we are planning on driving around southern and eastern europe for now. I'll put an item in tomorrow. I hope to get some more people involved - new modem to Kermit, and I have a teacher in Toronto and one in Stuttgart who I would like to invite into this confernce - both are experienced and should be able to add a lot. Thanks for hanging in there!
---- Jan23/91 22:50
16:3) Dave: Sorry to hear about the change in plans. It must be disappointing. Keep us posted about your adventures. By the way Clancy, are we discussing things that are of value to your study? If not, please let us know. Dave
---- Jan24/91 09:04
16:4) Clancy: I just want you to use this as you see fit. I'm the one who has to get off my duff and write about things I'm interested in - you folks write about things you're interested in.
---- Jan27/91 22:22
16:5) Dave: OK Clancy. Thanks again for the opportunity. Dave

Item 17 22:28 Feb03/91 6 lines 3 responses
Dave
Conceptual Planning

HELLO, IS ANYONE OUT THERE!!
By the way, I am attending a 3-part workshop, starting 2-4-91 on conceptual planning in science. I am excited to see what comes out of it. I'll be glad to share any information with you.
Take care,
Dave

3 responses
Feb10/91 13:09
17:1) Dave: I attended this workshop this week. It was a little different then I had planned. I thought that it would deal with planning the science curriculum with a plan for developing a unified curriculum. It is based on teaching for conceptual change. How do we change incorrect thinking, in regard to science? As Science For All Americans points out, we all have misconceptions in science that logically make sense. This week I will be doing two clinical interviews with a high and low student on activities dealing with forces. I'll keep you posted on my work. Take care, Dave
- - - - Feb10/91 19:44
17:2) Barbara: Sounds like you are helping someone out with their research.. I am taking 2 doctoral courses this winter and have discussed conceptual change. Seems there are misconceptions... and then there are alternate conceptions- those which are "wron g" ideas- but come from consistent thinking- consistent with data that people gather in during their life. Also-----am taking a technology course with Carl Berger and Joe Kracjik- talking about Star Schools- Kidsnet, etc- spent 2 hours being frustrated using KidsNet- Acid Rain Unit.-
- - - - Feb17/91 13:09
17:3) Dave: I'm surprised about the Acid Rain Unit. I have never used it, but it seemed pretty clear cut. What are the problems. In regard to conceptual change, the workshop is by Glenn Berkeimer from MSU and I understand that it is part of the SEMS project. Do you have any information on this. I know it ends up relating with the Model Curriculum for the state. Any info would be appreciated. Thanks, Dave

- -

Item 18 13:02 Feb10/91 6 lines No responses
Dave
Conversation

I assume that you left for your European trip. Please let us know how you are doing. What kinds of activities will you be doing during this trip?
Are you still doing the science activities with the various schools? What schools are involved?
Welcome to Larry--I look forward to hearing from you. Are you a teacher?
Dave

No responses on item 18

- -

Item 19 18:17 Mar10/91 1 line No responses
Dave
Weather

Hello to everyone. It is March 10, and it is a lovely day.

No responses on item 19

Item 20 15:59 Mar16/91 4 lines No responses
Dave
Conceptual Change

I just finished the unit on planning for conceptual change which I spoke of earlier in an item. It now makes sense to me and I would be happy to discuss this topic with anyone.
Dave

No responses on item 20

- -

Item 21 16:00 Mar16/91 3 lines No responses
Dave
NSTA

Is anyone going to NSTA in Houston? I'll be going with my family. Let me know if you are going.
Dave

No responses on item 21

- -

Item 22 15:23 Apr20/91 3 lines No responses
Dave
Hi

I just wanted to say hi and see if anyone has any ideas on anything to share.
Dave

No responses on item 22

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