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FOURTH GRADERS AND COMPUTERS:

A CASE STUDY

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FOURTH GRADERS AND COMPUTERS:

A CASE STUDY

By

Michael James Roessler

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ABSTRACT

FOURTH GRADERS AND COMPUTERS:

A CASE STUDY

By

Michael James Roessler

In the school year of 1983-84, the author investigated the use of microcomputers by the 26 members of a fourth-grade class in a small town in Michigan. Ethnographic research techniques, including participant observation, interviewing and videotaping, were utilized to gather data about the students' first year of extensive experience with computer-assisted instruction. The researcher sought answers to three main questions:

1. What is the social context surrounding the use of computers in this school?

2. How do the students relate to the computers?

3. What do the students learn by interacting with the computers?

It was found that, by the end of the school year, the students had become computer literate in the sense of being able to use the computers effectively. They viewed the computers realistically, and they avoided anthropomorphizing them. Generally, however, these students attributed exaggerated teaching powers to the computers.

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While running simple drill programs, the students experienced many powerful emotional encounters at the computers. These encounters became part of a "hidden curriculum" of computer use--incidental lessons that the students were absorbing while they were computing. There were four main elements to this hidden curriculum:

1. Computers encourage quantification.
2. Using computers entails a loss of privacy.
3. Work generated on a computer can be evanescent.
4. Access to computers is a privilege.

The fact that these lessons were not intended by the teacher or the school indicates the need for a careful analysis of what young students learn as a result of working with computers. Regular debriefing sessions and planned-incident strategies are recommended by the author as ways of controlling this hidden curriculum by moving its desirable parts into the school's explicit educational program.

ACKNOWLEDGMENTS

Many people helped me with this study. Those who contributed the most--the students, staff and parents of Wolverine School--cannot be acknowledged by name because of the need to protect their privacy. These individuals welcomed me into their lives and trusted me with their answers to my many questions. I hope that this study does justice to the spirit of their cooperation.

My committee members provided valuable assistance on this study. Dr. Douglas R. Campbell helped me plan my research and transform my data resources into a meaningful report. Dr. Norman Bell and Dr. Richard McLeod offered insightful comments on my manuscript, particularly on my analysis of the educational computing movement. My advisor, Dr. William Joyce, spent untold hours guiding me on this project, and on many others that I have undertaken during my graduate career. His friendship and encouragement have greatly enriched my life.

To the extent that I have been able to master the tools of educational ethnography, I am indebted to Dr. Campbell and to Dr. Frederick Erickson. I envy their subtlety and their commitment to this fascinating methodology.

Like all Ph.D. candidates, I often thought about dropping my thesis and moving on to less imposing tasks. If it weren't for the steadfast encouragement of my family and friends, I am sure that I would have done so. My sister, Cindy; my parents, Jim and Maryellen

Roessler; and my adopted parents, John and Jean McInnis, all contributed emotional support at key times. Friends who were particularly effective in this regard include Bill Adams, Sam Smith, Rosie Bogo and Karl Tomecek.

Finally, after four years of simultaneously neglecting my family and drawing nourishment from them, I have an opportunity to acknowledge their support. My wife, Mary, and my daughter, Katie, have been gems throughout my graduate career. Mary doesn't type manuscripts, but she is a fine editor. Her thoughtful comments throughout every step of the research process helped me tremendously. Mary and Katie's faith and encouragement have been essential to me on this dissertation. I dedicate it to them.

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CHAPTER I

INTRODUCTION

Ten years ago, computers were relatively expensive and were accessible only to people connected with large organizations like universities and large businesses. With the development of microcomputers, many American schools, families and small businesses have now found computers affordable. The result has been the widespread dispersion of computers into our society. Currently, over 94% of the schools and 13% of the families in the United States have one or more computers (McGinty, 1985; "Newsbriefs," 1987). Total sales of educational software alone have been running over $130 million annually (Reinhold, 1986). According to most educational technologists, this surge represents only the beginning of a series of basic changes in our instructional delivery system. The final result will be the development of elaborate learning centers with computers integrating high capacity storage devices, touch-sensitive television monitors, videodisc players and drawing tablets into systems that provide students with tutorials, simulations and all-purpose work stations (Education Turnkey, 1985; "Radical change," 1987).

Questions

This rapid infusion of computers into our society has raised a number of basic questions for educators. What do students need to learn to become "computer-literate"? What role (or roles) should

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computers play in the educational process? How should they be integrated into the existing curriculum? At what grade level and in what ways should students be introduced to computers? What are the psychological, social and political consequences of bringing computers into the schools? For the most part, schools have decided to leap into the computer age and learn the answers to these questions in the process (Pogrow, 1983). Though research on computerized learning has been on-going for over 25 years, most of it was conducted in the 1960's and 1970's using large, mainframe computers and somewhat limited forms of computer-assisted instruction. The school microcomputer lab of today, with its wide variety of computer activities and devices, needs to be investigated on its own terms, to see which aspects of the earlier research still hold true (Sheingold, Kane & Endreweit, 1983). As educational psychologist Mary Alice White has stated, ". . . we haven't begun to crack the shell of what it is to learn electronically" ("Into the Electronic," 1981, p. 9).

Purposes

This case study was designed to investigate these questions as they apply to computer use in an elementary school. It is based on a method of research called "educational ethnography," a form of descriptive, on-site research that is being used increasingly to investigate change in our schools. Educational ethnographers immerse themselves in the school community to be studied, using a variety of data-gathering tools, including participant observation, videotape recording, photographing and interviewing. Unlike experimental researchers, ethnographers perceive the members of the community studied as informants, not as subjects.

Though educational ethnography uses many of the tools of traditional ethonography, the two methods are distinct. General ethnography seeks to describe the entire way of life of a bounded social group; whereas educational ethnography focuses upon a particular cultural scene like a classroom, a playground or a computer laboratory (Erickson & Mohatt, 1982). For this reason, educational ethnography is sometimes called "microethnography." In the remainder of this report, the term "ethnography" will be used to refer to the research approach known as "microethnography" (Erickson & Mohatt, 1982).

The focus of my study is a fourth-grade class in a small town in Michigan. When I began my observations in early 1984, this school was experiencing its first year of widespread computer use, based on a laboratory of 14 computers linked together in a network. This lab was used primarily for drilling students in mathematics, but also for teaching computer literacy by occasionally having them try other kinds of computer activities. From January through the end of the school year, I observed the students in the regular classroom and at the computer lab. I interviewed them, their teacher, their parents and members of the school community in an attempt to understand the role of the computers in that school. I began this inquiry with three broad research questions:

1. What is the social context surrounding the use of computers in this school?
2. How do the students relate to the computers?
3. What do the students learn by interacting with the computers?

Implicit in these questions were a number of assumptions. I assumed that the context of computer use would be an important factor in how the students perceived the computers and worked with them. This context, I believed, would include factors like how the lab was arranged, who decided what activities would occur there and what the adults said when they referred to the computers. I also assumed that using the computers in school would entail a "hidden curriculum" for the students, that they would be influenced somehow just by the experience of using computers as a surrogate teacher. It was my hope and belief that I could identify parts of this hidden curriculum by observing the students and their interactions with the computers, and by interviewing them formally and informally.

Limitations

No study is without its inherent limitations, and this one is no exception. Because I began in the middle of the school year, I missed the opportunity to observe some key events, like the students' first visit to the lab and the principal's initial in-service designed to introduce his teachers to the equipment. Nevertheless, I did my best to piece together this information through interviews and the collection of relevant documents.

Another limit that I experienced was the inaccessibility of certain kinds of personal information. On the whole, my adult and student informants were wonderfully candid and helpful; but, quite naturally, their view of me influenced what information they were and were not willing to reveal. Because I was known as a middle school computer teacher and a software author, some people (particularly some adults) seemed unwilling to share with me their negative feelings about computers. Ethnographers are always confronted by these obstacles, however, and so they generally rely on observations more heavily than on interviews.

Another limitation of ethnography relates to the reader's natural desire to generalize from the population studied to other groups. An ethnography is a case study, often of a unit that was not selected by random sampling. Thus, the generalizability of the results is always somewhat limited. Ethnographers normally handle this dilemma by thoroughly describing their sites, informants and methods and allowing the readers to decide the extent to which the results can be generalized to groups that interest them (Erickson, 1986; Goetz & LeCompte, 1984). In this study, I have strived to observe (and explain) standard ethnographic procedures in order to maximize the readers' ability to make these comparisons. In so doing, I have tried to present sufficient detail to allow the readers to function as co-analysts in the project. I have also preserved all of my notes, tapes, transcripts and other artifacts so that they can be inspected by interested scholars.

Organization

The organization of this study is a compromise between the established format for presenting a dissertation and the ethnographer's need to present a natural history of the inquiry. Chapter 2 provides the mandatory review of the literature, and Chapter 3 presents a full description of the methods used in the study. Because educational ethnography may be unfamiliar to many of my readers, I begin the latter chapter with a brief explanation of this methodology and the criteria used to evaluate an ethnographic report. Chapters 4 and 5 consist primarily of background information: descriptions of the site, my key informants and the role of computers in the school. Chapter 6 begins the particular description of events, portraying, in detail, what happened during one ordinary visit of the students to the computer lab. Based on this vignette and the analysis that follows it, I then make a case in Chapter 7 that, by the end of the year, these fourth graders were remarkably competent as computer users. Chapters 8 and 9 address the issue of the hidden curriculum of computer education as it was experienced by this class. Chapter 8 analyzes how these students viewed the computers and how they related to them. In Chapter 9, I proceed to identify four aspects of computer use that these students were forced to adjust to as they worked in the lab. These adjustments, I submit, reveal the ways in which they were being socialized into the information society. Finally, Chapter 10 summarizes the findings of the study and identifies their implications for teaching, curriculum and research.

A large part of this rather lengthy report consists of quotations and narrative vignettes. This emphasis hopefully adds credibility to my report and enables the reader to use the results in ways that I never could have imagined when I conducted the research. It also enables my informants to tell their own stories (at least indirectly), though, I'm sure, in ways that they never imagined.

CHAPTER II

REVIEW OF THE LITERATURE ON EDUCATIONAL COMPUTING

The rapid diffusion of microcomputers into American homes and schools has generated widespread interest in computers and their impact on education. The resulting literature has focused upon three main questions:

1. To what extent do computers enhance learning?
2. What do students need to learn about computers?
3. What is the hidden curriculum associated with the infusion of computers into the schools?

In this chapter, each of these three areas will be reviewed in turn, with the emphasis placed on those studies bearing upon elementary students.

To What Extent Do Computers Enhance Learning?

Most of the experimental studies of educational computing have attempted to measure the effectiveness of computer-assisted instruction (CAI). As early as 1969, there was sufficient research for Feldhusen and Szabo to write a review of this literature. Though they found much of the research to be of poor quality, they felt justified in drawing three conclusions:

1. CAI will teach at least as well as live teachers or other media.
2. CAI saves time when compared to other teaching methods.

3. Students respond favorably to CAI.

Since 1969, innumerable studies of the effectiveness of CAI have been conducted, eventually switching their focus from mainframe computer terminals to microcomputers. With surprising consistency, these studies have supported all three of the conclusions drawn by Feldhusen and Szabo.

In 1972, a review of 10 major studies of CAI drill-and-practice by elementary students was undertaken by Vinsonhaler and Bass. They concluded that "The effectiveness of CAI over traditional instruction seems to be a reasonably well-established fact in drill-and-practice for both mathematics and language arts . . . " (p. 31). They called, however, for more research into why CAI is effective.

More recently, reviewers have used meta-analyses to integrate research findings on CAI. Burns and Bozeman (1981) evaluated studies of computer-based mathematics teaching in elementary and secondary schools. They found that computer tutorials raised achievement test scores by .45 standard deviations and that drill-and-practice programs raised them by .34 standard deviations. In 1983, Kulik, Bangert and Williams published a meta-analysis of 51 studies of computer-based instruction in grades 6 through 12, including drill-and-practice, tutorials, computer-managed teaching, simulations and the teaching of programming. They found that using computers raised students' final examination scores by about .32 standard deviations, from the 50th to the 63rd percentile. Two of the studies reviewed by Kulik et al. measured the efficiency of computer learning. They found that CAI saved anywhere from 39-88% of the students' learning time.

Two recent reviews of the research concluded that computers teach math more effectively than they teach language (Johnston, 1986; "Younger Students," 1985). These same reviewers found that computers are more effective when used with elementary students than with secondary students and more effective with secondary students than with college students. Johnston suggested that the reason for this effect may be that younger students can accomodate more easily to the computer's structured approach.

Recent research has sought to measure the relative effectiveness of CAI compared to other learning treatments. Levin and Meister (1986) calculated that, in reading and math instruction, CAI was more effective than increasing instructional time or reducing class size but less effective than peer tutoring. A similar comparison was carried out by Niemiec, Blackwell and Walberg (1986), based on 110 studies instead of the 2 used by Levin and Meister. This second analysis found that, in math, peer tutoring was slightly more effective than CAI but that, in reading, CAI was twice as effective as peer tutoring. In terms of cost-effectiveness, Niemiec et al. concluded that "Compared to peer tutoring, adult tutoring, increasing the length of the school day, and decreasing class size, an average CAI program produces the greatest gains per $100 of instructional expenditure" (p. 751).

When interpreting these results, one must be careful not to equate the successes demonstrated in these experiments with those achieved by most computer-using schools. As has been pointed out by the Education Turnkey Systems study (1985), most of these experiments were based on giving students at least 10 minutes of computer time per day. This degree of contact is far more than the 20 minutes per week given to the average student in the computer-using elementary schools of the United

States. The level of teacher preparedness seems to be a key factor that must be considered as well (Brady, 1985; Education Turnkey, 1985).

One major reason underlying the effectiveness of computer-based learning may be that most students enjoy working on computers and, hence, are motivated by them. This enjoyment has been substantiated by a variety of experiments and anecdotal reports (e.g., Larter, 1983; Cox & Berger, 1981). Some authors have suggested that the computers' appeal is a result of its novelty, a novelty that will surely wear thin with time (Education Turnkey, 1985). A study conducted by Hess and Miller (1972) gives reason to question this pessimistic outlook. They studied 40 fourth graders who had been working with CAI since first grade and found that, after four years, the students maintained a strong interest in the instructional programs that they were running.

Several researchers have investigated the question of why computer-based learning is motivating to students. Frederick Bell (1974) analyzed six large-scale computer research projects in order to answer this question. His conclusion was that the use of computers created a better learning environment than what he saw as the sterile environment normally provided by schools:

> Computer-related learning environments catalyze people to do outstanding work, because they provide a setting in which each student can create things, make things work (a computer for example), obtain real recognition for work well done, and teach others how to do these things which he has learned to do well. (p. 18)

It is important to point out here that the computer uses described by Bell extended beyond CAI to include programming and the taking of practice tests on the computer.

The motivating value of CAI was analyzed by Hess and Miller (1972). Assuming that competence testing was a key movitating factor, they videotaped their fourth-grade subjects at the computers in order to study how changes in the level of difficulty of the programs affected their engagement with the computers (as measured by posture, gestures, facial features, etc.). To the researchers' surprise, the results showed that the engagement level was highest, not when the students worked at their competence levels, but when they did the easier lessons. These findings at least partially parallel those of Neideffer and Evans (1982) who surveyed undergraduates on what characteristics made games interesting to them. Their subjects divided into two groups: those who preferred short, relaxing games governed largely by chance and those who preferred fast-paced, challenging games that forced them to be creative.

Based on interviews with 65 elementary students, Malone (1984) discovered two additional factors that made computer games appealing: curiosity and fantasy. Concerning the latter, he found that different fantasies were needed to appeal to different students. Most of the girls, for example, did not find aggressive fantasies to be movitating.

Computer-based education has inspired considerable research into the details of the learning process. When given a chance to design educational computer programs, experienced educators have been forced to admit that their instructional design skills were inadequate (Clement, 1981). According to John Seely Brown (1977), an artificial intelligence developer, we really don't even have an adequate theory of when and how to give hints to a student engaged in a learning task. Similarly, Tobias (1982) has argued, not much is known about what students think as they learn: when and how often do they stop to

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summarize what they have learned, for example, and exactly how do they react when they get confused? Computers have inspired research into these questions for two reasons. One is that the computer can be programmed to track many of these phenomena as students run an instructional program. Secondly, computer programs make it possible to individualize instruction by analyzing learning styles, cognitive strategies, ability levels, and many other factors (Hartley & Lovell, 1984). For these reasons, research should enable us not only to improve the quality of educational software but also to raise our understanding of the learning process in general.

What is Computer Literacy?

The rapid infusion of microcomputers into homes, schools and businesses has created support for the inclusion of a completely new subject in our nation's K-12 curriculum--computer literacy. In addition to using computers to drill students on their math, English and other subjects, it has become commonplace to maintain that they should become "computer literate" as well. A few years ago, A Nation at Risk recommended at least a semester of computer science for all students (Hacker, 1984). Since then, at least 26 states have established guidelines for the teaching of computer literacy (Snider, 1986). States, school districts and even local businesses have pumped millions of dollars into the purchase of school computers, and public support for these efforts has been high. A Gallup Poll taken in 1983 found that 72% of those surveyed believed that computer training should be required for all high school students ("Public Favors," 1984). The arguments given for the urgency of computer literacy education have been largely economic. If the United States hopes to compete more effectively in the world marketplace, it must find a way to produce workers with better technical skills (Anderson & Atta, 1985; Hacker, 1984; Pogrow, 1983). Another major concern of the computer literacy proponents has been to help students cope with the information revolution that is sweeping through society at a faster pace than the industrial revolution did before it (Hepburn, 1985; Toffler, 1980).

Though a concensus has emerged that schools should teach computer literacy, agreement as to the meaning and content of that subject has not. Most authors on the subject define "computer literacy" operationally. Beverly Hunter, for example, has written that "It's general definition is 'whatever a person needs to be able to do with computers in order to function in an information-based society'" ("The Best Way," 1984, p. 41). The use of this kind of definition has meant that the content of computer literacy curricula has changed along with the rapid shifts in the new technology and current ideas of what an information society is like. Since 1980, three different concepts of computer literacy have emerged:

1. learning how to program computers
2. learning to use computers as a tool ("computer applications")
3. acquiring appropriate attitudes and knowledge about computers

Each of these concepts has acquired backing from a different group of researchers and educators.

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Learning how to program computers.

The initial enthusiasts for computer literacy tended to equate it with computer programming. The clarion call for this approach was issued by Alfred Bork, Thomas Dwyer, Arthur Luehrmann and Seymour Papert (Papert, 1980; Taylor, 1980). These men argued that learning to program a computer enabled students to work in "one of the richest environments known to man" (Dwyer, in Taylor, 1980, p. 94). They believed that learning to program (especially, learning to debug programs) taught students general problem-solving skills, or "algorithmic thinking" (Luehrmann, 1982; Papert, 1980). It was for these reasons that Papert and his colleagues developed the language of LOGO. They believed that learning to program in LOGO would improve students' understanding of mathematics and would also teach them about the learning process itself.

A wealth of anecdotal evidence has surfaced to support the assertions that young students can learn to program and that they enjoy it (Holzman & Glaser, 1977; Roessler, 1987; Solomon & Papert, 1982). There is little experimental evidence, however, to substantiate the argument that learning to program teaches basic problem-solving skills. A 1978-79 study by Foerster and Goris ("Action Research," 1981) showed that fifth and sixth graders taught to write simple programs to solve their math problems did improve their problem-solving skills better than the control group. Johnston (1986), on the other hand, has reported the results of a study by Marshall Linn revealing that students only learn problem-solving skills when given extensive programming experience with exemplary teachers who instruct problem-solving directly. Similarly, recent reports from the U.S. Department of Education and the Center for Research into Practice claim an inability to detect any transfer from learning programming to general problem-solving abilities (Snider, 1986). The Department of Education reports that problem-solving is best taught by using software designed for that purpose.

When microcomputers first became available, most school districts were very enthusiastic about teaching programming, many beginning at the elementary levels. Since then, the number of teachers wishing to teach programming has diminished ("Micro-as-Tool Wins," 1985; Sherman, 1983). One reason for this shift may be the evidence that programming is less essential for the job market than was once believed (Moursund, 1986; Otto, 1984). A study of this question was published in the Winter, 1985, issue of the *Occupational Outlook Quarterly*. It concluded:

> In summary, about 1 in 8 of all workers now uses a computer. Of these, about 5 percent need extensive computer training. Less than 10 percent need to learn programming. All the rest--more than 4 out of 5 of all who use computers--are in occupations where using computers means only operating them; these workers learn the necessary skills in a few hours to a few weeks of training, most of which is given on the job or by manufacturers of the equipment. (Goldstein & Fraser, p. 29)

According to the Bureau of Labor Statistics, even by 1995, only 1% of all American workers will need extensive training in computer programming (Goldstein & Fraser, 1985).

Computer applications.

Another reason for the declining interest in teaching programming has been the development of increasingly sophisticated software. These new programs have made it possible for computer users to achieve results that, five years ago, would have required an advanced knowledge of programming (Levin & Souviney, 1983; Moursund, 1986; Roessler, 1987). Consequently, many computer experts have called for an increased emphasis on the teaching of the computer's use as a tool. This use is often referred to as "computer applications" or "computer-integrated instruction" (Moursund, 1986; Snider, 1986). According to Moursund, the head of the International Council for Computers in Education, computer-integrated instruction "is now viewed by most computer education leaders as the most important component of computer literacy" (1986, p. 6). An endorsement of this view has emerged from a recent Delphi study. In that study, Waggoner (1986) found that 35 experts in educational technology rank ordered the desirable computer skills for workers in the following way:

1. word processing
2. cognitive skills
3. data bases
4. telecommunications
5. electronic spreadsheets
6. modeling/simulation
7. programming
8. graphics
9. robotics
10. maintenance

The need for the development of two of these skills has been demonstrated by recent investigations. One is data-base searching. Research has revealed that branched searches are very difficult for most people to learn (Hamaguchi, 1985; Pogrow, 1983; Thomas, 1983). Similarly, 90% of home computer users have failed to buy modems and utilize the opportunities of telecomputing at least partially because many people who have bought modems report that they find on-line communications to be bewildering (Covert, 1986). There are two possible solutions to these kinds of problems: either make people more computer-literate or make the computers more user-friendly. Research on specific experiences of teaching people to use computers should prove valuable on both of these fronts.

Acquiring appropriate knowledge and attitudes about computers.

The third major interpretation of computer literacy has been that of approaching the computer as a subject matter--what are computers, how do they work and what impact are they having on the individual and society? Calls for the emphasis on teaching students to answer these questions have come from many quarters: the Council of Europe (Vorbeck, 1985), the National Council of Teachers of Mathematics (Battista & Steele, 1984) and the National Council for Social Studies (Napier, 1985). Proponents of this definition of computer literacy have been concerned with helping students cope with technological change and the wide array of ethical questions that accompany it. A sampling of objectives to achieve this goal was developed by Sesow and Stricker and presented to the National Council for Social Studies in 1982. The computer-literate student:

1. Knows how use of computers will improve one's life.
2. Knows the historical events preceding the development of computers and microcomputers.
3. Knows how computers can be used for telecommunications and satellite communications.
4. Knows the changes in vocational fields as a result of use of computer technology.
5. Knows the possible uses of computers in business and industry.

6. Understands the potential impact of computers in one's life.

7. Understands the future impact of computers on individuals and society.

8. Analyzes one's attitudes about using computers.

9. Analyzes the attitudes and values others place on computers.

10. Evaluates the legal and ethical questions related to computer use. (quoted in Napier, 1985, p. 193)

Many educators, particularly social studies educators, have argued that these objectives need to be addressed directly by the curriculum (Napier, 1984). Others have maintained that they can be taught indirectly. The beliefs of this latter group were summarized by Bill Dempsey, a member of *Electronic Learning's* National Advisory Board: "When the computer is used throughout the curriculum, kids can learn most of what they need to know through osmosis. That's a lot more effective than cramming everything into the artificial environment of a computer literacy course" ("The Best Way," 1984, p.43). Some researchers have maintained that this knowledge about computers is a natural by-product of teaching students to program (Minsky, 1977).

There exists a small amount of research bearing on this "osmosis theory" of teaching about computers. A survey of West German young people (ages 16-20) revealed that they had become increasingly aware of the problems accompanying technological change even though the topic was seemingly ignored by their textbooks and their teachers (George, 1984). In 1983, Richard A. Diem used ethnographic techniques to study 151 children of ages 8-12 as they worked in a computer day camp. Despite the fact that these students had been exposed to a variety of computer experiences, both in and out of school, Diem (1985) found that they had not considered the social implications of using each other's data. Nor had they considered the right to privacy as it related to the misuse of informational technology. On the other hand, when their privacy was violated, these students became upset and demanded harsh penalties for the violators.

Battista and Steele (1984) investigated the indirect teaching of computer literacy by assessing the learning gains of three groups of fifth graders: a group that used math CAI, a group that learned programming and a control group. Their measuring instrument was the Minnesota Computer Literacy and Awareness Assessment. They found that both the CAI and the Programming groups earned significantly higher scores than the control group in the affective domain, which included components of enjoyment, anxiety, education and efficacy. Only the CAI group scored significantly higher than the control group on the cognitive subscale, though; and, even so, the scores of the CAI group were well below an acceptable level of 80%. The students in the Programming group, it seems, focussed their interest on controlling the computers to the exclusion of learning about how computers are used. Battista and Steele concluded their article by calling for additional research:

> Much more research is needed in this area to determine the effects of various types of computer-based instruction on students' knowledge and attitudes towards computers, and how these effects depend on age and intellectual ability. Such research is essential for quality curriculum development in the area of computer education. (p. 658)

Educators, it would seem, need research to help determine what constitutes "appropriate knowledge and attitudes about computers" and how best to teach them.

What is the Hidden Curriculum of Educational Computing?

The third major area of research on computer education has dealt with the by-products of computer education. How is the technological revolution changing schools and the students who pass through them? Communications theorists have known for many years that it's not just the content of the media that changes society but also the nature of the media themselves (McLuhan, 1964; Postman & Weingartner, 1969). Thus, it is incumbent upon researchers and educators alike to investigate the probable impact of integrating the new electronic media into schools and society. Since these impacts can occur whether they are planned or unplanned, they are commonly referred to as "the hidden curriculum" or "hidden agenda" of computer education (Kohl, 1985; Turner, 1984). The literature on this phenomenon can be divided into two parts: one focusing on the effects on the schools and the other on the effects on the students themselves.

Effects on the schools.

Computer-based learning can occur almost anywhere--in a school, a home, a shopping center or a doctor's office. In addition to microcomputers, microprocessors have made available other new forms of learning devices, including talking toys, problem-generating calculators, video games and interactive videodisk systems. All of these new teaching media have joined television and movies as potential influences on the knowledge and attitudes of young people. As such, they constitute either a complement or a threat to education.

Many educational thinkers have perceived this relationship as a serious threat to the continuation of schools as we know them today. Stanley Pogrow (1983), for example, has argued that self-paced, individualized programs will enable students to learn so well at home that schools will suffer a major loss of credibility and a total "environmental collapse" about their systems. Schools could be needed, he maintained, not to teach basic skills but to provide creative learning and socialization activities. Similarly, Chandler has argued that "Schools will not last much longer unless they become more responsive to change and more open to radical restructuring" (1984, p. 71).

In the light of events occurring in the last two years, these statements appear a bit shrill. In particular, it has become more difficult to take these threats seriously since the limitations of the educational uses of home computers have surfaced (Sanger, 1985; Snider, 1987). Nevertheless, a case can be made that the microcomputer revolution has placed stress upon schools and teachers. Researchers in many settings have found that teachers often know much less than their students about how to run computers (e.g., Larter, 1983; Sheingold et al., 1983). Even teachers who know computers are often using them without knowing exactly what it is that their students are learning from the experience (what one writer calls "teaching in experimental mode"). The result has been some teacher anxiety and, presumably, a loss of credibility. Furthermore, there is developing a modern form of the generation gap, in which the teachers are products of a print-oriented society and their students are products of an electronic society. According to a report from the Southeastern Regional Council for Educational Improvement (Willis, Thomas & Hoppe, 1985), this gap is at least partially responsible for soaring dropout rates, discipline problems and low credibility ratings that many schools suffer from today. When Sheingold et al. (1983) investigated three different computer-using school districts, they found the issue of teacher comfort with the computers to be a key issue requiring further investigation. Their observations and interviews, though, revealed that teachers themselves were often the driving force behind the infusion of computers into the schools. In two of the districts that they studied, the teachers generally admitted that they were inadequately prepared to teach with computers. These teachers reacted not by turning against computers, but by trying to find more time to use the machines, evaluate software and observe their students at the computers.

In addition to challenging teachers to upgrade their skills, school computers pressure them to accept new roles. To the extent that computers can instruct students without requiring teacher intervention, they encourage teachers to function less as knowledge dispensers and more as support persons or consultants. Since most of a normal class session is usually given over to teacher talk (Goodlad, 1984), this role represents a major shift. Some experts think that schools will have to respond by developing whole new job categories like "media planners" and "media aides" (Education Turnkey, 1985).

Computers seem to generate a concomitant pressure to individualize instruction. One of the main arguments used for computer-based education is that it can respond to the pace of the individual student. Some advocates of CAI maintain that computers can (or soon will) respond with the patience of Job and the questioning powers of Socrates (Evans, 1979; Jackson, 1968). Schools are accustomed, however, to moving students through the grades in lock-step (Jackson, 1968). What happens when the computer opens the door for the brighter students to move through the material at their own pace--from 6-10 times faster than their slowest peers? In 1969, Anthony Oettinger identified this conflict between computerized education and the standard operating procedures of schools. Based on how schools had responded to previous individualizing technologies (like language labs and books), he predicted that schools would thwart the individualizing potential of computer education. As the Carlson (1965) study had already shown, schools responded in that way to programmed instruction.

The study of educational computing undertaken by the National Commission for Employment Policy (Education Turnkey, 1985) has recently echoed Oettinger's concerns. Their reading of the literature showed that the potential of computer education could be realized only if teachers would integrate computer software and the accompanying individualization into their teaching. Unfortunately, they found that 80% of schools reported that the use of computers had not changed their methods of teaching. Furthermore, less than 20% of the school districts in the U.S. had undertaken any long-range planning to help integrate the new technologies into their curricula. Consequently, the authors of this report recommended "a massive training initiative," supported by the public and private sectors, in order to further teachers' skills with the new technologies and to teach them to individualize instruction.

While schools have not responded to the computers' push toward individualization, they have responded to the natural push toward management. As computers have given business managers an opportunity to measure their workers' output more closely (Neuhauser, 1984), so they have given school administrators a tool for measuring their teachers:

> During the remainder of the decade, as a result of state or district policy, technology will be viewed as an element of staff productivity. It will be increasingly used to measure and evaluate staff performance as a basis for career ladder schemes (including merit or incentive pay) presently being planned or implemented in approximately 25 states. (Education Turnkey, 1985, p. 7)

Teachers, in turn, have taken to using microcomputers for purposes of measuring their students. Many educational computer programs have built-in management systems that track student progress, either openly or surreptitiously. In addition, there has been an outpouring of generic utility programs designed to help teachers grade tests, calculate grades and track student learning on an objective-by-objective basis. In this way, the microcomputer revolution has dove-tailed with the back-to-basics movement and the push toward competency-based testing (Chandler, 1984; Education Turnkey, 1985; Kohl, 1985; Lias, 1982).

New media create a bias toward what they do best (Lias, 1982). Consequently, it is predictable that computers will push schools toward quantification and the systems analysis approach to administration. Lias has warned that there is a large hidden agenda contained in this approach:

> The most annoying and destructive result of living with computers from day to day is that we take the dominant characteristics of them--rational, mathematical logical-calculator--and then transfer these characteristics onto fellow humans. This causes us too often to disregard the intuitive, emotional, dreaming, worshipping, inventing, moralizing, laughing, and playing aspects of people. (p. 238)

This assertion, were it to prove true, would obviously constitute a serious negative by-product of computerizing our schools. Other authors have expressed similar concerns (Kohl, 1985; Oettinger, 1969), but these effects have not been substantiated by research. The case study approach, like this study of Wolverine School, would seem to be needed first, to identify how these effects might manifest themselves, if they appear at all.

On the other side of the coin, computers may be inducing teachers to emphasize the playful side of education. Because students enjoy using computers, some authors fear that teachers will use them even when their educational value is dubious (Bork, 1984). This possibility also needs to be investigated. Does educational computing constitute an invasion of the video game parlor into the classroom? Are microcomputers inducing teachers to emphasize electronic fun at the expense of education? These are key questions. Certainly, it is clear that the home computer education movement was derailed, at least in part, by the home video game express (Sanger, 1985). Similarly, it has been reported that people in business have developed numerous subterfuges for using their work computers to play adventure games (Covert, 1985). In this way, the computer's dual personality as a work/game machine raises some interesting questions about its potential impact on our schools.

Effects on the Students.

If the infusion of computers into our schools is affecting teachers and curriculum, it is natural to wonder if they might not be having an equal, or even greater, impact on students. In addition to teaching them subject matter and computer literacy, is it not possible that computer education is teaching students a hidden agenda that might not be so palatable to educators, were it to be identified? These concerns are voiced periodically in the literature and are sometimes tied to the assertion that computers should not be moved into the schools until their possible side-effects have been explored more carefully (Brady, 1985; Kester, 1984). Unfortunately, much of the literature on this question is based on anecdotal reports only.

Investigation of the computers' psychological impact began with ELIZA. Developed in the mid-1960's by Joseph Weizenbaum of M.I.T., ELIZA was a program that enabled a computer seemingly to talk with people by giving responses like those that a psychologist might give. To Weizenbaum's amazement, people who tried the program demanded to be allowed to "converse" with the computer in private. Soon, a number of psychiatrists picked up on the idea and began to assert that a more elaborate version of ELIZA could serve as a valuable pyschotherapeutic tool (Brady, 1985; Weizenbaum, 1976). Since that time, computers have been used successfully to interview medical patients and alcoholics (Frude, 1983; Hepburn, 1985). The fact that some people formed such intimate relationships with computers so disturbed Weizenbaum that he undertook the writing of a book about the dangers of this tendency and, in so doing, opened up a whole new area of the literature on computers. This literature was capably summarized by Neil Frude in a book called *The Intimate Machine* (1983). Frude documents the fact that the human tendency to attribute life to inanimate objects (animism) is often applied to computers as well. He cites, for example, the study by Scheibe and Erwin that found that 39 out of 40 subjects personified a computer game as they played it. Their study was based on secret tape recordings of what these people said as they played the game. Students, Frude claims, are capable of similar reactions. When a personalized talking computer called LEACHIM was used in New York schools, for example, the 9- and 10-year-old students became deeply involved with it on a personal level. According to Frude, children are more vulnerable to misperceiving a computer in this way because they accept as literal the personhood of the machine. Toy manufacturers, of course, encourage this perception when they create talking dolls and stuffed animals (Dolezal, 1985; Frude, 1983).

Frude's arguments have been substantiated and refined by the seminal research of Sherry Turkle (1984). In 1979, she undertook a six-year ethnographic study of the interaction of children and adults with computers and electronic toys. Focusing upon those who were deeply involved with computers as video game players, hackers or students, she sought a glimpse of the ways in which computers will eventually come to influence us all. Turkle found that people of all ages do, indeed, form intimate relationships with the computers. The kinds of relationships that they form, however, are very different. Like a rorschach inkblot test, the computer functions as a projective medium, reflecting back to people a mirror of their minds. Computers also allow for the creation of microworlds into which many people wander, like Nick, the hacker who told Turkle, "The computer is your world, your reality. When someone screws around with this they are messing with your universe" (p. 236).

Turkle found that children seem to pass through three phases in their reactions to computers. From ages four to eight, they react by formulating metaphysical questions. These "children philosophers" wonder quite openly about the attributes and personalities of the machines: can computers cheat, can they feel things, can they know things? According to Turkle, "Putting very young children together with computers encourages a rich and continual philosophizing" (1984, p. 137).

Around the age of 9 or 10, this metaphysical reaction seems to give way to a drive for mastery. In this second stage, the children lose their interest in philosophical questions and begin seeking ways to dominate the computers, to use them as a way of proving themselves. Students in this phase are attracted to video games and are in some jeopardy, claims Turkle, of losing themselves in the microworlds contained therein. Turkle found that the children of this age who played video games took their cartoon-type characters quite literally.

Once students have outgrown this "unreflective control phase," Turkle discovered that they return to philosophizing about the computers. In this third phase, Turkle's adolescent subjects used the computers to develop their self-understanding. Deborah, for example, learned self-control by making rules for her life similar to the rules she made for the computer when she programmed in LOGO. George used analogies with computer programming to try to "debug his life." In this final phase of relating to computers, Turkle's informants were falling into a trap that she, and other researchers (Bolton, 1984; Weizenbaum, 1976), have found very disturbing: they equated the workings of a computer with the workings of their own minds. In yielding to that temptation, they were moving in a direction that could become the greatest impact of the computer upon our society: changing our views of human nature to coincide with our understanding of how computers work.

If computers can change our views of human nature, is it also possible that they can change our relationships with other humans? This concern--that forming a relationship with a computer can have isolating, anti-social effects--has been voiced by many scholars (Frude, 1983; Kester, 1984; Langeveld, 1985; Nowotny, 1982). An exploratory study by Feldman and Sears (1970) in 1966-67 lent some credibility to this concern. By studying two groups of first graders--one using CAI and the other not--these two researchers found that the CAI-using children exhibited more sedentary and constricted behavior in the regular classroom. Since that early study, a number of reports have been issued supporting the opposite conclusion: computer use seems to increase social interaction. Turkle (1984) found that her student informants shared their insights into programming quite naturally. Similarly, Turner's ethnographic study (1984) of computer use in a California middle school revealed that, though the students accepted the computers as friends and playmates, their visits to the computer stimulated socializing with other students. In fact, Turner hypothesized that the computers encouraged the development of a new student role--that of kibbutzer. The Sheingold et al. study (1983) also noted the birth of this new student role. Consequently, it would seem that, for most students at least, the use of computers offers the prospect of more social interaction rather than less.

Another concern about the student-computer relationship relates to the question of authority. As Weizenbaum argued in an interview in 1985 (Brady, 1985), since televisions have already come to have too much authority in young people's minds, won't the interactive qualities of computers contribute to their idea that truth is something which emerges from a cathode ray tube? This contention is supported by research carred out in the late 1960's and early 1970's by Hess and Tenezakis (1970). They arranged for the introduction of CAI into a lower socioeconomic, predominantly Mexican-American, junior high school and then used questionnaires and semistructured interviews to investigate what they called "the socioaffective outcomes of CAI."

What they found was that the computer had a certain charisma for these students and that it had at least a limited capacity to act as a socializing agent for them. In fact, the students who ran the CAI program came to see the computer as being fairer, easier, clearer, more likeable and better than the teacher. Generally, they accepted the computer's authority. According to Hess and Tenezakis the implication of their study may have been that computer-based learning is particularly beneficial to students who see themselves as objects of discrimination. On the other hand, they warned, it may be precisely these students who are most susceptible to being duped by computers. These researchers called for research on other socioeconomic groups for comparative purposes.

Hess and Tenezakis arranged for the installation of a mainframe terminal in the school where they carried out their study. Thus, it is possible that the "charisma" that the students attributed to the computer may have grown at least partially out of their knowledge of the source of that computer--"those university people from Stanford." A question that arises, then, is whether or not these same student reactions are occurring in schools that have purchased microcomputers. Hess and Tenezakis's study, like so many of the early studies on mainframe computers, needs to be verified in the computer-using schools of today.

In *The Second Self*, Turkle (1984) argued that adults see computers as a new way of life, but children accept them as a fact of life. As students learn to accept computers in this way, they may also be learning to accept certain undesirable characteristics of computers as well. Doing so should help them cope with future shock, but it would also mean a loss of the sense of having decision-making power over these machines (Smith, 1985). If contact with computers is having this effect on students, it is essential that it be investigated now before the dispersion of computers into the schools permanently alters students' views of them (Rogers, 1984). A major purpose of my research has been to investigate this phenomenon and to provide baseline data with which future researchers can compare to their findings.

A final issue related to the microcomputer revolution's effects on students is the question of equity. According to many educators, allowing equal access to all students regardless of their sex, race or socioeconomic status, is the most important issue related to the infusion of electronic technology into the schools (e.g., Hepburn, 1985; Pogrow, 1983). The urgency of this concern is felt most deeply by those who see the electronic revolution splitting society into two groups: the technocrats and the less educated underclass (Nowotny, 1982).

Survey research has indicated that schools serving wealthy communities tend to have more computers than those in poor communities. A 1985 survey showed that the ratio of students to computers in the wealthiest American districts is 54:1, compared to 73:1 in the poorest districts (DuBois & Schubert, 1986). This difference is significant, certainly, but may be in the process of being resolved. According to the Education Turnkey report (1985), the falling costs and increased distribution of hardware may dissolve this quantitative difference by 1990. A 1983 survey sponsored by the National Science Foundation (Anderson, Welch & Harris) has lent credence to this prediction by showing no significant differences in computer exposure given to black and white students.

Even if the quantitative differences in computer exposure were to melt away, however, more tenacious qualitative differences will probably endure. Reports from several sources (Anderson et al., 1983; DuBois & Schubert, 1986; Lockheed & Frackt, 1984) have indicated that poor students are likely to use computers for CAI while their wealthy counterparts are learning programming, computer applications and more creative uses of computer inquiry. As summarized by Daniel Watts, this trend means that "Affluent students are learning to tell the computer what to do, while less affluent students are learning to do what the computer tells them to do" (Lipkin, 1984, p. 20). There is one indication that this problem, too, may lessen over time, however. The Education Turnkey report (1985) found that the longer schools used microcomputers, the less computer time was given over to drill-and-practice.

In terms of computer equity, sex discrimination may ultimately prove more powerful than socioeconomic discrimination. Only 35% of the students in high school programming classes are girls (Gilliland, 1984). High school girls, instead, are more likely to take word processing (Fisher, 1984). These differences apparently carry over into the job market: women hold 80% of the clerical jobs and 63% of the computer operators' jobs, but only 25% of the systems analysts' and 31% of the computer programmers' positions (Kolata, 1984; Sanders, 1984). According to Nowotny (1982), women are most vulnerable to becoming the new underclass because many of them will be forced to accept low-paying clerical jobs in their homes and care for their children at the same time. Furthermore, the invasion of computers into the home will give women less privacy and make them more vulnerable to being controlled by information originated from afar.

Current research indicates that elementary girls are no less capable at computers (and no less interested in them) than are their male counterparts (Lockheed & Frackt, 1984). Several subtle factors seem to be working to discourage their interest, though. Educational software is geared more toward boys than girls (Malone, 1984; Sanders, 1984). Computer advertisements and software titles are overwhelmingly masculine in their orientation too (Rose, 1984). Girls seem less responsive to the gamelike nature of many computer programs and less likely to want to explore computers for no particular reason (Gilliland, 1984; Sanders, 1984). The general aggressiveness of boys in a computer lab seems to discourage girls as well.

On the positive side, Kolata (1984) has suggested that two predominantly feminine traits--patience and attention to detail--are important skills for advanced computer work. Furthermore, girls are less likely than boys to drop out of school, and they have just recently become more likely to attend college and to earn bachelors' and masters' degrees (Hacker, 1984).

Though the microcomputer revolution has threatened to work against the competitiveness of women and and the poor, it has offered a promise of doing the opposite for special education students. Many educators have found computers to serve the special needs of these students (e.g., Larter, 1983). According to Christopher Evans, this may be because computers are "lucid, non-patronizing and endlessly patient" (quoted in Hawkridge, 1983, p. 158). Handicapped students have also benefited from computer technology, although experience has shown that many of them need hardware adjustments like special keyboards and lower computer tables (Harvey & Ginther, 1984; Larter, 1983).

To the extent that qualitative differences will affect the opportunites available to disadvantaged groups, a statement from a teacher in Toronto can be used to focus on the major questions:

> Teachers must decide what students should know about micros; some students may need to know about programming; others need to use it to learn (as a tool); others need only know about micros generally. (Larter, 1983, p. 96)

According to this view, educators must not only determine what students need to learn about computers but also which students should learn what. Researchers and educators alike need to analyze this idea and to assess its validity. If it is determined that it represents a wrong-headed and discriminatory point of view, then we must learn how to cope with this view when it surfaces in the minds of teachers, principals and other educational practitioners.

Chapter Summary

It can be seen from the foregoing review of the literature that there remain considerable gaps in our knowledge of educational computing. Though the effectiveness of computer-assisted instruction is well-established, key questions about the nature of computer literacy and the best way to teach it remain unanswered. Furthermore, there is a need for research into the effects of computerization upon our schools and our students. The development of microcomputers has created a need to replicate previous studies carried out on mainframe computers, and it has placed a special urgency on those studies because its dispersion is so widespread.

CHAPTER III

METHODS AND BEGINNINGS

This study is an investigation of a cultural phenomenon--the interactions relating to computer use in an elementary school. To enable myself to record and analyze these interactions most productively, I adopted the methods of educational ethnography. This school of research has proven quite successful in exploring the culture of a single school or classroom (Bogdan & Biklen, 1982; Borg & Gall, 1983). Because the assumptions and techniques of ethnography differ significantly from those of the mainstream, experimental research tradition, I have decided to begin this chapter with an introduction to educational ethnography. After describing its purposes, techniques and criteria for evaluation, I will focus on my particular case study, explaining how it began and outlining the procedures of data gathering and analysis that I followed. This background chapter should assist the reader, then, in evaluating the remainder of my research report.

The Nature of Educational Ethnography

Educational ethnography is a research methodology based on the methods of anthropology. Since schools are social systems built upon customs, beliefs, statuses and roles, ethnographers maintain that they should be studied in the same way that an anthropologist studies another culture. Educational ethnographers generally focus upon a single cultural unit like a class, a school or a community. They

devote months, and sometimes years, to on-site research, gathering data primarily through participant observation and interviewing but also through photography, videotaping and artifact collection.

Ethnography is based on the philosophy of phenomenology, which assumes that different perspectives of reality are equally valid (Bogdan & Biklen, 1982; Ihde, 1977). For example, consider a situation in which a teacher is being evaluated by the principal as she teaches a lesson on geometry. The teacher may perceive the situation in terms of the instructional content that she is conveying (why don't they understand congruent triangles?); the principal may see it in terms of the techniques that are being applied (why doesn't she use modeling?); while the students may define what is happening largely in terms of the time factor (will she let us out early so we can beat the lunch rush?). Ethnographers believe that it is only through identifying these multiple perspectives that a researcher can adequately describe and analyze what is happening in this classroom. Consequently, the ethnographer sees the members of the school community not as subjects but as informants. The idea is to observe them, listen to them and learn from them (Spradley, 1980).

Ethnographers seek to identify the categories that their informants use to understand their world. This process requires a deliberate effort to set aside one's own perceptions. Ethnographers call this "epoche" or "making the familiar strange" (Ihde, 1977). To this end, ethnographers frequently change the positions from which they make observations. They vary the time of day for their visits and initiate conversations with individuals who might provide an entirely different perspective on what is happening at the site. Videotapes can be particularly helpful in achieving epoche because they can be viewed in so many ways: forwards, backwards, sped up, slowed down (Erickson, 1982). Using these and other techniques, ethnographers work toward the goal of creating a cultural description that would make sense to the various participants.

This emphasis on the "meanings perspectives" of the informants also dictates that ethnographic researchers exercise flexibility in their perceptions of the research problem. These researchers commonly enter a site with a set of research questions but remain continuously open to the possibility of revising them if the situation warrants it (Geer, 1969). For example, in their study of two teachers and their interactions with native American students, Erickson and Mohatt (1982) based a large portion of their analysis on the way in which each teacher left the class in order to run an errand. They used their videotape transcripts to analyze how many times each teacher left, for how long, and with how many directives per minute. These are not the questions that a researcher would be able to anticipate at the beginning of a study but, in this case, they proved to be the key to understanding the major differences in the teaching styles of the two teachers involved with the study.

In ethnography, data analysis is a continuous process. After each visit to the site, the ethnographer records his or her observations in detail (without analysis) and then, in a separate place, records any new hypotheses that have been suggested by the events of the day. If an hypothesis is deemed worthy, it is tested by formulating predictions of behaviors that will occur under certain conditions. If future observations prove insufficient to test the hypothesis, the researcher may utilize additional data-gathering methods to do so, for example, making enumerations or initiating interviews with informants most likely to disconfirm the hypothesis (Spradley & McCurdy, 1972). Hypotheses are continuously formulated, tested and revised in this way. This process is called "analytic induction" (Erickson, 1986; Geer, 1969).

Criteria for Evaluating an Ethnographic Report

Ethnographic reports are generally quite exhaustive. According to Frederick Erickson, they should contain nine main elements:

1. Empirical assertions
2. Analytic narrative vignettes
3. Quotes from fieldnotes
4. Quotes from interviews
5. Synoptic data reports (maps, frequency tables, figures)
6. Interpretive commentary framing particular description
7. Interpretive commentary framing general description
8. Theoretical discussion
9. Report of the natural history of inquiry in the study (1986, p. 145)

These elements are all necessary, Erickson maintains, so that the reader is able to experience the setting vicariously and function as a co-analyst of the case reported.

By including all nine of these parts, the ethnographer seeks to demonstrate that the assertions generated match the realities studied (that the study is internally valid). To further enhance internal validity, there are a number of additional criteria that an ethnographic report should meet:

1. Narrative descriptions should reflect the perspectives of the persons involved. When possible, these descriptions should be shared with the participants and their reactions should be included in the study (Erickson, 1978).

2. Assertions should be supported by evidence drawn from a variety of data sources. For example, statements made by informants in interviews should be checked against the actions of those informants, the statements of other interviewees and any other relevant sources of information. This process is known as "triangulation" (Goetz & LeCompte, 1982; Gorden, 1980).

3. The researcher must show that a systematic search for disconfirming evidence has been conducted. This search usually involves checking each major assertion against the entire body of field notes and videotapes. If any notable discrepant cases are discovered, they must result in a revision of the assertion, or they must at least be presented for the consideration of the reader (Erickson, 1986; Goetz & LeCompte, 1982).

4. The effects of the observer on the actions of the informants must be continuously monitored and assessed by the researcher. Furthermore, the relationship between the researcher and each key informant must be monitored as well (Goetz & LeCompte, 1982).

A properly conducted ethnographic study should be very high in internal validity because of the duration of time that the researcher spends at the site and the variety of procedures that are followed to identify the perspectives of the informants (Goetz & LeCompte, 1982). As a consequence, Borg and Gall (1983) have written, ethnography is likely to generate many new hypotheses and those hypotheses should be thoroughly grounded in the real world.

Educational ethnographers know that the outcomes of their studies depend on who they are, what concerns they bring to the site and what relationships they form with the informants. They cannot maintain, therefore, that another researcher would have achieved the same results. They seek to demonstrate, instead, that had other researchers been present at the time, they would have accepted the study's observations, if these observations had been pointed out to them (Erickson, 1986; Schatzman & Strauss, 1973). In the case of mechanically recorded data, the results can be presented to these researchers for review and confirmation (Erickson & Wilson, 1982).

External validity poses a serious problem for the ethnographer. Since random sampling is not used in the selection of the target group, how can the results be generalized to other groups? In many cases, they cannot. Say, for example, that a researcher is studying a teachers' strike and its impact on a school. Certainly no other school would have quite the same elements of personality, history and physical plant, so no other school could have quite the same experience. The ethnographer believes that the study would be nonetheless valuable as a case study that could be used to identify factors for consideration by educators and researchers alike. According to Goetz and LeCompte, the consequence of this fact is that ethnographers must strive for comparability and translatability:

> Comparability requires that the ethnographer delineate the characteristics of the group studied or constructs generated so clearly that they can serve as a basis for comparison with other like and unlike groups (Wolcott, 1973). Translatability assumes that research methods, analytic categories, and characteristics of phenomena and groups are identified so explicitly that comparisons can be conducted confidently. (1982, p. 34)

The assumption here is that the comparisons are carried out by the readers and that it is the responsiblity of the researcher to provide the information to make that possible. In additon, if they desired, readers should be able to replicate the methods of the study from the information given in the report. This requirement makes it incumbent upon the researcher to present a full description of the site, the participants, the role of the researcher and the methods of data collection and analysis.

The Origins of This Study

In my data gathering, data analysis and reporting of this case study, I have strived to match the standards identified in the previous section. The remainder of this chapter contributes to this effort by describing the initial assumptions of this study, how I chose and entered the site, what role I established there and what methods of data collection and analysis were used. In Chapter 4, I will provide further background information by describing the site and my key informants there.

Beginnings.

This study began as a project for a sequence of graduate courses in educational ethnography that I took in 1983-84. As a software author and a middle school computer teacher, I was very interested in the microcomputer revolution and its impact upon the schools. I planned this study in December of 1983, a time of great enthusiasm for educational computing. Sales of microcomputers to homes and schools were booming; computer enthusiasts like Arthur Luehrmann and Seymour Papert were very much in the news; and commission reports on education were calling for mandatory courses in computer literacy and/or computer programming (Hacker, 1984; "School Micro," 1985). To an extent, I was caught up in this enthusiasm. In a paper that I wrote at that time, I described the microcomputer revolution as a major element in our society's transition to the information age. I wrote, "In my research, I hope to get a glimpse of the cultural implications of this great change in our society" (Roessler, 1983, p. 2). I also recorded the specific changes that I intended to explore in this study:

> I plan to research the effects of the microcomputer revolution on a class of fourth graders at -------- School in --------. I plan to focus my study on these students as they work with the computers. How do they relate to the machines? Do they have anxieties about the computers? How do they think that they work? Are there differences between the ways boys and girls relate to the computers? Are kids from white-collar families more comfortable with them than kids from farm and blue-collar families? Do the computers change the way students relate to each other? I also intend to observe the way adults influence kids' views of the computers--what their teacher, principal and parents communicate to them about this subject. (1983, p. 1)

Implicit in these questions were a number of assumptions:

1. that the computers would be presenting many stimulating challenges to the students;
2. that interacting with the computers would force them to make many adjustments (including, perhaps, overcoming "computer anxiety");
3. that how well they met these challenges and made these adjustments were matters of importance to their education.

In that same paper, I expressed some skepticism about the microcomputer revolution:

> Parents, teachers, students, and administrators have taken turns telling each other how important it is for our schools to acquire these marvellous machines and then figure out what to do with them. (p. 1)

Nevertheless, the primary motivation for my study was the belief that these computers were, indeed, going to become a positive part of our educational program and that we should find the best ways to help our students learn from them.

Choosing and entering the site.

The researcher's choice of a site and her or his method of entering that site are important considerations in an ethnographic study. I chose Wolverine School because it was just going through the stage of computerization that I wanted to study. After two years of experimentation with 2 Texas Instruments computers, they had just installed a laboratory of 14 Radio Shack computers linked together by a network. All of the teachers had agreed to have their students use the computers once a week, and so the opportunity was given me to observe the students during their first year of extensive exposure to educational computing.

There were some practical considerations involved with my choice as well. Wolverine School (as I will call it) was within a reasonable distance from my home, and I had known and respected its principal, Mr. Peterson, for several years. Among small-town administrators in the area, he was known for his early interest in computers. I knew he would be supportive of my research endeavors.

In mid-December, I talked to Mr. Peterson and asked his permission to conduct my field work in his building. He agreed and said that he would be interested in my results. When asked to suggest a teacher who would be good for me to work with, he suggested Mrs. Rosemont, a fourth-grade teacher who had demonstrated her interest in computers by taking a course in BASIC at a nearby community college. Knowing of Mrs. Rosemont's reputation as a capable teacher, I concurred with this choice. Since I was very busy with final exams at that time, Mr. Peterson and I agreed that I would return to ask Mrs. Rosemont's permission after Christmas vacation.

On January 10, I visited Wolverine and talked to Miss Serge, the library media aide who was in charge of the computer laboratory. I briefly described my study and asked for her cooperation. She consented. We consulted her computer schedule and discovered that Mrs. Rosemont's class used the lab on Thursdays and Fridays. Since I could visit regularly on Tuesdays and Thursdays, we agreed that Mrs. Rosemont would be a good teacher to ask. Miss Serge then offered to try to switch the schedule so that Mrs. Rosemont's days would be Tuesdays and Thursdays. I thanked her for the offer and went to see Mrs. Rosemont.

I arrived at her classroom at 3:35, just after the students had been dismissed. I told her that I wanted to study her students and their work with the computers. She readily agreed, noting that she had two aides in her classroom each day, so she and her students were used to "having other people around" (Field notes).

A week later, I returned to the school and showed a copy of my proposed parent permission form to Mr. Peterson and Mrs. Rosemont. They both approved it. Mrs. Rosemont expressed surprise that anything so formal was necessary. When I asked her to introduce me to her class, her face took on what seemed to be a quizzical expression, perhaps because it was dawning on her that my study was going to be more intensive than she had realized (Field notes).

On Thursday, January 19, Mrs. Rosemont did introduce me to her students. I explained that I was a middle school computer teacher and that I wanted to study what they were learning from the computers. I said that I wanted to observe them in their regular classroom and in the computer lab and that I might want to interview some of them and to videotape them as well. I asked how many would like to participate in my study, and all of them raised their hands (Field notes). Then I explained about the permission forms and gave them to Mrs. Rosemont to hand out at the end of the day. Within a week, the signed forms had been returned and I was ready to begin my research.

Reflecting back on this site and the conditions under which I entered it, I think it can be said that they were nearly ideal. I was given carte blanche to gather data in most any way that I saw fit. The only special limitations on my study were self-imposed: in order to allay any concerns that the parents might have had, I had stated in my permission slip that I would not be administering any tests or consulting their student files.

Data-gathering Methods

The primary tools of educational ethnography were used to gather data for this case study. They included participant observation, interviewing, videotaping, photography and artifact collection. The specifics of how each of these was employed will now be discussed in turn.

Participant observation.

In ethnography, the main data-gathering instrument is the researcher. Consequently, it is very important to establish an appropriate role and to monitor that role in order to identify potential sources of bias. From the beginning of my research at Wolverine School, I sought the role of a "passive participant observer" (Spradley, 1980). That means that I mostly sat in as a spectator or, as I described it to Mrs. Rosemont's students, as "a little mouse in the corner." My presence must have been somewhat more obtrusive than that, however, because on most days I was a little mouse with a portable tape recorder in his lap. Generally, though, I began my research following the precept that "Phenomenological inquiry begins with silence" (Psathas, quoted in Bogdan & Biklen, 1982).

In my research course, we had been taught that ethnographers must be open to all kinds of data sources, beginning with general observations and only later narrowing down to more focused ones. Thus, I noted phenomena like the verbal expressions, body language, dress and social interactions of the students and adults; the lighting, acoustics, furniture and decor of the rooms; and the routines and overall atmosphere of the institution. In other words, I tried to make what Spradley calls "grand tour" observations (1980).

Since a school is a site where writing is often done, I decided that I would carry a spiral notebook and take notes as I observed, despite the fact that it would increase my obtrusiveness somewhat. In that notebook, I recorded short notes to myself and also quotations that I thought might prove important later. Whenever possible, I recorded quotations verbatim. Sometimes the students came up and asked to see my notes. In those instances, I gave them a quick look at the page I was writing on but never offered to let them browse through the notebook. After this happened once or twice, I learned to jot down cryptic one- or two-word reminders for any bits of information that I considered sensitive. My intention was to avoid unduly changing their behavior by revealing what kinds of observations I was making about them.

Each time I left the site, I went off by myself and read that day's notes, fleshing them out in any way possible. Usually, this process would add another 25-50% to the length of notes for that visit. Any time that I included a quotation, I identified it as word-for-word or a paraphrase. When possible, I went right from this mind-dumping session to the computer to record even more notes. There, I used a data-base program to record a variety of entries, coding each into one of these categories:

P Procedural details

D Description

C Comments (and speculations)

J Journal entries

I Ideas for research strategies

Each entry was identified as to the date it was recorded and to the stimulus that had triggered it (for example, reflections on a visit or a journal article). After each session at the computer, I immediately printed out all of the entries for that session in the order of their entry.

Because I was a full-time graduate student during this school year, it was not always possible to record these reflections right after a visit to the site. To minimize the introduction of bias into these entries, however, I kept a rule never to discuss a site visit with anyone until I had made my notes at the computer for that session.

Throughout my study at Wolverine School, I defined my subject broadly, seeking to observe events of all kinds. I attended Parents' Day Lunch, a parents' night at the computers and a Macintosh demonstration for interested staff members. I went to a statewide computer conference that Miss Serge attended, and I visited a computer fair that was given by the Grantsville Middle School. Whenever possible, I joined the teachers or the students for lunch. In casting my net broadly, I tried to understand the entire culture of Grantsville Public Schools and the role it served in the community.

Interviews.

Much of my data was gathered through informal interviewing. While walking back to class I would chat with Mrs. Rosemont for a few seconds; or, while watching a student use the computers, I would ask a question like "How do you get the computer to show you your scores?" Given the role that I had established at the school, this technique seemed to work well, especially since I was careful not to do it when it would disrupt class or call the group's attention to myself.

My first formal interview was conducted on January 26. Some of the students had just run a new program for the first time, and I was anxious to see how they reacted to it. I took four volunteers and interviewed them during recess. This interview seemed to me to be a disaster. The transcript revealed the students to be playing roles and more or less telling me what they thought I wanted to hear. After that, I decided to heed the advice of my research professor and postpone my formal interviews as long as possible. I didn't interview another student until February 28. In the meantime, I used a separate data-base file to build up interview questions for each of the persons that I wished to interview. I also read Ives's book, *The Tape-Recorded Interview*, and learned how to interview more subtly.

Over the course of the term, I formally interviewed 17 of the 26 students, singly or in small groups. These interviews were generally conducted in the library where we were relatively undisturbed and free to walk over to the computer lab if a question about the hardware arose. I began my student interviews with a standard set of open-ended questions and then added ones specific to each interviewee. I always tape recorded these interviews and worked to help the student relax before each interview began. In addition to the students, I interviewed a number of the adults as well, including Mr. Peterson, Mrs. Rosemont, three other Wolverine teachers, Miss Serge, and several other adults in the Grantsville community. I transcribed all of the student interviews in their entirety since they were the focus of my study. In this report, all citations to interviews are from transcriptions of tapes unless they are labeled "Interview notes."

Videotapes.

In March, I made videotapes on four separate days, always including a computer session and twice adding footage taken back in the regular classroom. When videotaping, I followed as closely as possible the procedures outlined by Erickson and Wilson (1982). This meant setting up the equipment ahead of time, using a wide angle lens to minimize the need to keep re-directing the camera and generally working very hard to make the equipment as unobtrusive as possible. For each of the computer sessions, I was able to start the recorder before Mrs. Rosemont's students entered the lab and just leave it running until they left. This technique freed me to observe in my usual way. Each time I set the microphone from the videotape recorder in the center of the lab (taped upright to one of the carrels), and I ran a tape recorder in one corner of the lab. This setup gave me two mics and a Mike to record the students' comments during these sessions.

Later, when I transcribed these tapes, I cross-checked these three sources against each other.

I prepared the students for these videotaping sessions by explaining how they would work and generally trying to demystify the process. Nevertheless, I could tell that the students were slightly more self-conscious on these particular days. My transcripts show two or three comments per session like "Hey, I'm on T.V." (Field notes, 3/1/84) or "Smile, you're on Candid Camera" (Transcript, 3/20/84). Nevertheless, as expected, the demands of their work seemed to carry them back to their normal routines very quickly.

Photography.

Still photographs proved to be a surprisingly effective tool for my research. I took photographs on four separate days, using techniques described by Byers and Collier (Byers, 1964, 1966; Collier, 1967). This meant using a wide-angle lens and taking some shots more or less randomly so as to avoid just photographing phenomena that I was already aware of. I also photographed objects that I wanted to study more intensively, like the lab itself, a computer keyboard and a student's computer design. At times, the students pressed me to take certain photographs. I generally resisted these requests but did take posed shots of the entire class and of the students as they grouped themselves one day during a break in the regular classroom. How they posed, and with what persons and props, was very revealing. At the end of the year, I gave two photographs to each of the students to thank them for participating in my study. Delivering nine of these to their homes gave me an extra opportunity to visit with some of their families.

Another technique that I used was suggested by Byers (1966)--bringing the photographs to the site and letting the informants talk about them. This approach helped initiate conversations with some of the shier students and gave me additional information on how they viewed themselves, each other and their work at school.

Artifact collection.

Any anthropologist worth a travel allowance brings back artifacts. Erickson recommends that ethnographers think of their work in the field as a time to fill a box with "data resources" (1986). I eagerly filled mine with all manner of documents generated by the people at Grantsville Schools, including administrative memos, computer printouts and software catalogs. Mrs. Rosemont helped me build up a file of student material by allowing me to photocopy several sets of the essays and worksheets that they created for her. At the end of the year, she gave me the sheets that she had used to track the students' progress on the computer math program.

Before and during the time of my research, I also monitored educational journals, television programs and the local newspapers for articles, programs and ads pertinent to my study. I did this in order to sample the kinds of information about technology and computers to which my informants were being exposed.

Methods of Data Analysis

Unlike experimental researchers, ethnographers begin data analysis as soon as they enter the field. This analysis consists of formulating, testing and revising working hypotheses. My conception of this process coincides with the following description taken from Blanche

Geer's "First Days in the Field":

> Although he spends a good part of his time just listening to informants or drifting along with a group to see what will happen, the observer also forms hypotheses during the field-work period. These are called working hypotheses. Some of them are so simple they can be tested immediately by having a look at a group or asking questions of informants. Others, usually based on an accumulation of data, predict an event or state that people will behave in specified ways under certain conditions. These undergo a prolonged process of testing, retesting, preferably by more than one field worker, over a period of months and years. There is no finality about them. They must be refined, expanded, and developed. (pp. 152-153)

I recorded my working hypotheses into my data base as "Comments" and tested them by observing, asking questions and reviewing my fieldnotes and transcripts. In many cases, as Geer suggested, the best way to test these hypotheses proved to be making predictions of future behavior.

Once the period of data collection has ended, ethnographers expect to spend at least an equal amount of time analyzing the data and writing up the results. This is not surprising considering the sheer quantity of data involved. The approach that I used was a combination of those outlined by three sources: Spradley's *Participant Observation* (1980), Schatzman and Strauss's *Field Research* (1973) and Erickson's chapter in *The Handbook of Research on Teaching* (1986). It consisted of 6 steps:

1. *Review the data corpus and transcribe the tapes.*
Rereading my field notes and transcribing almost all of my tapes gave me a better sense of the development of my study and a set of ideas on how to proceed with the analysis.

2. *Make a cultural domain analysis.*
A "cultural domain" is a category of cultural meaning that includes other smaller categories like "Things that can go wrong at the computer" or "Types of comments that students made to each other at the computer" (Spradley, 1980). I made a list of the

domains that seemed relevant (23 of them) and then reviewed all of my field notes and transcripts, entering each instance that seemed to fit into one of these domains into a data-base program. Once I had finished, I printed out all of the categories in each domain. This process helped me to evaluate the ampleness of my data, and it gave me ideas of concepts to pursue in step 3.

3. *Identify key linkages.*
Having reviewed my data and made a domain analysis, I was able to identify several "key linkages." These are recurring themes that run through the data, linking domains to each other and providing a model or metaphor with which to analyze the data (Schatzman & Strauss, 1973). I found, for example, that the students' casual conversations were replete with references to characters from the mass media and that this interest in the media helped explain their perceptions of the computers and their interactions with them.

4. *Formulate and test assertions related to these key* linkages.
Assertions are general statements about the data that a researcher suspects to be true. I formulated assertions and then tested them against relevant data found in field notes, transcripts and audiovisual tapes.

5. *Revise the assertions.*
Each time that an assertion seemed to be supported by the data, I tested it further by asking myself, "Is there any other possible interpretation of the information being explained by this assertion?" When I found instances not fitting a key assertion, I submitted them to a discrepant case analysis. The result, in many cases, was a rejection or modification of the original assertion. As suggested by Erickson (1986), when a modification occurs, it should result in a higher-order assertion because it can explain more of the data.

6. *Repeat steps 4 and 5.*
The formulation, testing and reformulation of assertions continued over a period of months. It ended when I decided that I had established a set of assertions that would illuminate the key linkages and stand the test of careful scrutiny by other researchers.

This sequence of steps for data analysis is standard for an ethnographic case study, as are the techniques that I used for data collection. If I have created a good ethnography, the remaining chapters will unfold as a story. As it unfolds, this story should reveal the choices that I made and my reasons for making them.

Accordingly, my readers should be able to evaluate the plausibility of my arguments and to formulate alternative assertions of their own.

Chapter Summary

Chapter 3 has described the origins of this case study and the methodology used to carry it to completion. Because of my desire to analyze a cultural phenomenon--the interaction of students with computers--I used the tools of educational ethnography, including interviews, photography, videotaping, participant observation and artifact collection. As is typical in this type of research, I carried out on-going data analysis from the first day that I entered the site. The final data analysis involved the formulation and testing of assertions as described in the writings of Schatzman and Strauss, Erickson and Spradley.

CHAPTER IV

DESCRIPTION OF THE SITE AND MY KEY INFORMANTS

As was explained in the previous chapter, an educational ethnography must contain full descriptions of the site and key informants of the study. These descriptions are needed to help the reader assess the ways in which the study's findings can be compared to other sites. This chapter provides this background information, beginning with an overview of the town that I have called Grantsville and then proceeding to a description of Wolverine School and my key informants there.

Grantsville

In 1983 when I began my research, Grantsville was a city of many faces. Its large, old two-story houses set off by maples of the same age gave the small city a foundation of Victorian splendor. Forged on top of this foundation was a predominantly working-class culture, evidenced by the stream of pickup trucks, motorcycles, and souped-up cars that cruised the streets of Grantsville. The streets themselves revealed another face of the city. Many had deteriorated into a surface of crumbling potholes, the legacy of an electorate not always willing to provide financial support for public projects. The main business thoroughfares had been freshly paved, though, thanks to a revival of civic pride, a state grant, and a 1% city income tax that the voters had accepted, repealed, and then accepted again. A new park had been built, a parking area "greened up," and a Grantsville Pride Week declared to commemorate these and other improvements in the community.

Grantsville is what social scientists call an "exurb"--a suburb grown up beyond the suburbs, a small-town community made possible by a freeway that skirts it and runs straight to the automobile factories in the heart of the nearby central city. About one-fourth of the employed adults of Grantsville work in the automotive industry. Others work mostly in local stores, gas stations, and restaurants. The single largest employer in town--Grantsville Public Schools--employs a large proportion of the white-collar members of the community. The college-educated residents include the teachers, their spouses, and a sprinkling of professional people and office workers ("Grantsville School," 1984).

In terms of racial and ethnic groups, Grantsville is extremely homogeneous. There are no Black families living there, and the families representing established minority groups could be counted on one hand. Most Grantsville families are of Dutch or German origins.

Grantsville Public Schools

Though there is a grade 1-12 Catholic school in Grantsville, most of the childen in the city and its environs attend the public schools. The Grantsville district has just over 2,000 students, about half of whom live outside of the city limits. The system consists of two elementary schools, a middle school (grades seven and eight), and a high school. The two elementary schools--Wolverine School and Spartan School--were constructed from the same floor plan in 1974 and 1975.

Like the streets, the public schools have suffered from periodic swings in the citizens' willingness to accept increased taxes. Since there are only three small factories in town, the tax base is limited, consisting mostly of homes and small businesses ("Grantsville Schools," 1984). Sixteen years ago, the voters refused to accept an increased tax burden so the middle and high school students were cut back to half days and forced to share a building. As a result, the high school lost its accreditation for three years. Since that time, the district has gradually improved its condition but, in the process, has undergone some very divisive conflicts over property tax rates and the question of whether the district is or is not wasting the taxpayers' money. In the summer of 1983, a turnover in school board members and the passage of a three-year millage gave the district some breathing room and a chance to enjoy what President Harding once called "a return to normalcy."

Mr. Hastings, who had been the superintendent for four years, was deeply concerned about the structural changes undermining the American economy, in general, and the automotive industry, in particular. Often, when he spoke before local groups, he warned his listeners that Grantsville's young people could no longer count on the high-paying factory jobs that had traditionally awaited the city's high school graduates. Rather, he said, they had to prepare for the economy of the future--the world of high technology.

Partially as a result of Mr. Hastings' influence, the school system had made a major effort to infuse microcomputers into its schools. In the spring of 1982, the administrators agreed to spend the entirety of the district's next three years' of Chapter II Grant money on computer equipment for the middle and high schools--$11,400 per year. This money, normally allocated for equipment for the libraries and media centers, was used to purchase seven Apple IIe computers for the middle school and seven Commodore 64s plus two Superpets for the high school. The elementary schools in the district had found their own sources of funding for computers--parents and students selling everything from jewelry to fudge to nuts. As a result, Wolverine School had 2 Texas Instrument computers (TIs) and a network of 14 Radio Shack Model IIIs. Spartan School had two Apple IIs and four Apple IIes for student use.

Overall, the Grantsville Public School System seemed to be on the upswing at the end of 1983. Freshly painted walls and newly installed computers reflected the message that the administrators wanted to convey--"this is a clean and progressive system."

Wolverine School

Wolverine School has an open-school structure and a back-to-basics philosophy. If you will look at Figure 1, you can see that the building itself is shaped like a "Y." The classrooms are concentrated in the arms of the "Y," with the "Lower Pod" (first through third grades) to the left of the base and the "Upper Pod" (fourth through sixth grades) to the right. In the center of these two pods, at the notch of the "Y," is the media center. The classrooms in these pods are large and irregularly shaped. Each has its own outside door and just one small window which runs along the side of the door. There is an eight foot wide opening where each room connects to the rectangular

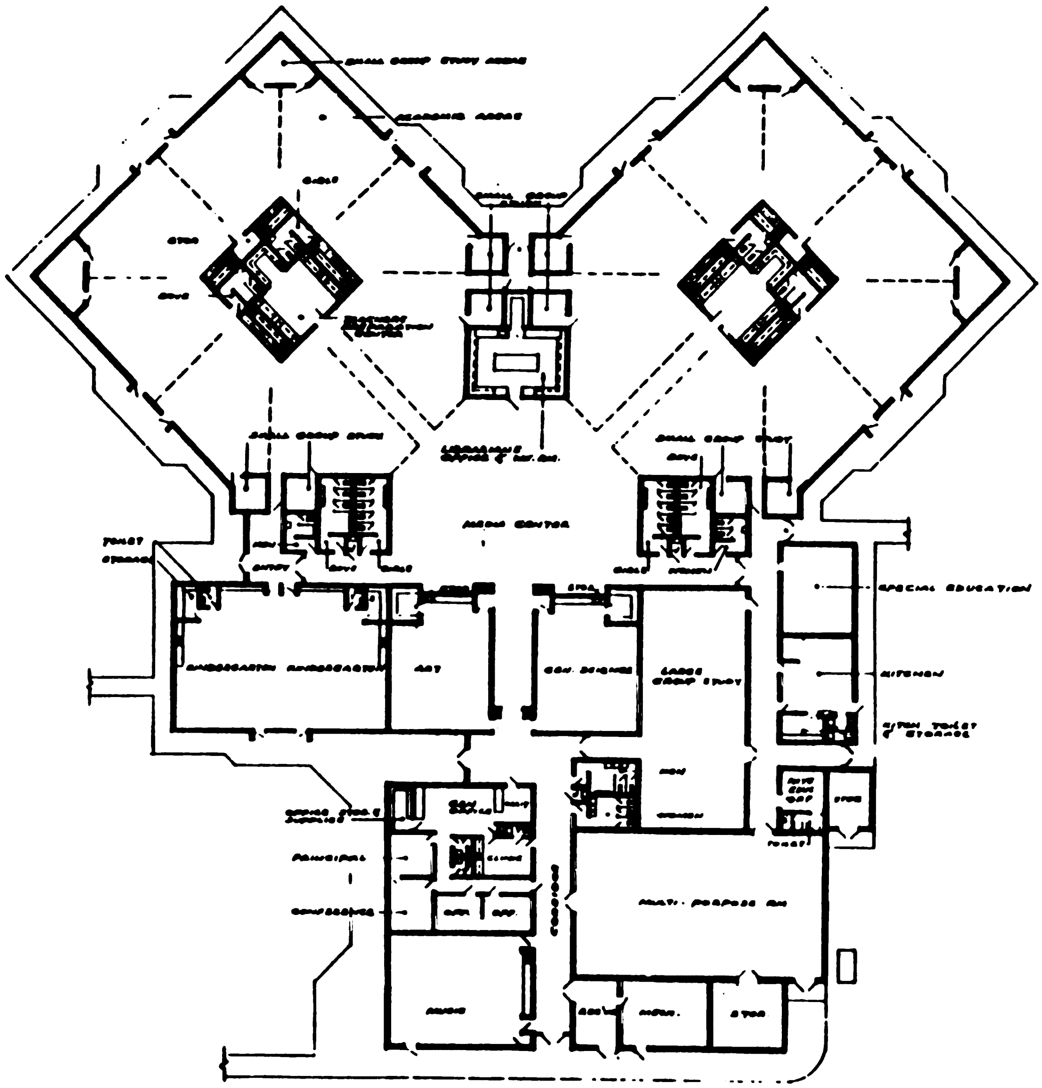

Figure 1. Floor plan of Wolverine School

hallway surrounding the teachers' preparation center. These doorways were initially almost twice as wide, reflecting the open-school philosophy that was popular when the school was built.

Among the staff members of Grantsville Schools, Wolverine had a reputation for being a solid, back-to-basics school with a cooperative and older group of teachers (Interview notes, Mrs. Rosemont, 5/24/84). Evidence of Wolverine's academic success was displayed in the trophy case just inside the main door. There, one could read commendations from the governor for achieving the established criteria on the statewide assessment tests: 75% of the students meeting at least 75% of the objectives on both the reading and math tests. Wolverine School had earned this honor four years in a row. No other school in the district had ever won it. Wolverine's achievement was especially impressive because its territory included the less affluent and more rural parts of the district.

Mr. Peterson and his influences.

Mr. Peterson, the principal, set the tone for Wolverine School. In his nine years as principal, he had stressed basic instruction and the achievement of measurable results. Not coincidentally, Mr. Peterson had also been a prime mover for computer-based education in the Grantsville school system. In 1981, he moved Wolverine into the computer age with the purchase of the two TIs. They were used mostly for CAI but also for teaching gifted students how to program in BASIC. It was Mr. Peterson himself who taught these students programming. In the summer of 1983, Wolverine purchased a Radio Shack Network 2 system, with one master computer and 14 Model III computers to run off of it. This network was set up in the media center, as is shown in Figure 2.

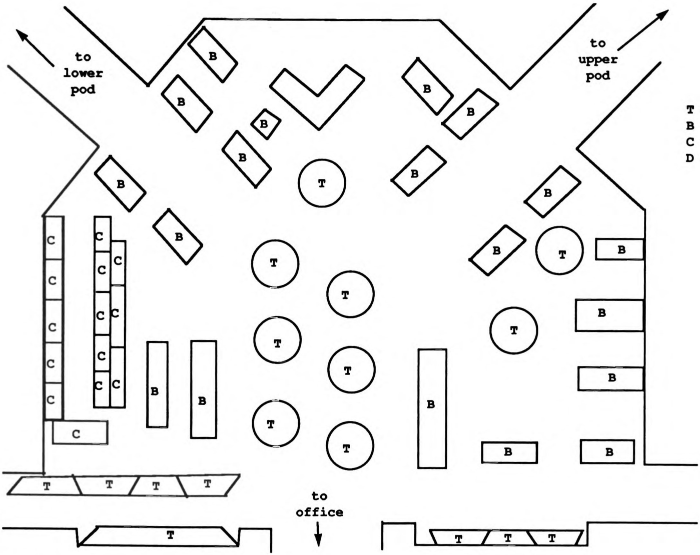

Figure 2. Floor plan of the media center

At the same time, the school also obtained a Model 4 Radio Shack computer and a printer for the use of the teachers and administrators. This system was initially placed along the west wall of the media center but was moved into the main office early in the year. It was used to chart the progress of fifth and sixth graders in math and to provide computer capabilities for the school secretary, Mrs. Ewald.

Like the Spartan School and the Grantsville Middle School, Wolverine has very few assemblies or other special events during the school year, partially because none of these buildings has an auditorium. Consequently, only an occasional play or musical presentation breaks up the daily routine of basic instruction. Not that Wolverine School is a severe place, you understand; just that it is a school with few frills and an organizational commitment to the demands of "time on task."

Mrs. Rosemont and her students.

To place this study in perspective, it is necessary to share some information about Mrs. Rosemont and the students in her class. She had taught for 17 years, the last 15 in Grantsville. Her assignments there began with second grade and then changed to a second/third grade split class. In 1979, Mrs. Rosemont chose to transfer to the middle school, back when it had grades six through eight. She found her sixth-grade students rather difficult to handle so, the following year, she seized an opportunity to return to Wolverine and take up a position as a fourth-grade teacher. As a result of her middle school experiences, Mrs. Rosemont felt that she had become especially appreciative of the positive qualities of elementary students (Field notes, 2/16/84).

Mrs. Rosemont directed her class with firmness, but she was a supportive, open-minded teacher. The year I observed there, she experimented with "cooperative learning" methods in her classroom. She also had each of her students write a small book and create the cover for it. These and many other activities in which Mrs. Rosemont acted as a facilitator rather than a knowledge dispenser revealed her to be what is normally called a "progressive" or "liberal" teacher. In the freshness of her approach, she did not seem like someone who had taught for 17 years.

Of all the teachers in Wolverine School, Mrs. Rosemont was one of the most confident with microcomputers. That winter, she completed her second course in BASIC programming at the local community college. In addition, she had a Commodore VIC-20 computer at home, which she and her daughter used occasionally to play educational games (Field notes, 5/24/84). Most of the teachers at Wolverine didn't take their students to the computer lab. They just sent them down to Miss Serge, the library media aide (or "library media specialist," as her title was officially registered). For those classes, Miss Serge chose the program to be run, downloaded it from the master computer to the students' units, and then supervised the students throughout their session. Mrs. Rosemont was one of only three teachers who regularly supervised their own classes at the computer center. The other two were Mrs. Van and Mrs. Fine, who taught fifth and sixth grade respectively. These three teachers decided for themselves what programs their students would run each week.

From this description, the reader can see that Mrs. Rosemont was certainly above average in her interest in computers. As it turns out, her class was above average too. Two of the 26 students--Bonnie and Lawrence--were hearing-impaired. Since kindergarten, two special provisions had been made for these students. They had been provided with an adult aide who signed for them and they had been placed in a special class of sorts. Because the administration assumed that having these two children would place an extra burden on the teacher, it was decided that they would be placed in a class that was especially cooperative. The way this was done was to handpick seven or eight of the students who seemed most capable and keep them together as a group from year to year. Many of these students had learned sign language, thus becoming good friends and occasional interpreters for the hearing-impaired students. Each year, the remainder of the class was made up of students chosen more or less randomly from the rest of the students of that grade level. Consequently, Mrs. Rosemont's class was top-heavy with cooperative, capable students (Field notes, 3/6/84). One measure of the specialness of this group is that three of these students had a parent who taught in the district. Another indication of atypicality is that the families of 13 of the 26 students owned home computers, compared to the national average of around 7% (Gutman, 1984).

Each spring, the students at Wolverine School took the California Achievement Tests. Table 1 compares the scores for Mrs. Rosemont's class to those of the other two fourth-grade classes:

Table 1. California Achievement Test Scores for Fourth Grade (4/84)

Class	No. of Students	Mean scores (grade 4.7)			
		Reading	Language	Math	Battery
Mrs. Rosemont	26	6.1	6.3	5.7	5.8
Mrs. Christian	26	5.3	6.0	5.5	5.4
Mrs. Tuttle	22	5.2	6.2	5.2	5.3

The mean scores of Mrs. Rosemont's students were higher, especially in reading. Actually, all of these class averages are impressive. Because I knew that the secondary students of Grantsville did not score that well on standardized tests, these scores surprised me. I asked Mr. Peterson about them. He said that, when he was assigned to Wolverine, the averages were well below the 50th percentile, but that they had taken them up to between the 65th and 75th percentiles by focusing the curriculum on reading and math: "We built the curriculum so we would look good on tests" (Field notes, 6/25/86). He cited the use of the Wisconsin Design reading program in grades K-3 to be especially effective in this regard. After a while, he said, the scores started looking so good that they gave IQ tests to the district's students to verify that they were, indeed, working with an average population.

From this discussion, it is clear that neither Mrs. Rosemont nor her class were representative of the norm at Wolverine School. Rather, at least in terms of computer use, they constituted what one might call "the showcase class." Looking back, I can see that this is probably why Mr. Peterson suggested Mrs. Rosemont in the first place: partially, perhaps, to make the school look good, but mostly because the majority of his teachers had very little to do with computers. Nor did they want to. As he explained to me in the office, "You have to remember that the average teacher is scared to death of the computer" (Field notes, 2/28/84). This turned out to be an overstatement, but it served to underscore one big advantage that I gained by choosing Mrs. Rosemont. Her self-confidence enabled her to give me open access to her class and their activities throughout the school day. Those teachers who still felt anxieties about the computers would more than likely have been less comfortable with my presence and close scrutiny. With Mrs. Rosemont, I received access to the teacher's candid thoughts, but at the cost of representativeness.

Having realized this situation within the first month of my research, I made some appropriate adjustments. First, I continuously reminded myself that if any group at Wolverine School learned from computers, it would probably be this group. Secondly, I made a special effort to monitor other classes's computer work to help me gauge the extent to which Mrs. Rosemont's class differed from the rest. I also had frequent conversations with the library media aides at both elementary schools, comparing their observations of the general student population to my observations of Mrs. Rosemont's students.

Though the reader should remain aware of the special abilities of some of these class members, it is important not to conclude that all 26 of these students were exceptional. Remember that most of them were just average fourth graders from a small-town school. As will be explained in Chapter 6, Mrs. Rosemont divided her students into two ability groups when she took them to the computers. This fact will, at times, make it possible for me to discuss the work of her average and above-average students separately.

Chapter Summary

From the descriptions in this chapter, it can be seen that many of Mrs. Rosemont's students were above average in their academic abilities and their opportunities to use computers. Though their school system was not particularly known for educational excellence, it was one in which the microcomputer revolution had gained an early foothold.

CHAPTER V

PERSPECTIVES ON THE COMPUTERS AT WOLVERINE SCHOOL

Microcomputers are machines with many faces. Schools can use them for a wide variety of purposes--teaching students, grading tests, generating forms, analyzing data, printing banners and many other tasks. Before focusing upon the students' interaction with the computers, it is necessary to survey the views of computers held by these students and the school personnel who influenced them. This information will then provide the context for Chapter 6, which describes a typical visit to the computer lab by Mrs. Rosemont's class.

The Administration's Views

Mr. Peterson moved Wolverine School into the computer age. It was he who brought the TI's to Wolverine School, learned how to use them and trained interested teachers and students to do the same. When the parent fund-raisers generated more money than was anticipated, it was he who suggested that it be used to purchase additional computers. To understand the role of computers at Wolverine School, it is necessary to explore Mr. Peterson's views of them.

The principal's views of computers.

Mr. Peterson was a well-informed principal. He stayed current of a number of educational journals, especially those related to educational technology. He was aware of research showing that computer-assisted instruction teaches at least as well as other forms of instruction, and he was fascinated by the possibilities for the integration of computers into the schools (Interview, 2/21/84). Based on my observations and numerous discussions with Mr. Peterson, I can identify the five potential uses of computers that he recognized during the 1983-84 school year:

1. teaching students computer programming
2. teaching students computer literacy
3. increasing staff efficiency
4. drilling students in content-area skills
5. managing instruction

Originally, Mr. Peterson was very excited about the first item on this list--programming. In teaching some of his older students how to program the TI's, however, he found their interest to be limited, as was his: "Personally, I find it very, very boring--extremely boring--to sit and program" (Interview, 2/21/84). By the winter of 1984, he had decided that teaching programming was "of minor importance" because of the availability of menu-driven programs to do whatever one wanted with computers.

Mr. Peterson defined "computer literacy" as "what computers can do and the pros and cons of how to use them" (Transcript, 2/21/84). He considered teaching computer literacy to be "a valid goal" but not something that one would set up a separate class to teach. Rather, he believed that it could be integrated into many subjects, particularly science and social studies. In my observations at Wolverine School, I saw no instances of Mr. Peterson's pushing his teachers in this direction.

During the 1983-84 school year, Mr. Peterson and his secretary, Mrs. Ewald, frequently experimented with the third computer use on this list--increasing staff efficiency. They purchased a program that measured the readability of textbooks, and Mrs. Ewald tried it out by entering selected paragraphs from 16 textbooks (Field notes, 2/23/84). Also, they ordered a program that printed out ready-made school office forms: fill-in-the blank letters for such purposes as congratulating students for academic achievement or thanking parents for organizing fund-raisers. They experimented with this program and Mrs. Ewald liked it. They probably would have bought it, but it had several bugs, so they returned it to the publisher (Field notes, 2/21/84).

Mrs. Ewald was very enthusiastic about learning to do word processing. When I visited the school on February 28, I stopped in the office at 11:30 and found Miss Serge and Mr. Peterson helping her learn how to run their new word processing program on the Model IV computer and the printer that had been relocated in the office. They were all seated with the manual open before them. I asked them how it was going and Mrs. Ewald responded with a smile. "It's fun," she said (Field notes). Later that day, Mr. Peterson told me that all four schools had budgeted for an office computer but that Mr. Hastings would not let any building order theirs until the principals had agreed upon the same system.

Though Mr. Peterson was at least a passive supporter of the three computer uses discussed above, it was very clear where he placed his priorities--in a management system tied to computer-assisted

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instruction. In an interview on February 21, he explained it this way:

> It's really my personal point of view that the computer's greatest value is in criterion-based instruction. It will determine whether a child has passed and when they haven't, whether promotion is possible or not. It keeps track from an administrative point of view. It keeps track of teachers who are, in fact, teaching the subject as it's supposed to be taught, as the Curriculum Council has directed. It keeps track of the student, whether he's passing the course as should be, in terms of objectives, and so it ties your curriculum together into a neat little ball. . . . That's really the major thrust of computers right now--the most feasible part of it right now.

As a principal, Mr. Peterson was very concerned about ascertaining that his teachers were covering the prescribed curriculum. He told me that, before the computers, he used to have to pump the students for information to find out what the teachers were teaching. With an objective-based management system, he hoped "to control and monitor" what they taught directly (Field notes, 2/28/84 & 3/19/84). To this end, Mr. Peterson had placed his fifth- and sixth-grade teachers on the computerized Heath Math Management System. Only Mr. Treetop was excused from this obligation because he was using a different math text. The other five were required to use the standardized tests that accompanied their Heath Mathematics books and to enter each student's answers into the management program or to let Mrs. Ewald type them in for them. This program then printed out individual student reports and all-class reports, objective by objective. Some of these class reports were taped on the wall by Mr. Peterson just outside of his office.

Mr. Peterson made it clear that this use of the computer to monitor achievement was just the beginning. In January of 1984, he spelled out his plans at an inservice presentation to the Upper-Pod teachers. As his agenda for that meeting explained (see Figure 3), he

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ELEMENTARY
TEACHER INSERVICE
1-26-84 Grades 4 - 6
(In the Computer Lab)
3:30 - 4:30 P.M.

The Future

1. Objective based instruction - by generic management systems to insure student and teacher success.

   Resulting in:

   (a) More homework for students

   (b) Longer student and teacher days and year.

   (c) More retentions and more children referred for special education.

   The Role of the Computer

   (1) To do the processing for a generic management system.

   (2) To provide extra drill for students not making mastery level after teacher instruction. (Replacing ditto)

   The Computer to Process the Management System.

   (1) Briefly demonstrate Heath Math Management Reports

   (2) Cards Reader - for speed - top priority next year.

   (3) Generic System for skill management in the following subjects:

      (a) Mathematics

      (b) Science

      (c) Social Studies

      (d) Language Arts

      (e) Reading

   The Computer to Provide Drill and Practice for NON-Mastery Students - by objective.

   (1) Demonstrate with Heath Read-Out.

   (2) Examples of two programs : Fractions 1 and Dragon Games.

Figure 3. Agenda for teacher inservice (1/26/84)

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planned to implement a generic computer management system that would track the students' skill development in all five major subjects. After instruction and testing, CAI would then be used to "provide extra drill for students not making mastery level."

The superintendent's views of computers.

This vision of the ultimate role of the computer was one that Mr. Peterson carried to his teachers and, apparently, to Mr. Hastings and the other administrators. Plans were being laid at that time to purchase an electronic card reader for each of the buildings. These card readers were to be connected to the computers so that a student's test answers could be read off a card and tabulated in just a few seconds. In the series of K-12 curriculum overhauls mandated by Mr. Hastings, each subject area committee was required to establish a computer-based management system that would accompany regular instruction. The card readers would be the foundation of this system. As Mr. Hastings explained to me, math was chosen to be first because it seemed to work best:

> One of the, uh, I guess, mandates that we arrived at was that we're not going to have a math program unless we can test it and the only way we can test it, in our estimation, is if it can be put on a computer. So, we're going to look for a program or at least when we go to select a math program, it's going to have to have some software. It's gonna have to serve individual needs and aggregate needs for that class or whatever. I think we all realize it's probably easier to do for mathematics than to other areas. (Interview, 8/21/84)

In that same interview, Mr. Hastings identified the implementation of this system as the foremost academic goal of the district. The main reason for this focus had been explained to me earlier by Mr. Peterson: Mr. Hastings feared that if Grantsville's standardized test scores ever

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fell below those of a certain neighboring district, the local voters might respond by rejecting a vote to maintain or increase the school taxes (Transcript, 5/24/84).

The Staff's Views

Mr. Peterson was one of the two main computer enthusiasts at Wolverine School. The other was Miss Serge, the library media specialist. The advent of the computers seems to have brought her extra work but also extra status. She was not intimidated by the computers and had freely made the efforts to learn programming and to absorb the technical information required to operate the network. As a result, most of the teachers relied heavily upon her in matters related to the computers.

Miss Serge, computer enthusiast.

Miss Serge was enthusiastic about a number of facets of educational computing. She enjoyed word processing and taught it to Mrs. Ewald and to the two students in her adult education class. She was always on the lookout for certain programs that would run on the Radio Shack network: LOGO, social studies programs and shape-recognition programs were on her target list at that time (Interview, 2/21/84 & Field notes, 5/10/84). Since she had a limited budget for software that first year, she was particularly interested in inexpensive and free programs (Field notes, 3/19/84). For the reader's inspection, I have compiled in Figure 4 a list of all the programs that Miss Serge had accumulated for the network by June of 1984. Almost all of these programs were acquired early in that school year.

Figure 4. Network programs owned by Wolverine School as of June, 1984

Program Title	Publisher
ALPHAKEY	Radio Shack
CELLS	Educational Activities
DECIMALS AND PERCENTS	Random House
THE DRAGON GAME SERIES	Educational Activities
GALAXY MATH FACTS--GAME I	Random House
HEART LAB	Educational Activities
HISTORY & GEOGRAPHY --STATES --REVOLUTIONARY WAR --PRESIDENTS --REGIONS --COUNTRIES	Micro Learningware
K-8 MATH PROGRAM, VOL. ONE	Radio Shack
PARTS OF THE MICROSCOPE	Educational Activities
TELLING TIME	Random House
TYPING TUTOR	Aquarius Software
USING MONEY AND MAKING CHANGE --IF YOU RAN A COOKIE SHOP --LET'S LOOK AT MONEY --THE EVERYDAY USE OF MONEY	Orange Cherry Media

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If Miss Serge had one particular fascination, it was for robots. She convinced Mr. Peterson to order a Big Trak programmable tank that winter, and she frequently talked to computer people in other buildings about the possibility of pooling resources to acquire a more sophisticated robot (Field notes, 3/19/84 & 3/20/84).

The teachers and computers.

In the fall, Miss Serge approached all of the teachers and arranged a weekly schedule for the computer lab. Each teacher was given two slots so that half of his or her class could use the computers at a time. Initially, all the teachers but one agreed to this setup. Miss Serge, who was not one to take "no" for an answer, finally convinced this teacher to cooperate because, otherwise, his students would have been the only ones in the school not getting to use the computers (Interview, 2/21/84). The completed schedule, then, was followed with few changes until the media center was closed on May 7.

As was explained earlier, only three of the teachers normally worked with their students at the computer center. The others sent their students to Miss Serge and let her supervise the computer-based portion of their students' education. This fact, in itself, reveals something about the level of importance of the computers in most of these teachers' minds. I discussed this situation with Miss Serge one day when we were chatting in the computer center. She said that it was difficult for teachers to accompany their students to the center because of the problem of what to do with the other half of the class. I pried a bit, and she admitted that there were ways of circumventing this problem. For example, as is revealed in the floor plan of the media center (Figure 2), there was a cluster of tables right near the

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computers. Those students not working at the computers could have been sent to work there. This was the strategy used by Mrs. Fine. Also, I asked Miss Serge why teachers didn't just bring their entire classes down to the lab and have their students work in pairs. She said that she wondered about that herself (Field notes, 5/10/84). This approach would not have worked very well for the individualized math program but it would have for many of the other programs used at the school.

The faculty room conversations that I participated in also seemed to confirm the lack of importance that most of Wolverine's teachers attributed to the computers. My field notes contain descriptions of 12 such conversations, usually with the teachers from the Lower Pod during lunch time. Thirteen of the 16 references that were made to computers were made by just three teachers: Mrs. Penske, Mrs. Gustav, and Mrs. Rosemont. The other teachers generally showed little interest in them, even when they were brought up by myself or one of these three teachers. Not once in these conversations did a teacher initiate a discussion about a computer program that was being used at the school.

A final bit of evidence confirming the relatively minor role that the teachers assigned to the computers surfaced in May. Beginning May 7, four weeks before the end of school, Miss Serge closed down the media center so she could work on her end-of-the-year cleanup chores and teach Mrs. Ewald more about word processing. From that day on, for about one-eighth of the school year, only students accompanied by their teachers were allowed to use the computer center. This rule effectively closed off the computers to all but three or four of the classes. On Thursday of that week, Mrs. Rosemont told me that she had heard "several" teachers complain about the media center's being closed

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down so early. I asked if anyone had complained about the loss of access to the computers. She said, "No, no one" (Field notes, 5/18/84).

Though the majority of Wolverine's teachers were mildly indifferent to the computers, there were, as you might expect, a few who were enthusiastic, balanced off by a few more who were antagonistic. The main teacher supporters of computer education were probably Mrs. Gustav and Mrs. Penske. Mrs. Gustav was the music teacher. During the 1983-84 school year, she took three computer courses from the Counseling and Educational Psychology Department at a nearby university. During school lunches, she frequently made comments about these courses and attempted to engage other teachers in conversations about computers. The only teacher who usually responded to these probes was Mrs. Penske, one of the first-grade teachers. Her son had taught himself how to program while in high school and was doing some programming for an educational software publisher. Mrs. Penske was learning how to do word processing on his Apple IIe. She also used his computer to create wordsearch puzzles for her class. In March, Mrs. Penske accompanied Miss Serge to the annual meeting of the Michigan Association of Computer Users in Learning (MACUL) in Grand Rapids. They both found it enjoyable (Field notes, 3/20/86).

The teachers in the third group--those who were opposed to computers--were the most difficult for me to identify. Because my work with computers was generally known to the staff, those who opposed them were probably reluctant to discuss their feelings with me. From all indications, though, such a group certainly existed. Mrs. Rosemont believed that many of the Wolverine teachers saw the computers as just "a

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"a fancy extra" that took away from the main function of education--teaching the basics (Field notes, 5/24/84). Mr. Treetop told me that, when several of the teachers looked at the computers, they thought about how many workbooks could have been purchased with the money that was spent on the lab (Field notes, 2/23/84). Mr. Treetop, himself, saw a great potential for the computers but believed that, as long as they were usely solely to run commercial software, they were "worthless" (Field notes, 2/23/84).

One place where I expected teacher opposition to surface was over the use of the math management system, since it was being used to monitor teacher behavior. To my knowledge, only one teacher reacted unfavorably to this use of computers. That was a fifth-grade teacher who agreed only with great reluctance to send his students' math tests to the office for processing and then offered what Mr. Peterson described as "minimal compliance" with the system for the remainder of the school year (Transcript, 2/28/84). Otherwise, Mr. Peterson told me, the teachers were favorable to this system. As far as I can tell, he was right. Even my closest informants never expressed any reservations about the use of the management system. It seemed to fit in well with Wolverine's back-to-basics philosophy.

Mrs. Rosemont's views of computers.

What about Mrs. Rosemont? How much importance did she attach to the use of the computers? More than most of the teachers, certainly, but not nearly as much as I had anticipated. She had willingly incorporated them into her curriculum, but her attitude toward computer time was casual. Twice when I was observing, inclement weather forced her class to eat lunch over 30 minutes later than usual. This change of s

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of schedule meant that they would not get to use the computers that day. She was upset both days that their lunch was delayed, but the reasons she gave for being so had nothing to do with the fact that the students would lose a day at the computers (Field notes, 3/19/84).

When I told Mrs. Rosemont in late May that I had concluded that computers were not one of her highest priorities for the students, she said that I was quite right. She said that they didn't fit her style very well because of the inflexibility of the schedule. She didn't like having to cut some activities short just because it was time to take a group down to the computer center (Field notes, 5/24/84). In fact, she said that if she hadn't agreed to let me observe her students at the computers, she would have used the computers even less than she did (Interview, 5/24/84). One reason for Mrs. Rosemont's lack of enthusiasm was her attitude toward the software. Twice she told me that she was not impressed by the educational programs that were currently available at the school. Once, she said, until the software improves, "We're all just grasping at straws. . . ." (Field notes, 2/16/84).

The Students' Views

If Mrs. Rosemont and the other teachers did not make the computers a high priority, what about the students' attitudes? Were the computers really important to them? Generally not. With few exceptions, Mrs. Rosemont's students liked to go to the computers. As Karen, the afternoon aide and signer described it, "They always seem to know when it's their turn" (Field notes, 2/14/84). Nevertheless, on those occasions when Mrs. Rosemont canceled the computer turn and just went ahead with other activities, few of the students complained or even asked about her decision. They just went along with the alternative activity without saying anything. Sometimes one or two students would come up and ask Mrs. Rosemont quietly, while the others did not give any sign of noticing that they had just lost their computer turn for the week.

I ate lunch with Mrs. Rosemont's students on 10 different occasions, and rarely did any of them ever bring up the computers to me or to each other. This fact is rather striking, given that they knew that computers had a special interest for me. Instead, they mostly talked about the food and the latest media events like movies, television shows and music awards.

Two of Mrs. Rosemont's students--Terry and Jack--were deeply involved with home computers. They brought considerable enthusiasm and expertise to the school. Terry's father was one of the computer teachers at Grantsville High School, and so Terry enjoyed many opportunities to use computers outside of school. Twice he had attended two-week summer computer camps with his father. For over a year, they had owned a Commodore 64 with a disk drive. According to Terry's parents, he used their computer about two hours a day, partially for playing video games but mostly for creative pursuits like drawing computer pictures, playing music and revising other people's programs (Interview notes, 2/26/84). Mrs. Rosemont and her students were correct when they assumed that Terry was the most able computer user in the class.

Jack was the most vocal computer advocate. His older brother, Rob, was a high school student who had taken up computer programming. Jack was very impressed by Rob, especially by the adventure games that he wrote on their home computers (Field notes, 1/26/84). Rob had taught Jack how to write short programs, including simple ones that used a FOR . . . NEXT loop. At school, Jack openly professed his liking of computers (Field notes, 1/26/84, 3/1/84 & 3/22/84). He often brought high-tech "action toys" to school, like model cars and robots (Field notes, 2/16/84 & 2/28/84).

Chapter Summary

All in all, the computers at Wolverine School did not occupy a central place in the lives of the students or the teachers. Most teachers would go weeks or months without touching a computer. The most computer time that any one student received was an hour per week, with the average being in the range of 15-20 minutes. In all my visits, I never saw a student using the lab before or after school. Lunchtimes were not used either. Only once did I see students using the computers during that time slot (Chapter 8). The computer lab, it would seem, had a specialized function. It was rarely used for other purposes. It is with this perspective in mind, that I would now like to turn to a description of a typical trip to the computer center.

CHAPTER VI

A TRIP TO THE COMPUTERS

I would now like to describe the sequence of events constituting one trip to the computers. This description will give the reader detailed information about the routines involved with the normal use of the computer lab at Wolverine School. It will provide a background from which the analytic parts of this paper can draw.

I have chosen to describe the March 1 visit for three reasons. First, it was one of the four sessions that I videotaped, so I can give more detailed information about it. Second, it involved the less able (and hence, more typical) half of Mrs. Rosemont's class. Finally, it was a session in which nothing out of the ordinary happened. From the point of view of the participants, it was "just another trip to the computers to run the math program."

The Visit

March 1 was a Thursday. I arrived at the school at 10:50, having set up the videotape equipment at the computer lab the preceding evening. After a brief visit to the office, I went to Mrs. Rosemont's room and sat near the door. The students were working on different projects and talking quietly. Many of them were drawing floor plans of their houses as part of a special unit on safety. (They were supposed to draw in the best escape routes in case of a fire). At 11:05, Mrs. Rosemont led them to lunch. Most of the students finished eating by 11:30 and went out on the playground for their first recess of the day.

At 12:00 the bell rang and the students started filing directly into Mrs. Rosemont's room from the playground. She let them enter, hang up their jackets and settle down without comment from her. At 12:10 she began the math lesson with a brief presentation on the addition of fractions. She called on a few students to answer questions about a sample problem. Then she handed out a dittoed worksheet. She explained that it was a short assignment and that, if they finished early, they should work on something else. She added that those who were going to the computers might have to finish up their assignments at home. All of the students worked on this assignment until 12:33 when Mrs. Rosemont announced matter-of-factly that those students going to the computers should line up. The students in the "Thursday group" opened up their tote trays and retrieved the index cards indicating what lesson they were on in the math program. They lined up at the door and Mrs. Rosemont led them down to the media center.

Karen, the afternoon aide, stayed behind with the Tuesday group. As I was to find out later, the way the groups were originally formed insured that most of the best math students (and, in fact, the best students) were in this Tuesday group. Back in September, when Mrs. Rosemont decided to use the K-8 MATH PROGRAM, she began by taking only those who were well along in the math book. (Most days in math, the students worked in the book at their individual paces). After what she described to me as "a few sessions," she began taking the less advanced math students on a second day of the week. This division worked out well, she explained, because initially the one group was running the MULTIPLICATION program while the other was still running ADDITION. That way, she only had to download one program each day (Field notes, 4/12/84). The upshot of this situation is that the group that went to the computers on March 1--the Thursday group--consisted of those who were slower in math at the beginning of the school year.

This group arrived at the computer center at 12:35. By the time they arrived, the videotape camera was already running, as was an audiotape recorder that I had placed on a nearby bookcase. Upon their arrival, the students moved right into a ritual that can only be called "the scramble for seats." Miranda arrived first and stood at computer 14. (The arrangement of the computers by number and the students' eventual positions are shown in Figure 5). Brett was close behind. He moved right to computer 12. Kathryn stopped just to the left of the chair at computer 13. Then Doris came up on her right to contest her claim. Kathryn placed both hands on the computer's keyboard and then sat down, causing Doris to give up on number 13 and hurry down the row to take number 11. Meanwhile, all but one of the other students had moved into the main aisle, aisle A. Samantha was in the lead. She stopped at computer 9. Dick slipped past her, looked at computer 6 and moved directly to 7. Montoya, who was right behind Dick, took computer 6. Cathy chose number 10. Jack and Ed came in to take number 8 at the same time. One of them said, "I got it!" They both sat down on the same chair, Ed from the right and Jack from the left. "I got it first," one of them claimed. After 5 seconds of sharing the chair, Ed gave up and went to computer 2. Del was just off to the side of number

2 looking at those who had sat down across from it, apparently trying to decide whom to sit across from. Once Ed took 2, Del moved right to 3.

Meanwhile, Brett had reached over and pressed the reset button on Doris's computer. Her protest came fast and loud: "BRETT!, I had it all set to go." He had just violated one of the main informal rules that students have at the computers: "Hands off my keyboard."

The final student to be seated was Bonnie, the deaf girl. In her rush to get a good seat, she had pursued an alternate strategy of entering the main aisle via aisle B. Just as she was squeezing past the master computer, Mrs. Rosemont stopped her and motioned her to go up aisle C. Bonnie did so, stopping to exchange some signs with Miranda who said, "Sorry." Bonnie moved on by Miranda, paused after a few steps to look back at her and then went around to take computer 5. Bonnie's expression was not a happy one. Apparently she and Ed were the big losers in the day's scramble.

From the time the first students arrived until Bonnie sat down, only 25 seconds had passed. Once seated, many of the students checked out the score screens left on the monitors from the previous class. Mrs. Rosemont then began preparing them to download the MULTIPLICATION program from the master computer into their computers:

> O.K., . . . look at your . . . . what it says on your screen and if it says "subtraction" like Montoya's, then you're going to have to press the orange button and start over. If yours already says "multiplication" . . . is there anybody's that already says "multiplication"? (No hands were raised). That's all right. Just press the orange button, CLOAD, and then . . . (inaudible)

Mrs. Rosemont then walked up aisle C past Brett and Doris. She looked to see if everyone there was set:

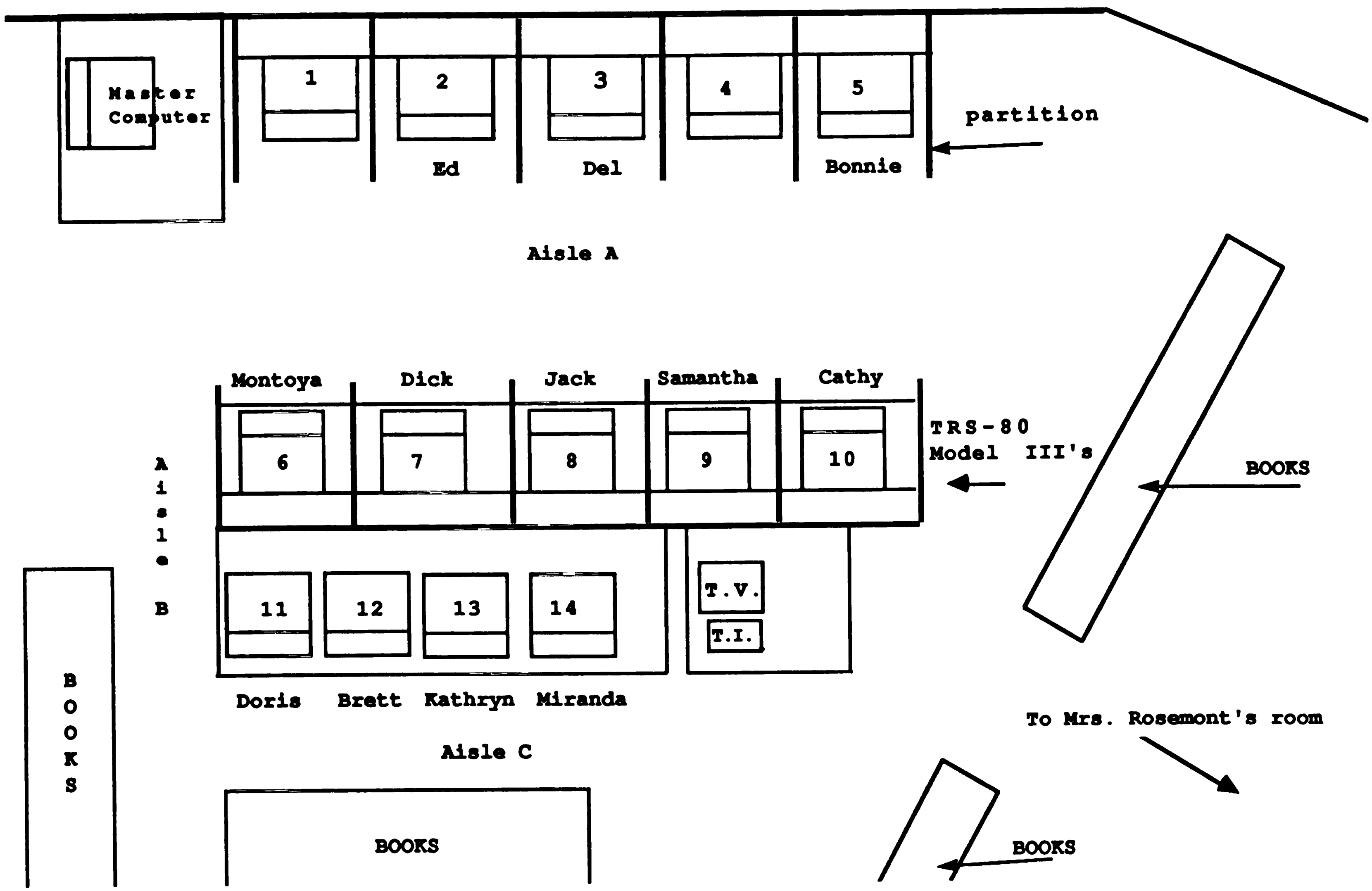

Figure 5. Seating arrangements on March 1

Mrs. R.: OK, what are you going to put for problems per session?

(Miranda, Montoya, and Brett raised their hands).

Miranda: Zero.

Mrs. R.: Zero. And whatever lesson number you have. Is there anyone who doesn't remember what lesson number they have? Jack, what are you doing?

At this moment, a noisy class entered the room and walked past the computer center. Only a couple of Mrs. Rosemont's students looked up. Kathryn removed the button on her computer that said "48K RAM." Miranda did the same. Del went up to Mrs. Rosemont to ask what lesson number he was on.

Mrs. Rosemont announced to the class, "Tell me this time if you don't get a little asterisk." The asterisk, in the Radio Shack Network 2 system, is a sign that a program is being downloaded into a "slave" computer. Actually, there are two asterisks that appear at the top of the monitor. One of them blinks on and off. Two seconds after Mrs. Rosemont's statement, five students said, "I got it," in near perfect sequence. Jack pronounced, "Everybody has it." After 80 seconds, the asterisks disappeared and the word "READY" appeared on all of the students' monitors. They each typed RUN, pressed the ENTER key and began running the program.

This program asks for the number of problems per session and then displays a menu offering Placement, Skill-building, or Test options. (As far as I know, all of the students chose Skill-building.) Then the program requires them to enter their name and lesson number. Finally, a series of multiplication problems geared to their own individual levels appears. When they answer correctly on the first try, the computer presents a happy face picture or a few words of encouragement, depending on whether or not they are beyond lesson 7. The reason for this differentiation is the authors' assumption that some students doing the first seven multiplication lessons might not know how to read very well. In this group, there were five students who were still getting smiley faces: Samantha, Jack, Bonnie, Ed and Dick. Since Mrs. Rosemont had the students request zero problems per session, that meant that they all should have been able to work continuously until she told them to enter the code (RT) and check out their scores.

Mrs. Rosemont passed out the students' computer record sheets. (See Figure 6 for a sample of this sheet). Then she went back to the classroom. None of the students watched her leave or commented on her departure. They were all absorbed in their multiplication problems. When a second class passed by, no one even looked up.

Within two minutes, a problem had developed for Kathryn. She explained to Miranda that she had requested lesson 15, but, shortly afterwards, the computer had said "PLACED AT 14," even though she was doing Skill-building. This had happened to her before.

The other students continued working, making occasional comments on their problems or their neighbors' problems:

> I got most of 'em wrong.
>
> I'm getting all zeroes.
>
> This is easy . . . . Look, that's the same one I got last time.
>
> You're getting the easy ones.

Cathy encountered some kind of problem and went to get Mrs. Rosemont. Bonnie, who had apparently entered 10 problems per session, had the

Student's Name ____________________ STUDENT RECORD

Scheduled Time ____________________ Kindergarten, 1st, 2nd, 3rd

Date	Program K/1/2/3	Lesson Number	Number Worked	SCORE 1 Try	2 Tries	3+ Tries	Avg. Resp. Time (Sec.)
2/2	M	20	5	2	1	2	9.4
2/9	M	30	19	12	4	3	6.1
2/28	M	20	21	15	5	1	7.0
	B	22	21		5		
	B	25	58	13	7	1	6.8
	B	28	26	22	7	—	5.1
3/29	B	30	21	17	3	—	6.0

Figure 6. Sample student record sheet

score sheet displayed on her monitor and looked around to me with what appeared to be an expression of dismay. I walked over and asked Del to help her. Mrs. Rosemont returned with Cathy and assisted her for about one minute. The patter among the students continued. Dick and Jack did some impromptu singing:

Dick: I got rhythm . . . I got rhythm . . .

Jack: You don't got no rhythm . . .

They continued working as they sang. This "I got rhythm" refrain was to be sung several more times during the session. There would be new variations, however, like Jack's "Dick is stupid . . . I got rhythm."

Mrs. Rosemont walked up the aisle past Jack, Dick, and Montoya. She said nothing about their musical offerings. When she came up aisle C, Kathryn explained her problem. Mrs. Rosemont told her to press RT and then go back to the beginning of placement 15. Then Mrs. Rosemont began walking toward the master computer. Brett, who had been looking at Kathryn's monitor, told Mrs. Rosemont that he was promoted from 11 to 15. She looked at his monitor momentarily and said, "OK, good." She helped him record this information on his sheet.

Dick then hit the asterisk key by mistake and announced it excitedly:

Dick: Montoya, you know what I did? I hit this . . . I hit this little doodad . . . (inaudible)

Jack: You mean the star?

Dick: Yea, the star with two dots under it, . . . by accident.

. . . .

Jack: Dick, I didn't know you were accident-prone.

Del turned around to listen to this conversation. He seemed to have grown bored with multiplication because he was figiting in his chair, jerking back and forth and causing it to rock. It had been 11 minutes since the students began running the program.

Mrs. Rosemont walked over and sat next to Bonnie, who had completed 10 out of 10 problems correctly and had gotten the score page again. Mrs. Rosemont had her begin over, but this time in a higher lesson number.

Kathryn came up and asked Mrs. Rosemont a question, then returned to her computer. Mrs. Rosemont walked up to the master computer and sat down. She began entering a small program, practicing something she had learned in her programming course at the community college.

All the students continued working, though the rhythm section echoed its refrain from time to time. Dick offered up a riddle too:

Dick: What kind of animals like baby elephants?

Jack: Fat ones!

Dick: No, mother elephants.

Soon thereafter, Dick posed a more philosophical question:

Dick: "Montoya, if you had 3 wishes . . ."

(His answer came from Jack).

Jack: The first one for me is having all the computers in the world. The next one is having all of the school wrecked and the next one is, uh, all the money in the world.

Jack explained this answer deliberately to anyone who would listen. Though he said it loud enough for all to hear, no one turned toward him. All of the students in view of the camera (Del, Samantha, Ed, Miranda, Kathryn, Brett and Doris) kept working.

At the same time that Jack was delineating his answer, Dick gave his own answer, explaining to Montoya that his first wish would be that all his other wishes would come true. Del, apparently finding this concept more interesting than multiplication, turned toward Dick and Montoya.

Kathryn was having the same problem again. She came to get Mrs. Rosemont, and they went back to her computer, discussed the situation and decided that she should switch to the empty computer next to Ed.

I walked up aisle A. Jack told me that if he had three wishes he would wish for all the computers in the world and for the school to burn down; but, he said, ". . . take out the computers because I'd want one of these." Jack's family already had two home computers, but he was a true-blue "computer freak."

As I walked by Dick, he said, "I've been doing these forever. When's it gonna tell me?" I walked by without responding.

The three students in aisle C began conversing about a common complaint. Doris initiated the conversation by poking Brett, pointing toward her screen, and saying, "I'm getting the same ones over and over again." Brett looked at her and turned back to his work without comment. Thirty seconds later, he leaned back, shook his hands at the computer and echoed a variation of the same complaint: "AGAIN! . . . I keep getting the same one wrong over again." He slumped in his chair as Miranda agreed with him: "I know, we keep getting the same ones over and over again." Their gripes registered, these three then settled back into (more or less quietly) doing their multiplication problems.

Del then began fiddling with the two contrast knobs under the left side of his computer. First he made his screen bright white. Then he made it all black and called to Dick so he could see it. Ed leaned over to check out Del's screen and then returned to his work. No one commented on Del's blank screen. They had all seen (and done) this trick before.

One of the students said, "Watch this smiley face . . . . watch this smiley face." From my notes and tapes, I can't tell who said it or who, if anyone, responded.

About 30 seconds later, Brett started flopping around in his chair and slapping himself softly on the head with both of his hands. He then continued his motions but with Doris's back as his target. She ignored him and continued working. At this moment, Miranda leaned back and looked at Brett's monitor. She saw that he was behind her and informed him of that fact: "You've got easy ones. You're lucky. I'm on 20. . . ." Brett's answer to this thinly veiled oneupmanship was not audible to me or to the microphones.

At 12:58, Mrs. Rosemont signaled the end of the problem session by saying, "OK, gang, you need to press RT." This began the next phase of the session, which might be called "Score recording and comparing." The interchanges here came quickly so I'll present them with a minimum of commentary:

Dick: 98 problems worked . . . heh, heh.

Montoya: I got 84.

Dick: 98!

Ed: . . . hundred . . . hundred and fifty-one--same as last time. Dick, same as last time!

Jack: I got 111.

Brett: 23 problems . . . . Wow!

Miranda: 35 PROBLEMS! I've gotta go back and get my pencil.

(Miranda left. Brett walked to the other aisle, checking out Doris's score along the way).

Jack: What's the date?

Dick: 92 right. . . . 92 right . . .

Mrs. R: Do you have yours written down, Jack?

Jack: Uh, not right now.

Mrs. R: Chitchat when you're done writing.

Jack: What's the date? . . . . Oh yea, 3/1.

Dick: Plus three tries. What is that?

Mrs. R: OK, three tries is wrong. They've got one try, two tries, and then wrong.

Kathryn: I'm on Skill-building. What should I do for Skill-building?

(Mrs. Rosemont returned with Kathryn to her computer).

. . . .

Ed: Mrs. Rosemont, I got the same score as last time, and I got promoted.

Mrs. R: Good!

Dick: So did I.

Brett: Mrs. Rosemont, my lowest score--7.17 seconds.

. . . .

Mrs. R: (Loudly, to the whole group) Just leave what's on the screen/ (interrupted)

Jack: /Look! I did 111 problems and didn't even get promoted!

Mrs. R: (inaudible)

Miranda: I got promoted to 21.

Brett: I got promoted to 16.

While the other students mulled around their computers or waited for a chance to tell Mrs. Rosemont how they did, Doris began experimenting with her computer by entering all kinds of responses. Miranda walked over and joined her. The two of them typed on Doris's keyboard.

Montoya, Dick and Jack went back to the classroom. Miranda and Doris continued banging away as Brett watched. Kathryn walked over to computer 13, the one she had begun with, and began entering different commands, but more deliberately than the other two girls. Perhaps she was trying to figure out what had happened with this computer.

Mrs. Rosemont then asked Del and Samantha, "Do you want to see what I did?" They came up to the master computer. Cathy ran up there too, though she had been on her way back to class (or perhaps because she had been on her way back to class). Mrs. Rosemont then demonstrated her four-line program. It used the LEFT$ command to create this display:

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These students grouped around Mrs. Rosemont and stared at her monitor.

By this time, Doris and Miranda were hitting the keys pretty hard. Kathryn came over and pushed reset three times, trying to stop them:

Doris and Miranda: (in unison) DON'T!

Kathryn: You guys are gonna get in trouble.

Kathryn then walked over to computer 14 and Miranda joined her there. They compared their scores on the math program. Then Miranda started banging on that keyboard. Kathryn left immediately for the classroom.

Cathy came over to Doris's computer. Doris showed her how she was able to make the word ERROR flutter up and down in a column on the screen. Del sat down at computer 12, next to Doris, and began to experiment with the keyboard himself. Miranda continued hitting the keys feverishly.

Finally, at 1:00, Mrs. Rosemont began walking out with Samantha and Cathy. As they passed by, Doris said, "Mrs. Rosemont, look what I did." Mrs. Rosemont glanced briefly at her monitor and moved on without comment. All of the students then left with Mrs. Rosemont except for Del, who was still poking numbers and letters on his keyboard. He continued even after three students from the next class came in and stationed themselves at the computers. Finally, half a minute after everyone else exited, Del did also. Thus ended the March 1 trip to the computers, just 25 minutes after the group had first entered the media center. Many events had transpired during this time.

Analysis of the March 1 Visit

By using the foregoing description of the March 1 visit as a background, it is now possible to make some generalizations about the students' behavior at the computers. In this section, I will make simple assertions based on all of the sessions in which they ran the math program. In the next chapter, I will take up the question of these students' general competence as computer users.

As the description in the previous section makes clear, there were several standard components of a computer session with the math program. These break into seven segments:

1. Walking to the lab
2. Scrambling for seats
3. Waiting for the program to be downloaded
4. Running the program
5. Recording and comparing scores
6. Exploring time
7. Returning to class

Each of these parts took place every time I observed one of Mrs. Rosemont's groups using the math program. Of course, all of them are strictly necessary except for numbers 2 and 6: the scramble for seats and exploring time. I will begin my analysis by taking a closer look at these two student-created segments.

The scramble for seats.

Though the computers were all the same age and model, the students always had at least a limited competition to see who would sit where. Those who were most concerned about seating arrangements on a particular day would usually find their way to the front of the line. The others would scurry in behind them with, at most, one or two students strolling in more casually at the end and taking whatever seats were left. Two of the students--Jake and Melody--told me in

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interviews that they had favorite computers (Interview, Jake, 5/25/84 & Melody, 5/10/84). Jake called his "my lucky computers." For the other students, the four computers along aisle C seem to have been preferred, since the first student to enter usually took one of them. Mostly, though, it was not the absolute position that mattered to them but the relative one: who sat next to them and across from them. It was obviously more than coincidence that the same small groups of students normally ended up sitting together. Of the students in the Thursday group, Doris and Kathryn usually sat next to each other, and Dick and Ed liked to sit close enough that they could converse. These patterns were followed in the March 1 scramble, though Ed was unable to sit next to Dick because of Jack's intransigence. One group of four girls in the Tuesday group sat together whenever they could manage to do so. This was not always easy, but they would sometimes con classmates who were already seated into moving so they could have their way. These four girls had formed a special group called "The MJT's" in honor of their favorite rock star, Michael Jackson. (MJT stood for "Michael Jackson's 'Thriller,'" a rock video that was popular at that time). They liked to sit together so they could talk and compare progress. Sometimes, they would try to enter all their responses simultaneously. Though the other students were not as group-oriented as the MJT's, it was obvious that most of them had definite ideas about whom they did and did not want for a neighbor. Maybe Al best summed up their feelings when he told me that he liked to sit next to certain people because "You just feel better" (Interview, 2/29/84).

The scramble for seats highlights an activity that occurred throughout each segment--social interaction. Some adults have exp

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expressed concerns that the microcomputer revolution will result in the retardation of students' social growth (Chapter 2). These people fear that interacting with a machine will take the place of good old-fashioned, face-to-face talking. The events that I observed at Wolverine School would definitely put these writers' minds at rest. For these students, at least, the drive to talk overwhelmed the drive to compute.

Consider the social exchanges that occurred during the March 1 session. These students carried on a running conversation from the time they arrived at the computer center until the time they left. They compared problems, exchanged gripes, told riddles, sang ditties, and even shared the fantasy of destroying the school. In my description, I presented most of the conversations that I recorded in my field notes or picked up on my videotape, but not all of them. Plus, there were undoubtedly many other exchanges that I was unable to hear or record.

One factor that contributed to the volubility of Mrs. Rosemont's students at the computers was her tolerance. Though she always maintained control of her class, she saw nothing wrong with allowing them occasional conversations at the computers. In fact, when I interviewed her an hour after the March 1 session she told me, "Dick has a real interesting mind. I really enjoy listening to him talk." This statement tells a great deal about Mrs. Rosemont and the atmosphere that she created for her class.

I observed five other classes using the computers at Wolverine School and they, too, had continuous or near-continuous student-to-student conversations. At times, Miss Serge and the other teachers

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showed less tolerance of this talking than Mrs. Rosemont did; but, nonetheless, the flow of conversation continued. This social interaction was facilitated by the close seating arrangements of Wolverine's computer network. All 14 student units were within an area less than a third the size of a regular classroom. The carrels surrounding computers 1-10 probably inhibited conversations some, but the students simply stood up, leaned or walked to circumvent them.

For comparison's sake, I visited Grantsville's other elementary building--Spartan School--to see what happened there where the individual computers were spread around the media center. There, too, it seemed that computer use was largely a social experience, because teachers often sent students down in pairs. Also, the computers attracted kibbutzers who would stand behind the users and comment upon the strategies employed. This practice raises questions about the public nature of computer work that will be discussed in Chapter 9 of this report.

Exploring the computers.

The second dominant theme of the events of the March 1 session is exploration. Call it what you will, the students showed a recurring tendency to fiddle, experiment, explore, or mess around with the computers. As I have defined them, one entire stage of the session was devoted to this activity. It ran from the moment one's score was recorded until, and even after, Mrs. Rosemont had declared it time to leave and had even left herself. Not all of the students took advantage of this opportunity each week. On March 1, only four of them conducted these post-session explorations: Doris, Miranda, Kathryn, and Del. On this particular occasion, Mrs. Rosemont also participated b

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by showing off her little program after some of the students had already returned to the room. In that afternoon's interview, she described her own activity as "fooling around with some string functions."

Chapter Summary

Lest the foregoing discussions of social interaction and "fooling around with the computers" give the wrong impression, I would like to close this chapter by stating that, on the face of things at least, computer-assisted instruction worked very well at Wolverine School. As can be seen in the description of the March 1 session, the students did work on the problems given them, even when they were left unsupervised. Their post-session comments reveal that the students did care about their scores and did want to get promoted to a higher placement. I checked the "average response times" recorded by the students in the March 1 session. The median time recorded was 4.5 seconds. This number indicates that the median student entered a digit into the computer once every 4.5 seconds. For the Tuesday group, in their next session, the median was 5.0. These figures indicate that, despite occasional lapses into rhythm, oneupmanship and fantasy, the students were able to carry on their work with some efficiency. One reason they were able to do this is that the math program has built-in waiting periods. There is a two to three second delay while the happy face or verbal reinforcement is displayed after a right answer and, after that, up to a five second delay before the next problem is printed out. Undoubtedly, many of these "extra-curricular activities" occurred during these waiting periods. In this instance at least, the kids were quicker than the computers.

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CHAPTER VII

THE CASE FOR COMPETENCE

Mrs. Rosemont's students impressed me with their competence at the computers. Generally, they were able to make the machines do what they wanted. To the extent that this generalization can be substantiated, it shows that they had acquired a key component of computer literacy.

Using the Math Program

In order to measure how well Mrs. Rosemont's students could handle the math program, I decided to go back and read through my transcripts and field notes for all of the sessions that I observed them running that program. There were 15 of them--9 for the Tuesday group and 6 for the Thursday group. For each of these sessions, I searched for instances where students asked for help with running the program. I did not include cases where students asked for help with the math involved or with filling out their score sheets. The results of this search are presented in Table 2. As it turned out, there were 17 of these incidents during the 15 sessions. Half of them occurred during the March 1 session that I described earlier. Three of these six were attributable to Kathryn's special problem. She would request lesson 15 and almost immediately be placed in lesson 14, in apparent disregard to the stated rules of the Skill-building mode that she was using. The fact that Kathryn should not be faulted for failing to understand this situation is indicated by Mrs. Rosemont's eventual solution to the

Table 2. Requests for help with the K-8 MATH PROGRAM

THURSDAY GROUP			
Date	Student	Nature of the Problem	Person Asked
Mar. 1	Kathryn	Was moved from lesson 15 to 14 though was in skill building	Miranda/ Mrs. R
	Kathryn	same	Mrs. R
	Kathryn	same	Mrs. R
	Cathy	not known	Mrs. R
	Bonnie	Did not know what to do when scores were displayed early	researcher
	Bonnie	same	Mrs. R
Mar. 22	Jack	Confused by opening sequence	general announcement
	Brett	Had entered a fake name and wanted to know how to change it before the teacher saw it	researcher
Mar. 29	Dick	Had misspelled fake name and wanted to change it	Montoya
April 26		No calls for help observed	
May 10	Brett	Screen was initially blank	Mrs. R
	Bonnie	Screen initially just a dot (had to move)	Kathryn

Table 2 (cont'd).

TUESDAY GROUP			
Date	Student	Nature of the Problem	Person Asked
Jan. 24		No calls for help observed	
Jan. 31	Melody	Broke out of program ("UL ERROR IN 5")	Mrs. R
	Enos	Problems with opening sequence	Mrs. R
Feb. 9		No calls for help observed	
Feb. 14		No calls for help observed	
Feb. 21		No calls for help observed	
Mar. 6	Lawrence	Was promoted at end of a lesson so the score sheet said "0 problems per session" though he had worked many	Mrs. R
	Lawrence	Troubled by a temporarily blank screen	Al
Mar. 20	Enos	Problems with opening sequence	Herm
	Amelia	Needed to change lesson number	Mrs. R/ Annie
April 17		No calls for help observed	
April 24		No calls for help observed	

problem: moving her to another computer. Similarly, three other calls for help resulted in moving the student to another computer. If we excuse these six queries as the probable result of computer quirkiness (or at least of behavior that was beyond the comprehension of this rather savvy teacher), that leaves just 11 other incidents of student requests for help with running the math program. Of these, six involved the two hearing-impaired students--Bonnie and Lawrence. They had the disadvantage of missing out on most of Mrs. Rosemont's instructions at the computers since their aide did not come down to sign for them. Even including the 4 times that Bonnie and Lawrence needed help, 11 instances of getting stuck in 15 complete sessions is not a bad record. Of course, it is possible that there were other instances that fell upon neither my ears nor my microphone. I was, however, looking for such instances from the start of my research because I knew that I wanted to see just how computer-literate these students were. Generally, these incidents were easy to spot, since they usually involved a discussion with Mrs. Rosemont.

One indication that Mrs. Rosemont assumed her students' ability to manipulate the computers was evidenced by her willingness to leave them alone for periods of up to 10 minutes while she worked with the students in the classroom. Also, when she was at the lab, she often would sit down to run a program herself rather than floating around to check up on them. This is another sign, I think, of her confidence in their competence.

Even a patient reader may be disappointed with the beginnings of my case for competence because these students ran the math program so many times. "Why shouldn't they know how to use it?," one might ask.

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The answer is that using this program, or just about any program, is more complicated than the casual observer might assume. In order to substantiate this point, it is necessary to give a detailed description of how to run the math program.

When the students arrived, they found all manner of things displayed on their monitors. They had to press the unlabeled orange buttons in order to reset the computers. Then the question "Cass?" appeared. None of the students knew that this was Radio Shack's way of asking "Do you have a cassette recorder?" Thus, the first command that they encountered was meaningless to them. They did know, however, that they were to press ENTER twice once "Cass?" appeared. Doing so registered the default values for the first two questions and put the rest of the opening display on the monitor:

```
Cass?
Memory Size?
Radio Shack Model III Basic
(c) '80 Tandy
READY
>
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Then the students had to type CLOAD and press ENTER. If they made a typing error, they had to know how to use the left-arrow key to backspace and fix it. Naturally enough, finding the right keys was something of an obstacle for most of these students since none of them had ever received formal typing instruction. In addition to finding the necessary letters and numbers, they had to learn to use two ENTER keys, CLEAR, SHIFT, BREAK, four arrow keys, and the orange reset button. After READY was entered, the students had to wait for the blinking asterisks to come and go. Then they could type RUN, press ENTER, and begin working with the math program.

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The RADIO SHACK K-8 MATH PROGRAM is generally "user-friendly," but it contains some features that are potentially disturbing. It begins with an open-ended question:

PROBLEMS PER SESSION (0 = NO LIMIT):

After responding, the user must press ENTER. Then a standard computer menu appears:

OPERATIONAL MODES

<A> STUDENT PLACEMENT
<B> SKILL-BUILDING LESSONS
<C> TEST
<D> CHANGE PROBLEMS PER SESSION

ENTER SELECTION:

Here the students must know to press the appropriate letter, not including the parentheses. Anyone who has worked around computers knows that simple menus like these are very confusing to some people. By the time I began my observations, Mrs. Rosemont's students handled this one very well.

A page is then displayed asking for the student's name and lesson number. Once these two questions have been answered, the student is presented with the first of many randomly generated problems from the level selected. Even then, there is more to know besides how to multiply. For example, in lessons 1-5, the students must give the answer to problems presented horizontally:

5 X 3 =

In this problem, the student is supposed to enter the "1" first and then the "5." In lessons 6 and 7, the format changes such that the student is presented with a mixture of horizontal and vertical problems. When answering the vertical ones, the order of entry is reversed: the first digit entered is put in the one's place and the second in the ten's place. This reversal is not accompanied by any explanation or warning in the program. Nor did Mrs. Rosemont make any explanations that I witnessed.

Lessons 8 and 9 both present problems vertically. Lesson 10, alone among all 50 lessons, asks not for the calculation of the product but for the missing multiplicand:

$$\_\_\_\_\_ \times 2 = 14$$

Once again, this change in format occurs without explanation.

From lesson 11 on, all problems are presented vertically. Once carrying becomes necessary (in lesson 13 and beyond), the student must enter carried digits in their proper places as part of the answer.

Most of the time, Mrs. Rosemont's students worked in the Skill-building mode, which is what the program authors would have expected. This mode leaves a student in the lesson selected for however many problems she or he requests. Sometimes, though, Mrs. Rosemont instructed selected students to use the Placement mode. In that mode, they were moved from one level to another rather quickly--every three problems in many cases. You can see how this could become confusing, particularly in lessons 4 through 11 where the configuration would be switching back and forth between vertical and horizontal formats, sometimes calling for the ten's digit first and other times for the one's digit, usually wanting the product but sometimes wanting the multiplicand. Even with Skill-building, where these changes come more slowly, there are many possible sources of confusion in running this relatively simple math program.

In this math program, there is a flashing cursor to indicate where the next digit entered will be placed. Both Mrs. Rosemont and I found this flashing to be distracting when we tried the program. It caused us to lose concentration and make mistakes when working in the higher lesson numbers (Field notes, 1/31/84). To my knowledge, though, none of her students ever complained about this problem.

Another factor that makes these students' accomplishments with the math program impressive is that, at any time during the year, one-third to two-thirds of them were working on problems beyond their current places in their math book. Mrs. Rosemont decided early on just to let them muddle through and figure out these new challenges for themselves. This means that, for many of her students, the first time they encountered "carrying" or two-digit multipliers would have been at the computer. As is stated in the program manual, the authors' intentions were that the math program would only be used to drill on what had already been taught in class. Consequently, they did not build in a tutorial function. Students who miss a problem are shown the right answer without being taught how to solve it.

The final challenge of using the math program is calling up and recording the progress report. This page appears automatically if a student completes the number of problems requested for the session. In the March 1 session, Bonnie twice requested just 10 problems and was presented with the progress report at the end of each set. By March 1, Mrs. Rosemont had decided to have her students enter 0 problems per session so that they could work continuously until she told them to stop. Then she would tell them to call up the score page by pushing RT, even though, according to the manual, using the RT code and recording the information for the score page was supposed to be done by the instructor. The procedure is somewhat tricky. First, a student must wait until the cursor is flashing and then press R. At the bottom of the screen, the words "WRONG KEY" flash. She must ignore this message and press T. "WRONG KEY" flashes again but, soon, if she has done it correctly, the progress report appears. If RT is pressed between problems when no cursor is on the screen, nothing happens. If the T is pressed too quickly after the R, the "WRONG KEY" message appears but the score page does not. Because of these requirements, students sometimes had to enter RT two or three times before they got the timing right. Still, I witnessed no instance where a student was unable to make this procedure work.

The progress report itself is intended for instructors, so it presented its own challenges to these fourth graders. (See Figure 7).

RADIO SHACK
COMPUTER ASSISTED INSTRUCTION
MULTIPLICATION

HERM'S REPORT

SKILL BUILDING LESSON 4

128	PROBLEMS WORKED		
113	WRONG		88.28%
14	RIGHT	(2 TRIES)	10.94%
1	RIGHT	(1 TRY)	0.78%

1.4 SEC., AVG. RESPONSE TIME
ENTER CODE TO CONTINUE

Figure 7. Sample score page from the RADIO SHACK K-8 MATH PROGRAM

Since they had not yet studied percentages or decimal fractions, a number like 11.11% must have confused them. Also, the report describes wrong answers in various ways. For example, problems in the "1 RIGHT (2 TRIES)" category are counted as wrong answers when the program determines whether a student is promoted or demoted. Furthermore, the standards for promotion and demotion vary from lesson to lesson. These criteria are never explained in the program but must be looked up in an appendix in the manual. Until late March, Mrs. Rosemont herself did not know exactly what the standards were for these all-important decisions. Sometimes, she would instruct a student to record a promotion or demotion that was not prescribed by the computer. Given all of this, it is not surprising that many of the students never quite understood the basis on which they were being judged. In the March 1 vignette, we saw how Jack was upset because he did 111 problems and didn't get promoted. Similarly, many other students went through the year thinking that promotions were judged only on the basis of the number of problems worked. I do not know if Mrs. Rosemont ever tried to rectify this common misconception with all of her students.

Another source of confusion in the progress report is the average response time. It is presented with the use of decimals and abbreviations that, initially, were probably unfamiliar to these fourth graders: "2.6 SEC., AVG. RESPONSE TIME." The concept of an average response time would itself be somewhat difficult for these students to understand.

This discussion of the math program has been rather lengthy (and less than exciting certainly), but I think it necessary in order to place the students' ability to run it in perspective. Computers are very exacting, so even carefully written programs like this one make all sorts of demands on the users. Probably the biggest problems for Mrs. Rosemont's students were created by the information contained in the program but not explained to the user, especially the changing criteria for promotion and demotion. Given all of these circumstances, I think it justified to conclude that Mrs. Rosemont's students had become reasonably (if not surprisingly) competent with the math program.

Handling THE DRAGON PROGRAM

The mastery of a single program does not make a person computer-literate. Anyone using computers in a job situation will most likely be required to handle several different programs. Furthermore, as computers become more common in our society, we will be required to cope with various kinds of programs: banking programs, word processing programs, accounting programs, telecommunications programs, and so on ad infinitum (or, ad nauseum, depending on your point of view). During this school year, Mrs. Rosemont had her students run five different programs besides the math program:

DRAWING (public domain)

IF YOU RAN A COOKIE SHOP (Orange Cherry Media)

OREGON TRAIL (public domain)

THE DRAGON PROGRAM (Educational Activities, Inc.)

HISTORY AND GEOGRAPHY (Microlearningware)

Typically, each student got to run OREGON TRAIL and DRAWING twice, and the other three programs once. This varied with the two groups (the Tuesday group and the Thursday group) and with the students' attendance records. I was able to observe the Thursday group when it was introduced to THE COOKIE SHOP. Also, I was observing on May 15 when both groups ran THE DRAGON PROGRAM for the first (and only) time. To continue my discussion of the computer competencies of these students, I have decided to describe their encounter with the latter of these two programs. My reasons for this choice are two-fold: I was able to see both groups run it, and the particular circumstances of that day created a special challenge for the Thursday group. When they came to the computer center, many of their computers were in the middle of the program, so they had to jump in and figure out the situation without benefit of the instructions.

Before describing these encounters with the dragon, I would like to explain an often overlooked fact about life with computers. Not only are there many, many procedures to be learned, but the level of applicability of each of these procedures must be learned as well. These levels of applicability form an array of concentric circles as shown in Figure 8. In order to generalize successfully from one situation to another, for example, a student must know if a certain procedure will work for all parts of a program, all programs that can be downloaded through the Network 2, all TRS-80 programs, or perhaps all programs in general. We have seen in the math program how certain procedures can be used in one part of a program but not in others. When Mrs. Rosemont and Miss Serge gave instructions, they usually did not bother to qualify them as to which of these levels they were appropriate for. They would say "Press RT when you want to end the program" and not "In this math program, you can press RT when you want to end the program." The students were left to figure out for themselves when RT would or would not work, when they were supposed to press ENTER, and so on. This ambiguity over the level of generalizability probably constitutes the greatest single challenge to becoming computer-literate. It must be taken into account when evaluating the problems these students had when learning to cope with new programs. Though half of them had home computers, only one of them had a TRS-80 computer, so even those with this apparent advantage were constantly guessing as to what procedures would work from one machine to another as well as from one program to another. With this in mind, let's look at the encounter with the dragon.

On Tuesday, May 15, Mrs. Rosemont took the Tuesday group to the computers at 1:00. This was later than usual, but, since the media center was closed, she had the greater flexibility that she had been longing for. On this day, she was able to extend her math lesson from 12:30 to 1:00 and still bring her students down to the computer center. She was also able to decide to run both groups, one after the other.

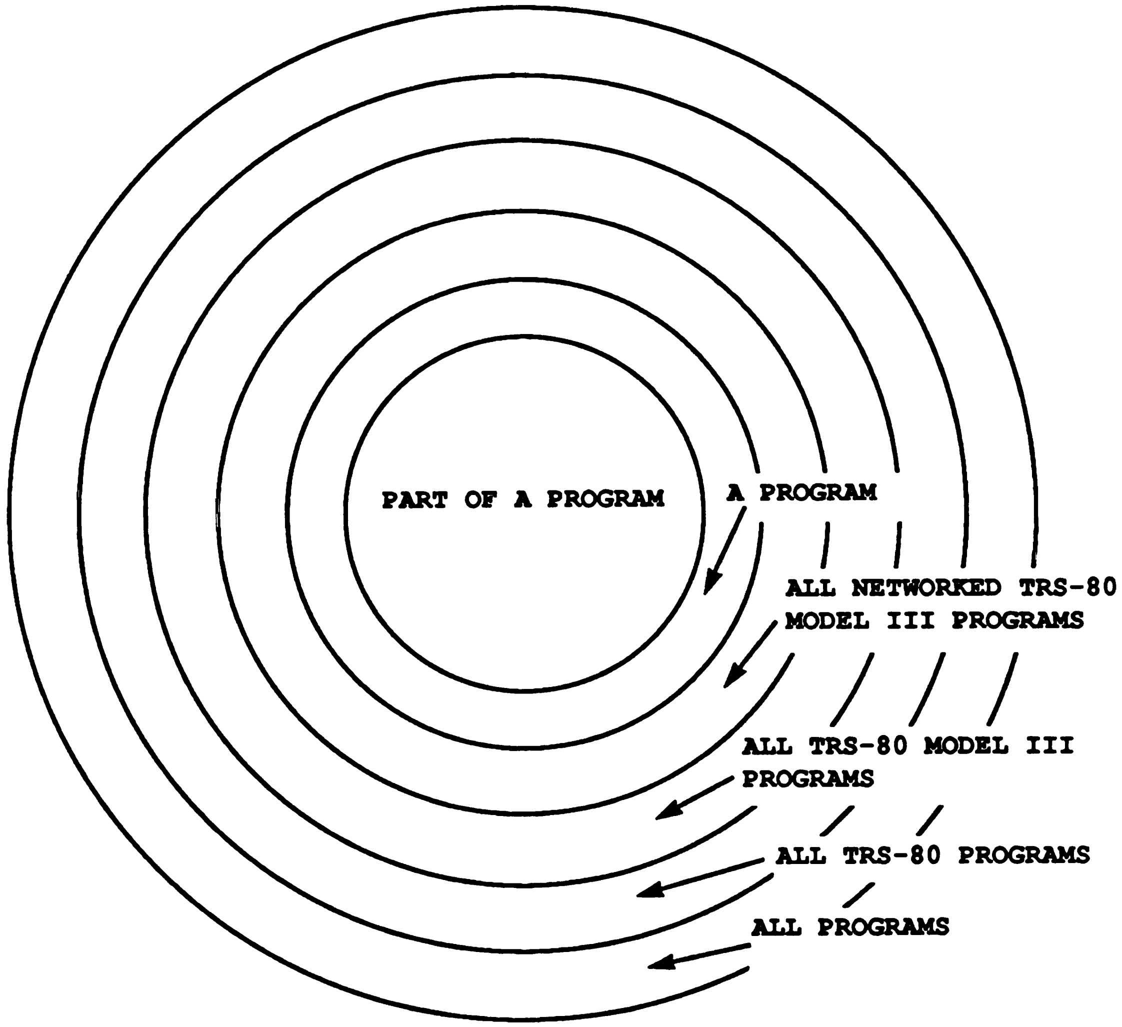

Figure 8. Levels of applicability

I arrived at the computer center a minute early and sat down at computer 2. Al, Jake and Enos arrived next and took three of the seats in aisle C. The four MJT's--Cari, Amelia, Annie, and Kate--managed to get their usual seats in the middle row. The final results of this seating scramble are shown in Figure 9. On this day, the students spoke more loudly than usual, probably because they were excited about running a new program. Consequently, I was able to record most of their conversations.

This Tuesday group, you will remember, consisted of those students who were strong in math, at least at the beginning of the school year. Eight of them had also gained the advantage of coming to the computers once a week to teach themselves programming. Normally, when they came to the computers, they showed competence and self-confidence. This day was to be no exception.

THE DRAGON PROGRAM is a drill program on the parts of speech. The students are placed in a maze and asked to identify a particular part of speech from a list of three words. If they answer correctly, they are moved one space closer to safety. Wrong answers result in moving three spaces closer to "your old flame," as the program describes the dragon. The instructions explain both the rules of the game and also give hints on how to recognize the kind of word that is being sought (adjective, synonym, or whatever). THE DRAGON PROGRAM is a simple program but somewhat difficult because it requires answers to many open-ended questions.

All these students quickly prepared their computers for downloading the program. Once it was loaded, they typed RUN and began reading the directions. Most of them read these aloud. They learned that they were to identify adjectives. Everyone forged ahead. Only one student had a problem working with the program. It was Kate. She had typed her answer and did not know how to make the program continue:

Kate: Do we press ENTER?

Corina: Yes, you press ENTER.

Kate: Annie, do you press any key?

Corina: You press ENTER!

Kate pressed ENTER and, from then on, she was fine.

By 1:09, the MJT's had all made it to safety, received their "treasure," and decided to run the program again. Already looking for new angles, Annie suggested that they try to "go to doom," which they did. Concerned about the possibility of repetition, Kate remarked, "I hope they don't give you the same ones."

None of the other students had any problem running the program. Al apparently had a problem identifying adjectives, though, because he got roasted five times. On each of these occasions, Jake announced Al's failure to the rest of the group.

By 1:17, the MJT's had each played three games and were experimenting with various answers to questions like "Do you want a rematch?" Others were trying different possibilities too. The findings of these experiments were announced to the entire group, usually in loud, excited tones. These students wanted to learn many things about this program, most of which had nothing to do with identifying adjectives.

Always a trailblazer, Annie switched her computer into "big print mode." This maneuver messed up the display, running many words off the

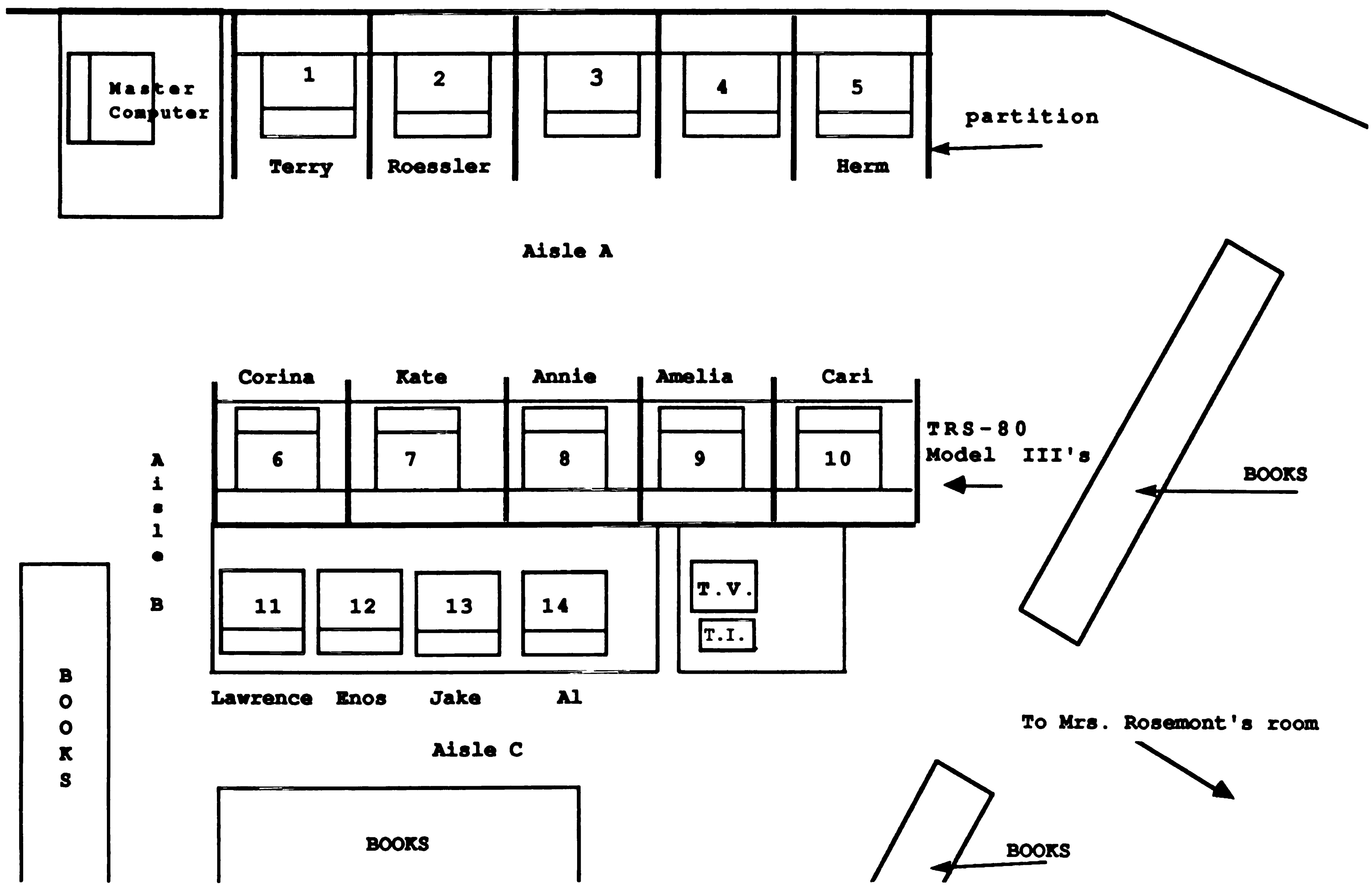

Figure 9. Seating arrangements on May 15 (Tuesday group)

edge of the monitor. Mrs. Rosemont laughed. (She had told me before how much she enjoyed Annie's cleverness). Herm came over to check out the results. "She killed her treasure," he announced to the entire group. Annie then looked to Amelia, perhaps a bit embarrassed. Amelia suggested that she "put RUN," which she did, causing the program to begin anew and thereby return to the normal print size. Herm went back to his seat, listed the program, and studied over the BASIC instructions for a minute or two.

At 1:20, Mrs. Rosemont told this group to return to the room and send the other students back to the computers. Most of the students left immediately. Others finished the game they were on before leaving.

The Thursday group came down and took the seats shown in Figure 10. Since many of them sat down to a computer in the middle of a game, there was some confusion. Cathy had problems:

Corina: It's a word that describes something.

Cathy: I know, but what do I do?

Corina: Type it in.

(Cathy then typed in YELLOW and looked around for more help).

Cathy: What do you push? Oh boy, what do you push?

Cathy's neighbors all ignored her, probably because they were intent on the program. Miranda, in fact, announced right in the middle of Cathy's queries: "Wow! This is neat." I walked over and quietly told Cathy that she had to press ENTER. With that bit of information, she could proceed, though she eventually got "burned up" by the dragon because she went 40 turns without making it to safety.

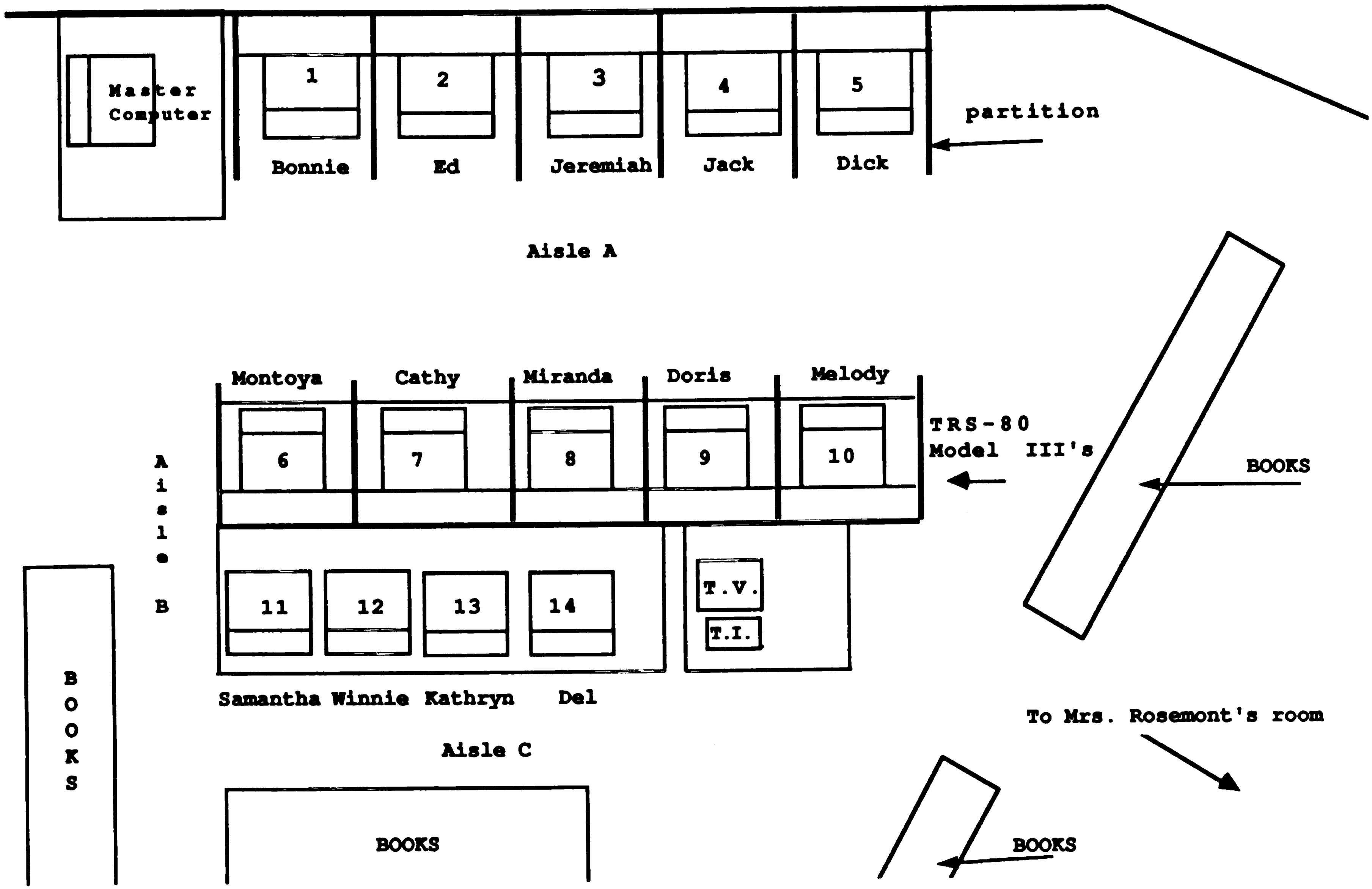

Figure 10. Seating arrangements on May 15 (Thursday group)

Doris became a bit flustered also. When she sat down, her computer was near the beginning of the program. She was apparently pressing a key inadvertently because it was moving from page to page at a rapid pace. "What do we do?", she asked, "I'm not even pressing any buttons."

As far as I could tell, the other 11 students were able to move into the program without any hitches. In doing so, Dick had to overcome a special problem because Herm had left his computer with the program's listing displayed on the screen. Dick sat down, looked at it for a moment, typed RUN, and began. No problem there.

I was wandering around and happened to be looking over Melody's shoulder about three minutes after she had arrived. Her first comment was "This is easy." Soon after that, she typed PRIENT instead of PRINT. When she pressed ENTER, the computer just erased her answer and left the rest of the page intact since she had not typed in one of the three anticipated responses. She looked at the screen for about 2 seconds and then retyped PRINT. This time she entered it correctly, but was informed by the computer that the correct answer was THICK. When confronted with this evidence that the program wasn't as easy for her as she thought, she did what I had seen other students do in similar situations--blame the computer. "How stupid!" she announced.

Dick finished his first game in five minutes. The computer asked him if he wanted a rematch:

Dick: Mrs. Rosemont, what would happen if I hit NO?

Mrs. R.: Try it.

(The program signed off and left Dick with a cursor).

Dick: What do I do?

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Mrs. R.: You're done. (She laughs). Try RUN.

Dick did so and began again.

Most of the other members of this Thursday group took much longer to finish a game. They worked more slowly than the Tuesday group. Some, like Miranda and Doris, talked frequently, giving the others periodic progress reports. Winnie, Samantha, and Ed, on the other hand, hardly said a word the first 10 minutes that they were there. They just worked intently.

After 1:35, a number of the students began reaching safety. When they did so, others suggested how they might answer the questions that ensued. For example, when Jeremiah got a treasure and the dragon asked "May I borrow a few thousand?" Melody said "Put 'NO.'" Ed suggested, "Put 'NO WAY.'" This group, too, was very interested in how the program would handle different responses.

At 1:40, after a 16 minute session, Mrs. Rosemont told the students that it was time to go. Within three or four minutes, she had them all heading back to the classroom.

All things considered, I would argue that the way both groups handled their first encounter with THE DRAGON PROGRAM shows that they had become competent at running computer programs. They could use the keyboard with reasonable efficiency, read and follow directions, and even infer directions when thrown into the middle of a program. More importantly, perhaps, they showed that they could handle a new program with confidence. Their general approach here might be divided into three stages:

1. Read the screens and figure out what the program demands.

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2. Start running it, using trial and error when not sure what to do. (Call for help if you get stuck).

3. Experiment with the program to learn its parameters.

This third stage can be reached rather quickly, as evidenced by my description of the Tuesday group. The Thursday group was slower in running the program, so they were delayed in reaching this stage. Nevertheless, several of them showed a desire to experiment with the program. The assumption underlying this behavior is that of control: "I can control this machine and I want to see what I can make it do." This is the attitude of self-assured competence, a key component of computer literacy.

Discrepant Case Analysis: Using ENTER

A careful ethnographer does a great deal of soul-searching (and transcript-searching) before settling upon the assertions to be presented in a report. This self-questioning should include an active search for evidence that calls one's generalizations into question. I have conducted such a search and found two counter-examples to my assertion that Mrs. Rosemont's students had become capable computer users. These counter-examples will be discussed in this and the following section.

Most confounding of all to me, was the difficulty some students had learning to use the ENTER key. We saw this problem occur with Kate and Cathy when running THE DRAGON PROGRAM. They typed their answers and then had to ask what to do next. In the second computer session that I ever observed at Wolverine, I saw the students behave similarly when they ran THE COOKIE SHOP for the first time. Miranda, Montoya,

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and Del all seemed perplexed when they came to a page that said this:

> IF YOU WANT TO BAKE 300 COOKIES IN A HURRY, JUST
> PRESS THE ENTER KEY.

John and Del looked at each other, discussed it for awhile, and finally did figure out what to do. Miranda had to ask them, "Do I press ENTER now?" A few minutes later, she came to a screen that said at the bottom, "PRESS ENTER TO CONTINUE." Again, she asked the boys for help: "Do you press ENTER when you get here?" (Field notes, 1/26/84) These instructions from the program are rather clear, and so it seems surprising that they should have caused these students any problems.

There are two possible interpretations as to why these five students experienced difficulties with such simple uses of the ENTER key. One possibility is that they knew what to do but were just anxious. Maybe they were a little uneasy about running a new program. In the case of THE COOKIE SHOP, this seems unlikely since John, Del and Miranda showed no other signs of anxiety. John, in particular, was obviously enjoying the program:

> Hey! "John's Cookie Shop! Got to open the door to get in.
>
> (He reached up and pretended to open the door to the shop that was drawn on his monitor)
>
> Oh, I just love that picture.

Later that afternoon, I interviewed John and Del during recess. They both said that they preferred THE COOKIE SHOP to all the other programs they had run at school. They described in detail what happened when they played this game, never mentioning any problems that they had with it.

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The second possible explanation of these lapses is that these students simply had not used the ENTER key all that much during the year. The math program, which is mostly what they ran, required very little use of this key. It read numerical answers one digit at a time as they were poked into the keyboard, so the students rarely had to press ENTER when using it. Even the famous RT did not have to be followed up with the ENTER key. Though I was surprised the time that John, Del and Miranda had the trouble that they did, I can see now why the "PRESS ENTER TO CONTINUE" instruction might have been foreign to them. As far as I can tell, this was not a problem for them later in the year when they ran another new program, OREGON TRAIL.

Discrepant Case Analysis: Winnie

Of the 26 students in Mrs. Rosemont's class, there definitely was one student, Winnie, who was not a capable computer user. There are many obvious reasons why this is so. Winnie was the social outcast of her class. She was treated cruelly by almost all of her classmates. They alternately teased her, ignored her, and told her how stupid she was. When forced to sit next to her, many students would cross their fingers as protection from "Winnie's cooties." Though Winnie never fought back, this harsh treatment went on continuously, but always behind Mrs. Rosemont's back.

Winnie also had a reading problem. Each afternoon, she went to the Chapter I reading teacher for special instruction. These sessions caused Winnie to miss out on most of her turns at the computer. She only got to use the computers about eight times all year.

As a consequence of these handicaps, you wouldn't expect Winnie to be very good at running a computer, and she wasn't. Open-ended

questions like "PROBLEMS PER SESSION?" usually stopped her cold, as did menus. I happened to sit next to Winnie when she ran OREGON TRAIL. The other students did really well with this program, their first chance to run a simulation. For her, it was a continuous struggle. After each instruction appeared, she would turn to me and ask for help. When I would ask her to read the directions aloud, it became clear that her weakness in reading was the main problem. She didn't recognize enough of the words used in that program.

Another problem that Winnie had with the programs was her lack of goal-orientation. She just did not respond to the overall thrust of these computer games. For example, on February 9, I watched her run the math program. She completed lesson 5 with 19 out of 25 problems right the first try. Then she just sat there for the longest time, looking at the score page. "Do you want to go on?" I finally asked. "I don't know," she said with an impassive tone. I showed her how to get back to the main menu, but then she had no idea (and little concern) about whether she was supposed to redo lesson 5, go on to 6, or just stare at the menu. Eventually, she went back and did lesson 1 and just generally floundered for much of the rest of the session. She talked about a television show ("Gimme a Break"), about what she was going to get for her birthday and various other things.

Winnie's choosing to do lesson 1 and to request different numbers per session shows another side of her. Even she was comfortable enough with the computers to experiment with them. Later in the session, she went on to try one of her classmates's favorites--entering weird names. She tried "WINNI" and "WINTY" and "WINNOO" and laughed heartily at each one. There were many limitations to what Winnie could do at the computer, but she had clearly gotten over any computer anxiety that she may have had.

Chapter Summary

In late March, Mrs. Rosemont told me that she had recently met a General Motors manager at a party. She said that he had "accused" her and the other teachers present of not giving their students an adequate background with computers. She became rather upset, asserting that her fourth-grade students were already capable computer users (Field notes, 3/20/87). As I have argued in this chapter, I believe that she was correct in making this assertion. Except for Winnie, her students were generally able to decipher computer menus and open-ended situations and make the machines do what they wanted. They were sufficiently comfortable with the computers to attempt a wide variety of experiments as they ran the programs that Mrs. Rosemont loaded for them. For most occupations, this degree of computer literacy would prove more than adequate (Goldstein & Fraser, 1985).

Of course, there were many facets of computer applications that these students had not yet been exposed to: data bases, telecommunications and word processing, to name a few. Nevertheless, the weekly sessions in the school computer lab had clearly given even the weaker, non-computer-owning students a good foundation on which future training could build. Learning how to run a computer seems to be a skill that young children can learn quite naturally.

CHAPTER VIII

COMPUTERS AND THE HIDDEN CURRICULUM--I

There are three main facets of computer literacy. As described in Chapter 2 of this report, they consist of learning how to program computers, learning how to use them as a tool, and acquiring appropriate attitudes and knowledge about them. The first of these goals was not a priority for Mrs. Rosemont, though she did arrange for some of her students to have limited experiences with programming (Chapter 9). The second goal--learning computer applications--was an avowed goal of Wolverine School. Both Mrs. Rosemont and the principal, Mr. Peterson, thought that the students were achieving this goal as a by-product of their work with CAI. In the last chapter, I made a case that they were largely correct in making this assumption. In this chapter and the following one, I will take up the question of whether or not Mrs. Rosemont's students were acquiring the "appropriate" attitudes and knowledge about computers. Since this area was not a carefully defined part of the Wolverine School curriculum, most of what the students did learn was by chance. They absorbed whatever it is that one absorbs as a consequence of working with computers. In this way, the knowledge and attitudes that the students learned was part of the "hidden curriculum" of computer education.

Much of what students learn at school cannot be found in the prescribed curriculum because, as Marshall McLuhan said many years ago, "the medium is the message" (McLuhan, 1964). Just by going to school

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and learning the rules, students learn how to take turns, how to vie for attention, and how to recognize when a new situation has arisen (Florio, 1978). The existence of this hidden curriculum is what concerns many people about the sudden, widespread integration of computers into the schools. If we encourage young children to interact with computers, what will the side effects be? What attitudes will they take toward these machines? Will they prefer the computer over the teacher? Will they acquire the idea that the computers are infallible? How will they react to being monitored by a machine? These are important questions and ones that an ethnographic study is well suited to address, since the researcher is able to observe the students interacting with the computers under natural conditions. In this chapter, I will take up the question of the "hidden curriculum" of computer education, beginning with a discussion of how Mrs. Rosemont's students viewed the computers and moving from there to a consideration of the interaction between the students and the computers. My discussion of the computers' hidden curriculum will carry over into Chapter 9. There I will present four facets of computerization that Mrs. Rosemont's students were learning to accept as they worked their drill programs.

How the Students Viewed the Computers

Mrs. Rosemont's students viewed the computers as black box machines. They rarely attributed living qualities to the computers, and they rarely speculated about how they worked or what they had inside of them. This view of the computers is what Sherry Turkle described in *The Second Self* (1984) as the "unreflective control phase" typical of students this age. For younger children, computers raise metaphysical questions, like whether or not these machines are alive and what it means to "kill" a program and bring it back to life. By the age of nine or so, Turkle argues, children cease to ask these questions and focus instead on controlling the machines:

> Children musing about objects and their nature has given way to children in contest. Reflection has given way to domination, ranking, testing, proving oneself. Metaphysics has given way to mastery. (p. 65)

I first read Turkle's book a year after I had completed my observations of Mrs. Rosemont's class. This particular passage and the rest of Turkle's description of her pre-adolescent informants, struck me as a near-perfect characterization of my student informants and how they viewed the computers. They rarely talked to the computers or talked about them, viewing them as complex entities that could be manipulated for the dual purposes of education and entertainment.

As Turkle points out, it is normal behavior for people in our society to talk to inanimate objects. Who of us hasn't communicated with a car, bowling ball or lawn mower that seemingly refused to work properly? For this reason, it is striking that in all of my notes and transcripts for 21 computer sessions, I was only able to find a handful of instances in which the students talked to the computers. One that I know of indirectly was when Jack told a friend that he was promoted in the math program because he had threatened to smash the "cpu" (central processing unit) if he wasn't (Field notes, 4/26/84). I overheard the other four instances myself:

> I'm waitin, Bubba. (Herm, field notes, 2/9/84)

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> "You hit the wrong key." No, I didn't, you dipwit. (Herm, field notes, 3/6/84)
>
> So do you, you little stupid computer. (Enos, transcript, 3/20/84)
>
> Shut up you stinkin' thing. (Del, field notes, 3/22/84)

The paucity of these instances of talking to the computers, especially considering that some of the programs could be frustrating to the students, implies that there might have been an unwritten rule against doing so. One suggestion of this possibility came out when Enos referred to his machine as "you little stupid computer":

> Herm: (loudly) How come Enos's talkin' to the computer?
>
> Enos: I am not! I'm not either talkin' to a computer, Herm.
>
> Herm: You're just callin' it names. (Transcript, 3/20/84)

Though my transcript shows no student reponse to Herm's attempt to embarrass Enos, the occasion for doing so hints at the possibility that, among these students, there was a taboo against talking to the computers.

Another clue as to how these students viewed the computers can be gleaned by analyzing how they referred to them. Because computers possess certain human qualities, it is tempting to anthropomorphize them. Some schools implicitly encourage this by giving their computers names. At Wolverine, the TRS-80 computers were not named, although there remained on the wall of the computer lab the name plates of the TI's--Alpha and Beta. If students consistently referred to a computer as "he" or "she," it would tell us a great deal about how they viewed them. In all of my notes and transcripts, however, I could not find a single instance of a student reference to a computer as "he" or "she."

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They consistently referred to the computers as "it" or "the computer." On four occasions the students did use "they" when referring to a program, a computer or the combination of the two. For example, in the last chapter, we saw Kate say, "I hope they don't give you the same ones" (Transcript, 5/15/84). Similarly, Amelia once became irritated that her computer didn't give the same sequence of math problems as Corina's: "Hey, they changed the numbers" (Transcript, 1/24/86). It is difficult to know just how to interpret these references to a single computer as "they." I tend to see them as signs that these students realized that the computers' responses were ultimately determined by the program's authors. If this interpretation is correct, then these four instances should perhaps be seen as evidence of a more mature and realistic view of the computers.

Big Trak.

Toy manufacturers often take advantage of the lifelike qualities of electronic machines by producing toys that talk and move in response to the children's commands. One of these toys found its way into Wolverine School in the form of a programmable Big Trak tank that Miss Serge had ordered. On Friday, April 13, Mrs. Rosemont took her class to the music room for an introduction to Big Trak. In describing this tank, Miss Serge personified it by frequently referring to it as "he":

> Well, what Big Trak is is a computer because he has a memory, and he's also a robot because he can do things without somebody standing there telling him what to do, ...
>
> This particular robot will take up to 16 commands. That's 16 different things that you can tell him to do. He can go 99 times his own length. . . . (Transcript)

Immediately following Miss Serge's explanation, two of the boys had a

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conversation which revealed their refusal of her invitation to refer to the Big Trak as "he":

Dick: You don't have a Big Trak.

Ed: Yes, I do.

Dick: Does it work?

Ed: Yea.

Dick: I didn't see it when I was . . . . (inaudible)

Ed: I just got it. (Transcript)

Later, Mrs. Rosemont referred to the tank as a "he": "Okay, Montoya, could you pick him up and bring him up here?" Right after that, Jake spoke to a friend, showing that he, too, refused to take the bait: "If you forget and leave it on, then it warns ya" (Transcript). Finally, I was set straight about the inanimate nature of Big Trak when one of the boys (Del or Ed) asked me about my tape recorder:

Boy: Is that recording?

Roessler: Yea.

Boy: Oh, that's nice.

Roessler: I'll get Big Trak when he talks.

Boy: It doesn't talk.

Roessler: When it makes noise. (Transcript)

We three adults did not normally refer to a computer as "he" or "she," but in these instances when we did, the students declined the temptation to follow our lead. In my transcript of the Big Trak session, there are 53 instances where the students referred to Big Trak as "it" and only five where they called it "he." Four of the latter came in a conversation between Herm and two unidentified boys:

> Herm: He's waving at us.
>
> Boy 1: Oh, it looks like he gots an arrow through his nose.
>
> Boy 2: Look it, he's waving at you.
>
> Herm: (laughs) No, he's waving at us. (Transcript)

Despite this interchange and one other reference to the Big Trak as "he," the evidence is clear that Mrs. Rosemont's students generally resisted the temptation to personalize this little tank or the Radio Shack computers. This contrasts with what Turkle describes as the typical adult approach: anthropomorphize electronic machines but refuse to grant them the dignity of life.

Discrepant case analysis: Herm.

The one exception to the general rule that Mrs. Rosemont's students did not personalize the machines was Herm. Even though Herm excoriated Enos for talking to the computers, it was he who showed a tendency to anthropomorphize them. He did this in two ways. One was to threaten the computer, as in "I'm gonna punch this thing" (Field notes, 3/20/84). The other was to refer to its death:

> I don't got no star. My computer must have died. (Field notes, 2/9/84)
>
> I think Al's died. (Field notes, 2/14/84)
>
> Hey man, I just did my 40th turn and it killed me. . . . That's stupid. I'm gonna kill it. (He thumped the keyboard with his hand). (Transcript, 5/15/84)

According to Turkle, younger children think of computers and electronic toys as alive and use speculation about their aliveness as a way to explore questions of life and death. I have no way of knowing if Herm's references put him in this category or not. Herm had certain violent tendencies and occasionally got in trouble for bullying other kids on the playground. It is interesting that he sometimes used the computer as an object of his aggression. In this way, he dignified the computer by threatening it in the same way that he would threaten one of his peers.

Limitations of the students' curiosity.

Though Mrs. Rosemont's students loosely categorized the computers as machines, they rarely speculated about how those machines worked. One student, Dick, occasionally raised this kind of question at the computers, but none of the other students ever seemed to respond:

> These computers are so complicated that I don't see how you could make one. (Field notes, 3/22/84)
>
> Mr. Roessler, how much would it cost if I threw this out the window? . . . All that would be left of it would be a big pile of wires and computer chips . . . Hey, Ed, do you know how much a chip costs? (Transcript, 3/22/84)
>
> You know what I wish I had? A computerized box that had fingers on it, smart enough to answer these questions for me. (Transcript, 3/29/84)

In all of my notes and transcripts, I can find only two other references to the inner workings of a computer. During the March 6 session with the math program, Enos explained that "I went too fast for the computer to get it in its mind" (Transcript). Jack's threat to smash the cpu was the other instance (Field notes, 4/26/84). In these statements, you can see the kinds of philosophical speculations that Turkle found to be typical of younger students (ages 5-7). As predicted, they were not typical of my 9- and 10-year-old informants, nor did they seem to strike a responsive chord among the other students when they were spoken.

Rarely did any of the students even ask about the meaning of specific phrases that the computers presented to them. Consider the opening sequence, for example, where the network presented two questions:

Cass?
Memory Size?

Over the course of 15 math computer sessions, 11 student interviews and 12 lunches in the student cafeteria, not once did a student raise the question of what "Cass?" meant (Do you have a casette recorder?). Nor did I ever hear a student speculate about "Memory Size?" and what it meant for their work at the computers. In my interviews, I asked three of the more computer literate students (Jake, Corina and Miranda) what "Cass?" meant. None of them knew. All they knew was that they had to press ENTER twice, type CLOAD and press ENTER again. That, seemingly, was all they wanted to know too. I was abruptly informed of this one day when Herm received an error message reading "INVALID LESSON NUMBER," and I asked him if he knew what it meant. "No, and I don't want to," he snapped, turning away from me and back to his work at the keyboard (Field notes, 2/14/84). There were several other questions that working on these computers might have raised:

What does "RT" stand for?

What is a "UL Error"?

What does the button that says "48K RAM" mean?

What does "CLOAD" stand for?

Only once in all of my observations were any of these questions raised. That was on March 22 when Brett had just been told to press "RT" to start over and Jack asked of the group, "What's "RT" stand for?" (Transcript) No one responded. Even though the students worked very hard to get promoted to a higher lesson, they apparently worked all the way through to the March 22 session without even raising the question of what the criteria were for promotion. Even then, I believe that most students went through the entire year not knowing what they were. Many thought it was based strictly on how many problems they did; whereas what was required was a minimum of 20 problems worked with an accuracy level of 80 or 90% (depending on the lesson). Similarly, I rarely heard any student question the meaning of the average response time that was given at the end of each lesson. On May 10, Melody told me that a score of 1.4 seconds average response time meant that she had done the whole set of problems in one minute and four seconds (Transcript).

The Computers and Control

The preceding discussion demonstrated that the students viewed the computers somewhat unreflectively as a machine. The next question to consider is one of control. Did the students control the computers or vice versa? The answer is--both. When the students were running the programs as the authors intended, they were usually being controlled by the computers. On the other hand, when they were experimenting with the machines in a variety of ways, they were seizing control for themselves. In both cases, the students seemed to use the situation as a way of confirming their own sense of personal competence.

Coping with standardized inputs.

The interaction between a computer and a human naturally creates a control problem because of their language differences. On which level will the communication take place: the computer's or the human's? The human would naturally prefer to communicate verbally in his or her native tongue. For example, Mrs. Rosemont's students might have wanted to say, "The answer is 10. Hurry up and go to the next problem." In the current phase of the computer revolution, this kind of communication will not work, of course, at least not with the microcomputers being used in the schools. This means that, to achieve a satisfactory visit to the computers, the students were forced to learn to communicate through the keyboard--no easy adjustment for non-typists. They also had to learn the appropriate words, or commands, to which these particular computers would respond. To an information specialist, this phenomenon is known as the computer's requirement for "standardized inputs" (Nowotny, 1982). Mrs. Thomas, the library media aide at Spartan School, called it the computers' demand for "attention to detail" (Field notes, 2/28/84). Whatever one calls it, this aspect of computing can be very frustrating. At times, it can make the user feel quite powerless. We have probably all seen adults confronted with this situation as it occurs with computerized cash registers. We wait, more or less patiently, as the poor beleaguered salesclerk tries to remember what key has to be pressed to cancel a mistake, incorporate a discount, or make the machine do whatever is needed to move on the corporate enterprise. These clerks are suffering from the same frustrations that caused the kindergartners at Wolverine to call over an adult and say, "It stopped. It won't go"

(Mr. Peterson, interview, 2/21/84). To the extent that humans yield to these requirements for communicating with computers, they are allowing themselves to be controlled.

Even though Mrs. Rosemont's students encountered this situation each time they went to the computers, I have no record of any of them discussing this phenomenon in the abstract. Like most everything else, they seem to have accepted it as one of the givens of computers. The students developed two strategies for coping with the computers' demands for standardized inputs. One was just to memorize the correct sequence of keys needed to move to the next part of the program, like "press ENTER twice, type CLOAD and press ENTER again." For regularly occurring situations, like the opening sequence, this strategy worked well.

My insight into their main strategy for non-recurring situations was provided by Herm and Al. On February 9, I was sitting next to them while they were working on the math program. Without my asking, Herm reached over and started up my computer:

Roessler: And what do I do here?

Herm: Put your name in and play with it!

Al: Yea.

Roessler: Now what?

Herm: ENTER.

Al: ENTER. Just put anything.

Herm: Just put anything. (Transcript)

What you do when the computer is stuck, according to these computer-literate fourth graders, is fall back on trial-and-error.

Will it possibly hurt the computer or destroy important data if you press the wrong key? They knew better. For better or worse, this was one of the main lessons that the students had learned by working with computers. The alternative was not consistent with their learning style, or at least their personal preferences: thinking about the words displayed on the monitor, puzzling through the meanings of expressions like "Cass?" or "Invalid lesson number," and just generally applying deductive logic. Had I described this approach to them and their peers, I know how most of them would have responded--why bother? And the truth is, as I have demonstrated in Chapters 6 and 7, their strategy usually got them where they wanted to go.

The question that remains, of course, is the possible spillover from these experiences. Was it good for them to learn the more complicated aspects of multiplication by taking guesses and seeing how the computer would respond? Were they less patient with Mrs. Rosemont's careful explanations in the classroom because they had experienced a less mentally taxing way of learning? It is hard to know, based on the information I was able to gather. Certainly, these are questions that educators need to consider very carefully before they decide to have their students spend a significant amount of time running drill programs on the computer.

The computer as authority figure.

During most computer sessions, Mrs. Rosemont had very little interaction with her students. She got them started and just let them work. To what extent can it be said that the computers became surrogate teachers? Did the students accept the computers' authority as much as they did Mrs. Rosemont's? If so, with what qualifications? These are important questions.

Hess and Tenezakis researched this phenomenon and reported their results in a paper called "The Computer as a Socializing Agent: Some Socioaffective Outcomes of CAI" (1970). From their work at a junior high school in California, they concluded that the students did, indeed, accept the computer as an authority figure, giving it a status comparable to what they gave to their teachers. Hess and Tenezakis isolated five properties of CAI that enabled it to serve as a socializing agent for the students:

1. The computer was capable of interacting with the students.
2. The computer acted as a reinforcing agent.
3. It seemed like a pseudohuman teacher to the students.
4. The programs were motivating and engaging for the students.
5. The computer became part of the authority structure of the school.

From what has been presented so far about Mrs. Rosemont's students and their work with computers, it can be seen that four of these characterizations of the students' relationships with the computers certainly were in evidence at Wolverine School. The one that was not is number 3. As I have shown in the first part of this chapter, my informants were loath to attribute human qualities to the computers. This fact, however, did not seem to diminish the power of the other factors.

It can be taken as a given that the computers did interact with the students, but it is worth a minute's reflection to compare that interaction to the students' interaction with Mrs. Rosemont. For each student, the computer provided a higher density of interactions. In a class of 26, a student will typically have one or two exchanges per hour with the teacher. When running the math program, the students were getting reactions at the rate of one for every five or ten seconds. Mrs. Rosemont thought that this was the main benefit of doing math on the computer. If a student was doing a problem wrong, the computer informed her or him immediately; whereas, in class, she or he might do a whole worksheet incorrectly before becoming aware of it (Interview, 3/1/84).

Although the computer was able to give more interactions per hour than the teacher, the quality of those interactions was comparatively low. Mrs. Rosemont routinely gave rich and patient explanations to her students, nothing like the terse written responses given by the computers. Like any good teacher, she tailored her responses to fit what she saw as the needs of the individual at that point in time, giving a compliment and a hug here and a firm warning there. By comparison, the computers reacted to a situation by giving a set response or by randomly choosing one from a list of equivalent expressions. All three drill programs that I observed the students running used positive and negative reinforcements in this way. Most of these were verbal, like "Good job, Amelia" or "Come on, Melody, don't go to sleep." Others were graphic, like displaying the smiling face or the treasure that was won. Perhaps the most dramatic was the negative reinforcement built into THE DRAGON GAME: death from the dragon's fire for those who committed too many mistakes identifying the correct part of speech.

My notes are replete with evidence that the students took these reinforcements quite seriously. Students getting wrong-answer or "hurry up" messages from the math program would sometimes cover their mouths or jerk back two or three inches from the monitor. Others would smile broadly upon reading of their own successess on the screen. The hearing-impaired boy, Lawrence, once literally jumped for joy when his computer informed him that he was promoted from lesson 22 to 27 (Field notes, 2/14/84). In an interview, Brett told me that he preferred the written comments over the happy faces when he worked the math program. When I asked him why, he said, "I don't know. It just gets me in a good mood" (Interview, 4/13/84).

The main reason that I know the students accepted the computer's reinforcements is that they frequently responded verbally to them, usually by reading them aloud: "I'm doing pretty good, I think. See--'You are right,'" is a typical example (Al, field notes, 2/14/84). This echoing of the computer's praises was often done for the positive reinforcement given for getting one right answer, but it was accentuated at the end of a game or math session. Think back to the comments that the students made at the end of the March 1 math session:

Dick: *98 problems worked* . . . heh, heh.

Brett: 23 problems . . . Wow!

Brett: Mrs. Rosemont, my lowest score--7.17 seconds.

These students clearly accepted, and took pleasure in, the computers' evaluations of their work. They seemingly internalized its standards for their performance. The fact that the students frequently echoed the computers' praises indicates, though, that they desired even more reinforcement in the form of human affirmation. They wanted their peers to know of their successes. Maybe, if they were lucky, they would enjoy the satisfaction that Jack received when Brett proudly announced his successes to the entire group (Transcript, 3/22/84). In this way, perhaps, they were able to take the one-dimensional reinforcements from the computer and parlay them into the more satisfying ones that come from one's peers.

I would not want to play down the computers' verbal reinforcements too far, however, because they did seem compelling to the students. One indication of the value they gave to these short reinforcers revealed itself on the day that I observed the class doing cooperative learning. The idea of cooperative learning is to place the students in mixed-ability groups of three. As they work on a small-group assignment, they are supposed to concentrate on developing some aspect of group cooperation. On this day, the students were told to work on encouraging each other; and so, before they began, Mrs. Rosemont had them generate a list of supportive expressions that they could use. As she listed them on the board, it became apparent that the students' list was remarkably similar to the expressions used in CAI programs:

Good job.

You can do it.

That's right.

Good idea.

Try again.

Good answer.

Yea, it's right. (Field notes, 2/16/84)

I am not sure if the students would have suggested these same expressions if they had not been working with the computer that year.

A second, and more poignant, affirmation of the computers' reinforcing powers occurred on Thursday, March 29. On that day, I arrived at Wolverine at 11:00 and joined some of the boys for lunch. After we ate, I accompanied Winnie to the computer lab so that she could run the math program. Mrs. Rosemont had asked me to do this because, as the only Chapter I reading student in the class, Winnie had missed out on most of her turns at the computer. Soon after we arrived, Corina joined us so that she could try some experiments on the computer.

Winnie was the pariah of Mrs. Rosemont's class. Though she was eager to please the other students, she always seemed to do the wrong thing. The other students picked on her and called her names. Worst of all, they pretended that she had "cooties" and would cross their fingers whenever she was nearby--a supposed defense against a possible cooties attack.

As a slow reader who had only used the computers four times in the past three months, Winnie was not exactly computer-literate. I watched her as she began the math program. The computer asked for the number of problems per session and she turned to me and asked, "I put my name down here?" (Field notes) I helped her answer this question and get into the problems on an early lesson. When she entered her first correct answer, the smiley face appeared:

Winnie: Oh, I hate those smiley faces.

Roessler: Why?

Winnie: I hate the way they look. (Field notes)

Four more times the smiley face popped up and each time she seemed to wince a bit. She scored well enough to be moved into a higher lesson, though. There, for the first time ever, she received a written positive reinforcement at the bottom of the screen. She read it, and the subsequent ones, aloud:

> Good, Winnie.
>
> All right, Winnie.
>
> Very good, Winnie.
>
> Very good, Winnie.
>
> Very good, Winnie.
>
> That's correct.
>
> You hit the wrong key.
>
> Keep up the good work. (Field notes)

At this point, Winnie turned to me, tapped her head with her finger, and said, "I have good brains up here." I was overwhelmed by the irony of this occurrence. Here, a girl who had suffered putdown after putdown from her peers finally received some unadulterated praise that made her feel good about herself and this praise had come--of all places--from the 8" X 11" screen of a microcomputer. Clearly, for at least one of Mrs. Rosemont's students, the computer had proven to be an effective reinforcing agent.

Hess's 5th property--that the computer became a part of the authority structure of the school--was also much in evidence at Wolverine School. Remember that Mr. Hastings and Mr. Peterson were interested in using the computers to monitor teachers and students

(Chapter 4). Their attempts at doing so did not affect Mrs. Rosemont's class as much as they might have because only fifth- and sixth-grade math tests were being run through the computer management system. Nevertheless, there were several aspects of the K-8 MATH PROGRAM that made it a natural extension of the school's authority. One was its measuring capabilities. The students were well aware that, at the end of each session, their number of right and wrong answers and their average response times were available for the teacher's inspection. Consequently, they did not go to the bathroom or get a drink during these sessions, though they often did so when working on seat work in the classroom. Once, Montoya started to leave his computer to get a drink; but, when Del reminded him how this action would affect his average response time, he turned around and came back: "Oh heck, someone's already there" (Field notes, 4/26/84). As it turns out, Mrs. Rosemont did not take this computer-generated data all that seriously. At the end of the year, she did not even save the student's final placements so they could be passed on to their fifth-grade teachers. Only occasionally did she confront a student for not performing well on the math program. On February 14, for example, she talked to Herm at the end of a session in which he had engaged in considerable time-wasting and had needlessly repeated an entire lesson:

Mrs. R.: Now, why did you do lesson 20 again?

Herm: I dunno.

Mrs. R.: You took the test the last time and got a hundred on it. Was 20 where you were placed before?

Herm: Uh huh.

. . . .

Mrs. R.: You were kinda slow today. You only did 15 problems in . . . (inaudible)

Herm: Uh huh.

Mrs. R.: How come?

Herm: I don't know.

Mrs. R.: Not with it today, huh?

Herm: Um huh. (Transcript)

This rather mild grilling was the toughest of the few instances when I overheard Mrs. Rosemont challenge a student for the inadequacies of his or her computer work. The students, I think, assumed that she would back up the computer's authority much more than she really did.

The occasions when the computers' authority was most strongly reinforced, or at least most conspicuously so, was when a computer imperfection made a student appear at fault. Computers are remarkably consistent machines so, when they do commit an aberrant behavior, people tend to blame the hapless user. On April 24, for example, Karen (the aide) took Mrs. Rosemont's students to the lab for a session with the math program. When the program was being downloaded, Winnie's computer broke out of the opening sequence, perhaps because she had pressed a wrong key. It printed "SN ERROR." Spying this error message, Herm announced to the whole class, "Winnie's messed up." Later, Karen came up and challenged her:

Karen: Winnie, come on, you can go.

Winnie: Mine messed up.

Karen: It says "READY." (Transcript)

Apparently, Karen failed to see that, below "READY," Winnie's monitor also said "SN ERROR." She then said to Winnie, "Are you sure you're supposed to be down here now?" (Transcript) About 10 minutes later, Winnie leaned back briefly in her chair while waiting for the computer to display the next problem. From the other side of the lab, Karen reproached her again, "Winnie, are you working?" (Transcript)

During that same session, Jake also learned a lesson about the computers' authority--that there are limits as to how far one can go in criticizing them. He was working intently on Lesson 37 and became agitated because he had accidentally hit the wrong number and the computer wouldn't allow him to change it:

Jake: . . . and then I pushed the wrong number and it said I was wrong. . . I hate computers . . . You can't erase!

Karen intervened on behalf of the computers:

Karen: Well, I hear lots of complaints about the computer. The computer does what you tell it to.

Jake: Yea, but you can't erase. I hate that.

Karen: Jake, if you're going to complain, why don't you go back to the room because I don't like to hear complaints.

As the best student in the class, Jake was not used to being treated in this way. He handled it well by dropping the argument and returning to his multiplication problems. Still, the repercussions of his challenge to the computer had only just begun. Though I had witnessed the entire scene, Karen came over and retold it to me. Then, when Mr. Peterson, the principal, dropped by to visit the students at the lab, Karen told him loud enough for all to hear. He supported her position by laughingly observing "The guy with the fingers is the guy with the problem" (Transcript). Later, Karen told Mrs. Rosemont the whole story. Days after this incident, students were still telling me how much Jake hated the computers. Mrs. Rosemont told me on May 5 that he did not like the math program (Interview). This was not true at all. In fact, he liked computers and took a special pleasure in working on the math program (Interview, Jake, 5/25/84). The problem was that he knew that, in the ADDITION part of this program, one could use the arrow key to erase a mistakenly entered digit. Thus, he sensed that the same procedure could have been built into the MULTIPLICATION program (Interview, 5/25/84). This feature would have been very helpful for students, like him, who were working on long and complicated problems. For this bit of insight into the workings of the program, he received some real headaches.

Winnie and Jake's experiences demonstrate that the authority of the computer could be turned against members of one of the lowest status groups in a school--the students. Does this mean that the computers were seen as being infallible and were always protected from criticisms? Not at all. My notes show over 40 instances of students complaining about the computers. When Del and Montoya encountered a difficult part of the COOKIES program, they blamed the program:

Del: This is stupid.

Montoya: I know. (Field notes, 1/26/84)

The math program was criticized because it was too slow, because it was boring, because it gave smiley faces instead of written comments or written comments instead of smiley faces. Few aspects of the program were immune from these verbal assaults. Either because she was slightly bemused or because she also saw the limitations of these programs, Mrs. Rosemont never responded to any of these attacks. She just ignored them.

Looking back on this rather lengthy discussion of the computer as authority figure, how can the level of the students' acceptance of the computers' authority be summed up? Perhaps the best way is to consider how much credibility they gave it as a teacher. Hess and Tenezakis's subjects generally preferred to do math at the console rather than with the teacher. They found the computer to be faster, fairer, clearer and more effective than their teacher (1970). Having read their study in January of 1984, I decided to ask my student interviewees if they thought that they could learn their math just by running the math program. I asked this question of 14 students, and all 13 who answered it said "yes." This was a striking affirmation of the math program's teaching powers since even the authors maintained that it was only a drill-and-practice program and not a tutorial. Furthermore, the program only covered computation and thereby omitted many other topics included in their math books: rounding, time, money, measurement, and geometry, to name a few.

After the students answered this question, I asked them how they would prefer to learn math: at the computers or in the classroom with Mrs. Rosemont. Their responses to this question are summarized in Table 3. You can see that 10 of the 13 who took a position on this question, chose the computers. This is a surprising result. Hess and Tenezakis thought that their students might have preferred the computers because they were mostly Chicano students who, as such, might have been victims of discrimination at school (1970). No such hypothesis could explain the reaction of these 10 students at Wolverine

School. Included in those preferring the computers were some of "la creme de la creme" of the school. They had a good teacher and a good math book too (Heath Mathematics). So the question to be answered is, why would these students put so much faith in the computers and think that they would be satisfied doing their math on them all year? As you can see from Table 3, part of the reason was just convenience. Two of the students preferred the computers because then they didn't have to copy the problems over. Brett's reason--"Because you don't have to wait so long to see if it's right or not"--is an affirmation of the computer's interactive qualities discussed earlier in this section. Maybe the best clues as to why so many students preferred the computer was given by Cari: "Because everyone thinks you can learn better and there's games to it." In this instance, "everyone" probably referred to her family. Typically, these students' families were pleased that their children were learning to use computers and believed that they were improving their math skills by using them. Brett was particularly clear about this:

> Mom thinks it's helping me a lot in math because I . . . I used to get like a half a page of math done when I first started fourth grade and now I get like two-and-a-half pages done. (Interview, 4/13/84)

I suspect that Brett's math output increased more because of the consistent pressure that Mrs. Rosemont put on him, but no matter. The point is that he, and others, were hearing (and believing) very reassuring statements about the computers' teaching abilities back in 1984.

The other half of Cari's statement reveals another explanation for the students' preferences for learning math on the computer: you can

Table 3. Student preferences for learning math

Student	Best way to learn math	Reason stated
Al	Mrs. R.	because understanding the teacher's explanations is "a lot easier"
Amelia	computers	none stated
Brett	computers	"Because you don't have to wait so long to see if it's right."
Cari	computers	"Because everyone thinks you can learn better and there's games to it."
Corina	computers	"Because the computer gives you chances."
Dick	computers	no need to recopy the problems
Doris	computers	"That would be fun."
Herm	computers	none stated
Jake	no preference	
Kate	Mrs. R.	she will help you through a problem
Melody	computers	can work at your own pace and you don't have to copy over the problems
Miranda	computers	none stated
Terry	computers	"because it's quicker"
Winnie	Mrs. R.	"because then there's more problems and you can figure them out."

play games on it. The language of educational computing is wrapped in the terminology of gaming. The programs often refer to the users as "players," and, at the end of many programs, the question is asked "Would you like to play again?" Many programs are referred to as games, too, like when Mrs. Rosemont said to me, "We usually do math because that's the only thing that we have games for" (Field notes, 1/17/84). Strictly speaking, the math program was not a game, at least not from the students' point of view. It put too much pressure on them and they were not doing it of their own volition (Huizinga, 1955; Sylva & Genova, 1976). The students themselves never used the word "game" when referring to the math program. They did, however, make references to the computers' potential as a game machine. Like on March 22, as the students waited for the math program to be downloaded and Jack blurted out, "Can I do something else? I want to do my own little program--D and D. I want to play a game" (Transcript). Of the students who had home computers, most families used them primarily for games, so that, too, makes it understandable how doing math on the computer might have preserved a game-like aura for the students, even though the program itself was viewed somewhat seriously.

From the students' perspective, learning on the computers seemed to promise it all--good education and at least the potential for some good fun. Though the math program elicited concentration and hard work from them, it makes sense that many of them would prefer it to Mrs. Rosemont's math lessons and doing the problems in the book.

The students take control.

In their brief history, computers have often been the battleground between managers who see them as tools of control and workers who see them as tools of creativity. In *The Second Self*, Turkle describes how the birth of the microcomputer fit into this struggle. By 1975, many computer programmers had become disillusioned with their jobs because programming had become fragmented. Programs were broken into pieces and each assigned to a programmer, reducing what had been a craft to an assembly line. It was these unhappy programmers and other technicians who bought the first microcomputers, thereby recapturing for themselves the powers of creation, the mystery of the computer:

> From the beginning, most promotional literature and popular accounts of home computer use emphasized the instrumental: how computers could teach French or help with financial planning and taxes. But from the beginning it was clear that this utilitarian rhetoric was not the source of real excitement. I spoke at length to members of that first generation of personal computer owners, the people who bought and built small computers in the late 1970s. Some justified their purchase of a personal computer by referring to a specific job--monitoring a home heating system, keeping records for a small business, establishing an inventory for a kitchen or a toolroom--but in most cases they also described a point at which their sense of engagement with the computer had shifted to the noninstrumental. They spoke about "cognitive play" and "puzzle solving," about the "beauty of understanding a system at many levels of complexity." They described what they did with their computers with phrases such as "building another room in my mind." Once people actually had a computer in their home, the most interesting thing about it became the computer itself, not for what it might do, but for how it made them feel. (pages 167-168)

In this way, the IBM minicomputer became the symbol of the corporate man, the microcomputer the symbol of the little man. According to Turkle, the conflict between the two approaches was whether the computer would be used as a tool of human creativity or as a machine that imposed its own rhythm and demands in a way that deadened human creativity.

This drama that Turkle describes was played out over the use of the computers at Wolverine School. With its management features and its tireless drilling of basic skills, the math program was the perfect embodiment of the administrators' view of computers. While the students accepted this view--that the computers could teach them math--they, like the early home-computer owners described by Turkle, felt the power of these machines to do more. In most cases, what they craved was divergent thinking and the chance to create something original. Terry, for example, told his parents that he did not much care for the math program that they were running at school. What he preferred, instead, was working on computer projects at home where he was programming his own math program, complete with drill on multiplication, division, addition and subtraction. He would spend hours making very impressive computer pictures using a program called DREAM HOUSE (Interview notes, 2/26/84 & 5/15/84). In third grade, Jeremiah became deeply involved with the school's Texas Instruments computers, particularly with playing chess on them. As a result, his mother had gone up to school and requested that he be given extra computer time. When I talked with her in January of 1984, however, she told me that he had not brought up the computers all year and that when she asked about it, he said "Eh, we're just doing math" (Field notes, 1/26/84).

In the interviews, I asked the students what their favorite programs were and received the results displayed in Table 4. Not one of the students chose the math program. Instead, they chose programs that gave them more control, especially DRAWING. Perhaps the student who felt strongest about this preference was Dick. On May 5, when they arrived at the lab, DRAWING was already loaded into the computers, so the students started creating pictures while Mrs. Rosemont looked for

Table 4. Students' favorite computer activities

Student	Date of Interview	Favorite school computer activity
Al	February 28	THE COOKIE SHOP
Brett	April 13	typing in a program
Corina	May 24	OREGON TRAIL or DRAWING
Dick	March 6	DRAWING
Doris	April 17	DRAWING
Herm	March 6	typing in a program
Miranda	May 18	DRAWING
Terry	February 28	THE COOKIE SHOP

the MULTIPLICATION disk. After a few minutes, she gave up on finding it and told them that they might as well draw for the remainder of the session. One of the students, who apparently didn't hear her, later said, "We're supposed to do math." Dick replied quickly: "Don't question a miracle!" (Transcript)

Though the students preferred other programs over the math program, mostly what they did was math, in 15 of the 21 sessions that I observed, to be exact. This fact triggered some grumbling, particularly from Cari, Herm and Dick. Herm summed up his reaction in the February 9 session: "Super boring" (Field notes). Mrs. Rosemont herself got bored running the math program; that was why she gave them some variety (Interview, 3/1/84). Interestingly, she assumed that they enjoyed the math program (Interviews, 3/1/84 & 5/5/84). This put the students who were bored by the math program in a quandary. How were they to live with the monotony of "5 X 0" and "7 X 0" for 20-25 minutes solid?

As is very clear from my description of the March 1 visit to the computers, their answer was to experiment. The students' exploration of the computers normally occurred in every stage of the session, beginning when they sat down at the computers and continuing until they left for the classroom. While waiting for Mrs. Rosemont to download the program, some students would try the one that was left in the computer's memory by the previous user. Or, they would just clear the memory by pressing reset and then try various responses to the computer's opening questions of "Cass?" and "Memory Size?". This was a risky time to experiment, though, because they had to have their computers ready when Mrs. Rosemont began downloading the program.

During the time that they were actually running the math program, the students would experiment periodically, even though doing so would cause an increase in their average response time. Adjusting the monitor's contrast way up and way down was the most common behavior of this type. Another favorite game was to start up an empty, adjacent computer and keep it going along with one's own machine. This trick, in addition to the post-session exploration time, offered the best opportunities to survey the higher levels of the program, since none of the students got past the first 38 of the 50 lessons on multiplication. Mrs. Rosemont and I never quite figured out some of the other tricks that her students discovered. For example, Terry and the MJT's learned how to make the print size much larger, throwing off the spacing and causing many words to run off the edge of the screen. Others learned how to call up certain test patterns on the screen, some that were solid pages of letters and numbers, others that looked more like hieroglyphics. Generally, these innovations spread in waves across the computer center. The discoverers could not resist showing them off and then many of their neighbors tried them out for themselves. Sometimes these explorations would take place on a dare, as in "I dare you to press BREAK" or "Push RESET, Doris" (Field notes, 1/31/84 & 5/4/84). Mostly, though, the students would just choose, on their own, to explore different possibilities. In this way, they presumably made the computer sessions more interesting to themselves.

Table 5 shows that experimenting was frequent and widely distributed among the members of the class. For the math sessions that I observed, the average was 5.07 experiments per session, 7.2 if the use of made-up names is included. Exploring the machines was more

Table 5. Number of experiments observed at the computers

BOYS				
Student	Use of a fake name	Expers. with K-8 MATH PROGRAM	Expers. with other progs.	Total
Al	1	9	0	10
Brett	3	7	0	10
Del	3	8	1	12
Dick	3	3	0	6
Ed	1	0	0	1
Enos	0	5	0	5
Herm	1	8	1	10
Jack	2	2	1	5
Jake	0	3	0	3
Jeremiah	1	2	0	3
Lawrence	0	3	0	3
Montoya	2	2	0	4
Terry	0	0	1	1
Boys' totals:	17	52	4	73
Boys' averages:	1.31	4.00	.31	5.22

Table 5 (cont'd).

GIRLS				
Student	Use of a fake name	Expers. with K-8 MATH PROGRAM	Expers. with other progs.	Total
Amelia	1	3	0	4
Annie	3	2	2	7
Bonnie	0	0	0	0
Cari	1	0	0	0
Cathy	1	2	0	3
Corina	0	0	1	1
Doris	2	7	0	9
Kate	1	1	0	2
Kathryn	1	2	0	3
Melody	0	3	0	3
Miranda	2	3	0	5
Samantha	0	1	0	2
Winnie	3	0	0	3
Girls' totals:	15	24	3	42
Girls' averages:	1.15	1.85	.23	3.23
Overall totals:	32	76	7	115
Overall averages:	1.23	2.92	.27	4.42

common among the boys than the girls.

When Mrs. Rosemont's students grabbed the opportunity to explore the computers, they were engaging in true play. This fact is made clear when their behavior is matched up with some of the characteristics of play identified in Johann Huizinga's *Homo Ludens*:

1. Play is voluntary.

2. It is an interlude in our daily lives.

3. There is a tension or uncertainty, something to be resolved.

4. The players experience a feeling of withdrawing together and being a part of a something special.

5. Knowing is sometimes given magical powers. It becomes an element of play. (1955, pages 7-12)

These attributes of play fit very well what I saw happening in the Wolverine computer lab as the students manipulated their computers in search of a little excitement. When they found a new trick and shared it with others, it was like finding an entrance to a cave or a key to a deserted house:

Al: Wait, this is cool. I like this.

Herm: There's gonna be a lot of problems. (He laughs). Look at that.

Al: Watch this.

. . . .

Al: 18 . . . You push the 8 first. I'm gonna do that on mine.

Herm: Oh man, I'm gonna do that.

. . . .

Al: Oh, my gosh! "Press C for carry." Um, cool. (Transcript, 2/9/84)

By exploring new parts of the math program, as Herm and Al were doing here, or running new programs left loaded in the computers, these students were able to expropriate for themselves some of the pleasures experienced by the first microcomputer owners. These pleasures were undoubtedly multiplied because playing them was illicit. If they got caught, they might receive a reprimand, though a harmless one, from their teacher or aide.

Another key element of play is role playing. Because the math program asked for the students' names and used them in some of its verbal responses, it provided a perfect opportunity for the students to pretend to be someone else. They became heroes and heroines of high-tech adventure movies (Hans Solo, Luke and Twin Vee), cartoon characters (He-Man) or rock stars (Michael Jackson). In doing the math program, these imaginary themes could not be carried too far, but at least the computer's responses could be read aloud for all to hear: "Very good, Hans" (Field notes, 5/10/84).

By using imaginary names and going off on their little side trips, Mrs. Rosemont's students were negotiating a compromise with the adults who wanted them to drill math at the computers. They were able to do this for three reasons. One was the complexity of the computers themselves. Even the opening sequence allowed room for exploration. If the students could find an empty machine with a different program loaded in it, they had a whole new world to explore. The second reason was the nature of the math program. Its use of the students' names and its slight changes in format at the different levels provided several areas for exploration. Its built-in pauses created opportunities for play and discussion too.

The final reason that these students could participate in their little forays was Mrs. Rosemont herself. In terms of status, she may have been closer to the principal than the students, but, in her ideas of inductive and deductive learning, she was far closer to the students. Her major thrust for the 1983-84 school year was to enhance the students' creativity, especially their creative writing. She had them work on it quite a bit but still felt, as her biggest regret at the end of the year, that she had not done enough (Interview, 5/24/84). The computer programs available at Wolverine School did not fit very well into this agenda: "That's what they are is drill. There's certainly nothing creative to them. I got bored running that program for a few minutes today" (Field notes, 3/6/84). She took her students to the lab most weeks, as she was expected to do; but, if her students were to launch off on an imaginary adventure while they multiplied, she wasn't likely to intervene on behalf of rote learning. Typically, she would just sit at the master computer, run her own program and occasionally listen in on their adventures. For example, after the March 1 session (described in Chapter 6), she told me that she could see why Dick's average response time was so high, given the level of chatter between him and Montoya. She chose not to say anything to them, though, "because they were having a real interesting conversation about wishes":

> Dick has a real interesting mind. I really enjoy listening to him talk. They were having a good time and they were sitting there doing their math and putting their numbers in. (Interview)

Symbolically, at least, Mrs. Rosemont established her position on computer education one day just after the Big Trak arrived. She and the school secretary, Mrs. Ewald, took it down the hall to the board office, carefully programmed it and sent it whirring into the superintendent's office. Once inside the door, it turned toward him, stopped and fired its lasers. Mrs. Rosemont told me what fun she had doing this (Field notes, 4/13/84). I suspect that it was also an indirect way to communicate with Mr. Hastings about the more creative uses of computers. If she could have, perhaps she would have had the lasers burn at least a tiny hole in his chart that described computers as management/drill machines.

With the tacit approval of their teacher, Mrs. Rosemont's students were able to carry out two lessons simultaneously: practicing multiplication and exploring computers. Looking back on my transcripts makes it clear that this latter set of learnings was not inconsequential. Here is a list of useful concepts and skills that some of the students learned through their extra-curricular explorations:

1. How the problems changed from lesson to lesson, including the switching from vertical to horizontal formats and the use of the carry in higher lessons;

2. How to adjust a screen's contrast and fix it if the print was not visible;

3. How to exit a program and then start it up again;

4. That the math program was unable to handle several numbers entered rapidly in succession;

5. That the computers were a safe environment, allowing them to type whatever they wanted without fear of doing damage.

By sampling new programs on the side, these students also put themselves in a better position to run those programs when Mrs.

Rosemont chose them for use in subsequent sessions. In some of the instances cited above, my field notes only show evidence of one or two students acquiring the concept by experimenting. The general practice, though, was to brag about (and thereby share) these learnings. The result was "cooperative learning" par excellence. Mrs. Rosemont worked very hard to implement cooperative learning in the classroom, with mixed results. Though her students may have denied her wish to get them cooperating in social studies, they turned around and gave her an ideal form of it at the computers. The difference is, of course, that it was on their own terms. Education is a funny business.

Chapter Summary

In summary, it can be said that Mrs. Rosemont's students were, indeed, forming attitudes and values about computers as they worked in the Wolverine School computer lab. Whether or not they were acquiring the "appropriate" attitudes and values is another question. Though they generally avoided the trap of anthropomorphizing computers, these students put too much faith in the computers' teaching abilities, more than their teacher or the math program's authors would have found acceptable. On the other hand, as a consequence of endeavoring to make the math program more interesting, these students undertook numerous experiments and thereby entered a contest with the computers as to who was going to control whom. Mr. Peterson described this contest in this way:

> The brighter, the older, kids will say "Can I alter the program to do what I want to do? It's making me play their game. Can I change the game to do this? (Transcript, 2/21/84)

For those individuals concerned about students allowing themselves to be blindly manipulated by computers, it is encouraging that Mrs. Rosemont's students reacted in this way. They maintained a realistic perspective on the computers, and they actively sought ways to manipulate the machines to their own advantage. This approach to computers is vital if they are to remain as tools of human beings.

CHAPTER IX

COMPUTERS AND THE HIDDEN CURRICULUM--II

A common assumption about the use of computers in school is that it will prepare our young people for the job market and the highly technological world of the 21st century. In using the computers, by osmosis as it were, they are to become socialized into the information age (Chapter 2). The last chapter demonstrated certain aspects of this socialization, showing how the students became accustomed to being managed by the computers and how they learned to put considerable faith in their teaching ability. As I observed Mrs. Rosemont's students, it became apparent that there were other lessons that they were learning from computers. These lessons first manifested themselves as awkward moments or complaints and then, later, as adjustments that the students had to make to the computers. In each case, I could see that the use of computers was beginning to change their ways of acting and thinking about the computer lab. Since these learning outcomes were neither intended nor desired by the school system, they constitute another aspect of the hidden curriculum of computer use. There were four main elements of this hidden curriculum:

1. Computers encourage quantification.
2. Using computers entails a loss of privacy.
3. Work generated on a computer can be evanescent.
4. Access to computers is a privilege.

In order to illustrate the first three of these lessons, I am going to provide one more extended description of the students at the computers. This one is taken from the March 22 session, a day when I videotaped the Thursday group as they ran the math program. On that day, Mrs. Rosemont walked them down to the lab at 12:28 and got them started. Then she went back to the room and sent Ellen, the aide, to supervise in the computer lab. Ellen moved up and down the aisles, talking quietly with the students about their work. At 12:52 she signalled the end of the session by announcing "Push RT. See if you're promoted and then we'll go back." Ed, a boy who had been working intently, pressed RT and saw this display come up on his screen:

ED'S REPORT

SKILL BUILDING LESSON 7

180 PROBLEMS WORKED
7 WRONG
15 RIGHT (2 TRIES)
158 RIGHT (1 TRY)

2.2 SEC., AVG. RESPONSE TIME
ENTER CODE TO CONTINUE

Most of the other students pressed RT and saw the same format appear on their monitors. Ed said quietly to Dick: "I didn't even get promoted." While some of the other students announced their successes, Ed wrote his scores on his progress chart.

A minute later Jack leaned over and asked Ed how many problems he had done. Ed told him. Then Brett leaned his chair way over to the left, placed his hand on Ed's carrel, and studied Ed's scores. Brett, who had only worked 31 problems with an average response time of 9.5

seconds, was apparently impressed:

Brett: Two minutes and two seconds?

Ed: That's every problem!

Brett: (loudly) Del, two minutes and two seconds!

Ed explained to Brett that he was unhappy because he had completed so many problems and still had not been promoted. He removed his score sheet from in front of Brett and turned to his left, signaling an end to the conversation. Brett returned to his computer. Fifteen seconds later, Brett stood up, walked over between Montoya and Del, and announced, "Ed did 180 problems . . . Yea, look." He stepped towards Ed's carrel and pointed to the monitor. Del and Montoya came over to see for themselves. They made no comment.

By this time, Jack had pressed RT and received good news. He had completed 190 problems with an average response time of 1.5 seconds, and he had been promoted to the next lesson. He shared the news with the group: "One hundred ninety problems!" Brett jumped up to check it out and loudly broadcast the messages that Ed probably didn't want to hear:

(to Jack): 190 problems!

(to Ed): Jack beat you . . . 190 problems!

(to Jack): 1.5 seconds. You beat em.

(to Ed): He beat you by a mile.

Brett bounced back and forth between Jack and Ed as he made these pronouncements.

In the meantime, Samantha was having a problem similar to Ed's. She had gotten Ellen's attention and was asking why she hadn't been promoted even though she had done 117 problems. This was the sixth session she had worked on lesson 5 and she was hoping to get out of it. Ellen asked me if I could explain what happened. While I explained that the program probably decided promotions on the basis of the percentage of correct answers, Del, Montoya, Jack and Brett all gathered around to view Samantha's monitor.

Ed began to leave. Brett stepped in front of him, gestured toward Jack's monitor and made some comment. Ed continued for a few steps, halted, and returned to his own computer. He lingered over it for two or three seconds and then pressed the orange reset button, clearing the screen.

As Ed passed by Jack's computer, he glanced at the screen again. Jack jumped between Ed and the computer, stretching out his arms as if to protect it:

Jack: Don't!

(Ed, who up to that point had done nothing more than look at Jack's monitor, reached for the keyboard with his left hand).

Ed: You've got to push/

Jack: /I want, I want people to see . . . .

Jack pushed back Ed's hand and then leaned over his computer to protect it. His head was turned to the left, ready to fend off Ed again if necessary. At this moment, Samantha walked around to the other side of Jack, reached under his chest and poked his computer's reset button, obliterating the evidence that Jack had achieved the promotion that had eluded her and Ed. Their work done, Samantha and Ed filed out, with

Jack following close behind. When Jack caught up with Samantha, he grabbed her wrist, but she immediately broke free of his grasp. The incident was over. They walked back to class together.

This session was an experience in frustration for Ed and Samantha, frustration that they eventually took out on Jack. The computers contributed to this conflict by measuring the students' efforts so accurately and by displaying their results where others could easily see them. In so doing, it accentuated a problem. If these students had been doing multiplication problems with pencil and paper, a difference of 1.5 and 2.2 seconds average response time might not have been noticeable. Furthermore, students who wished could have simply turned their papers over and hidden them from view. At the computers, they were forced to leave their score pages visible, at least until they had copied the results onto their progress sheets. If they had reflected on this experience, Ed and Samantha could have learned that computers generate a profusion of data and thereby facilitate comparisons between individuals. They also could have learned that computer use entails a certain loss of privacy. Jack, the apparent winner in the day's competition for glory, stood to learn a lesson too. He was proud of his accomplishment and wanted others to see it, perhaps a student from the next class, for example. Unfortunately, information stored on a computer chip is fragile indeed, a fact that played right into the hands of Ed and Samantha's jealous strategy. For Jack the lesson was one of the impermanence of computer data.

Computers and Quantification

Many people view computers primarily as number crunchers (Homan, 1985). This characterization is one-sided perhaps, but it is not without justification. Computers are easily programmed to gather, manipulate and store numerical data. Even when a program is written for some other purpose, the temptation to build in a management system is often present. The perfect example of this phenomenon is word processing. The use of a computer as a super typewriter has tripled the output of the average secretary and eliminated the drudgery of typing similar documents over and over. As a special feature of some word-processing programs, however, a measuring function has been appended. By entering a secret access code, bosses can now use this function to track the average typing speeds of their secretaries and to compare the number and duration of their breaks. They can even have this information printed out on graphs if they wish (Arnold, Birke & Faulkner, 1981). This small part of the program has big implications for worker-management relations. As you might expect, it has been the source of consternation and protest on the part of many secretaries (Neuhauser, 1984).

The management system built into the RADIO SHACK K-8 MATH PROGRAM has obvious similarities to those included in word processors. Is it correct to say that running this program was socializing these students to accept the use of the computer as an overseer? Perhaps. As I have demonstrated, Mrs. Rosemont's students not only accepted the computers' evaluations, they internalized them. They did so even though Mrs. Rosemont seemingly worked very hard at downplaying the importance of these measurements. A natural by-product of this acceptance was the encouragement of competition and its cousin, invidious comparison. Slight differences in speed or scores were often exploited for these purposes. Larger differences, made evident by the computers, proved particularly embarrassing to some students. Samantha, whose discouragement was revealed in the vignette at the beginning of this chapter, told me how she felt during the next visit to the computers:

> I've been in this computer all the time. It keeps me on (lesson) 5 . . . . And all the other kids are on 20 and 15 and all that stuff. It's drivin' me nuts. (Transcript, 3/29/84)

Even an intended positive reinforcement can acquire a negative connotation when placed in the context of these comparisons. In the last chapter, I showed how Winnie winced when the smiley face was displayed on her monitor. According to Miss Serge, this reaction was common amongst the fourth graders. They were embarrassed to receive a reinforcement associated with the "third-grade level" of the math program (Interview, 2/21/84).

Much of the comparing that was stimulated by the computers seemed to be misguided and superfluous. Many of the students did not even understand the meaning of the average response time. Brett raised a hullabaloo comparing Jack and Ed's average response times and he wasn't even sure if 2.2 meant two minutes and two seconds or two-and-two-tenths seconds. Furthermore, it was inappropriate to compare response times because the students were working on different lessons. Students who were multiplying numbers like 6 times 4 should have been able to achieve lower response times than those multiplying three-digit numbers times four-digit numbers. Many of the students working in the higher lesson numbers were also at a handicap because they were discovering for themselves how to handle the carry and how to add the products. Even when two students were working on the same lesson, bragging or putting each other down for completing an extra problem or two in 15 minutes seemed like competitive overkill. Many adults that I know would not be real pleased with having their computational skills or their typing speeds evaluated in this way.

The students themselves were probably incapable of making a conscious critique of the computer's encouragement of quantification and competition. No such analysis surfaced in my interviews, at any rate. Still, it is clear that they were sometimes annoyed by this aspect of computing and were forced to find ways of coping with it. Samantha and Ed's assault on Jack's computer was one way. Another was sinking into quiet resignation, which is what Winnie did. Other losers in this competition seemed to taunt the system as a kind of defense mechanism. Perhaps this is why Dick, who didn't get past lesson 7 until the end of April, verbalized so many of his daydreams at the computer. He certainly was defying the system on March 22 when he stopped multiplying and leaned back to see what the computer would do: "Ed, do you think doing this affects my score?" (Field notes)

The boldest strategy for covering up failure on the math program was developed by Doris. For several weeks she cheated on the system, recording unearned promotions on her score sheet and moving herself into higher and higher lessons (Interview, Mrs. Rosemont, 5/5/84). This tactic got her in above her head conceptually, but it gave her bragging rights:

Doris: That is easy. Now you're into the stuff that I'm into.

Miranda: I'm already on that, kinda.

Doris: Miranda, look at me! I've got three digits times four digits. (Transcript, 3/22/84)

For a fourth grader to defy the teacher's authority in this way was a daring strategem. The fact that Doris was forced to such extreme behavior to earn these bragging rights is an indication, I think, of how deeply she must have felt about being behind her friends in the math program. In developing this strategy and living with the consequences, she was experiencing some of the pain that many of us will endure, perhaps, as we make the transition to the quantitatively managed, computerized organization of tomorrow (Lias, 1982).

The Loss of Privacy

Related directly to the problem of quantification is the issue of privacy. The degree to which measuring a person's work output becomes a problem depends on who sees the information and how it is used. In American society, one of the biggest fears about computers is that they will be used to take away our privacy ("Adults See," 1984). Unfortunately, the truth is that much of this loss has already been incurred. Anyone doubting this fact should read Chapter 12 of Edward Lias's stimulating book, *Future Mind* (1982). This chapter is entitled "Is Privacy Obsolete?" and the answer is "yes." Right now, our federal government has about 18 records on each individual. Since 1972, banks have been required to keep copies of all checks and make them available to the Internal Revenue Service. The Supreme Court has ruled that we should harbor no expectation that our banking transactions will be kept private. Credit ratings on each of us can be called up on a bank's computer on a minute's notice. Computers and related media have made this kind of record keeping possible and so the necessary apparatus has been put into place. With two-way cables being run into our homes, what we watch on our televisions and what we purchase by use of the cable will become semi-private information. In a survey, data processors indicated that the privacy of information was the most critical issue facing their industry (Lias, 1982).

How the microcomputer revolution is affecting our privacy occurred to me one day in the Grantsville Board Office. As I was chatting with the superintendent's secretary, I absent-mindedly began reading a letter that she was typing on her word processor. It was obviously related to some private matter of the school board and so I caught myself and stopped reading it. Looking back at her, I sensed that she knew I was reading it and felt uncomfortable about it. This embarrassing incident set me to wonder why I presumed to read the letter. I soon realized that part of the answer is that a television monitor seems to invite snooping in a way that work done on paper does not. A key reason may be that the monitor is vertical and not easily shielded from the view of others. If this secretary had been typing the letter or writing it in pen, I would have had to lean over much farther to peek at her work and so I probably would not have done it. Another possible explanation of my behavior is that both television viewing and computing are usually experienced socially in our society. We commonly watch television with others. The dominant use of home computers is to play video games and there, too, it is acceptable for others to watch the monitor over the shoulder of the user (and, of course, to kibbutz, as well) (Sudnow, 1983). In bars and restaurants, people commonly share a large-screen television with strangers. As a result, we have come to think of information on a television monitor as public, or at least semi-public.

In the vignette at the beginning of this chapter, we saw how Ed and Samantha experienced this loss of privacy. Their classmates seemingly felt no compunction about looking at their monitors and evaluating their scores. This phenomenon was a common occurrence at the computer lab. It was evident in the description of the March 1 session (in Chapter 6) and the description of the students' encounter with THE DRAGON GAME (in Chapter 7). In the latter session, Al lost the game and was burned up by the dragon five times. Each of his failures was loudly announced to the class by Jake.

Children have less privacy than adults, especially when they are at school (Jackson, 1968). In the classroom, Mrs. Rosemont's students occasionally peered at and discussed each other's written work and drawings. There was a difference in degree, though. For example, I never heard a student announce loudly and repeatedly that another student had failed on a test or an essay. I doubt if Mrs. Rosemont would have allowed that.

By their actions, Mrs. Rosemont's students showed that they were sensitive to the additional loss of privacy entailed in working at the computer lab. Part of the reason that there were recurrent scrambles for the computers was a desire to avoid sitting next to potential snoopers. Some students didn't care where they sat or whom they sat next to, but others felt very strongly about it. As was mentioned in Chapter 6, the four seats in aisle C, with nothing but a tall book case behind them, were the apparent favorites of many students. These computers were almost always selected by the first students entering the lab, probably because they were more private. Mrs. Rosemont thought the students preferred these seats because she rarely walked behind them since the aisle was so narrow there (Field notes, 3/1/84). Amelia and Cari--two of the four MJTs--explained their desire to monopolize the seats in aisle C this way, falsely assuming that these computers were newer than the others:

> Cari: Those are the new computers . . . . And then nobody can sit by us either, cause there's only four seats.
>
> Roessler: Oh, I see. So if you can just get the four of you in there, then you get a little . . . little privacy maybe?
>
> Amelia: Yea (laughs nervously).
>
> Roessler: Why don't you want other people around you?
>
> Amelia: Cause like/
>
> Cari: /they bother me/
>
> Amelia: /like if we, if we like write our name [as something different] and then someone comes up and pushes ENTER, then the people around us are going to tease us and everything like that. (She laughs nervously). (Interview, 2/28/84)

In their explanation of this problem, Amelia and Cari placed the blame, typically, not on the nature of microcomputers, but on the students they considered most likely to violate their privacy in this way.

Another way in which Mrs. Rosemont's students revealed their sensitivity to the loss of privacy at the computers was by copying down their scores quickly and then clearing the screen. Almost as an afterthought, Ed went back and cleared his screen on March 22. On other occasions, students with low scores implemented this strategy more deliberately (e.g., field notes, 3/20/84). By April, the students had developed a clever variation of this approach. Someone figured out that the 8 1/2" X 11" papers on which they recorded their scores would fit perfectly over the monitor screen and would stay put if pressed into place. Of the four students who did this, one was Amelia, who was upset about not being promoted. Two others were boys who had goofed off throughout most of the session. Their comments revealed that it was guilt that had driven them to cover up their monitors:

> Al: Mrs. Rosemont, you wouldn't want to look at me. You wouldn't want to look at mine.
>
> Enos: Yea, you wouldn't want to look at mine either. (Transcript, 4/17/84)

Since one of these two was probably the inventor of the paper-screen cover, this would seem to be a perfect instance of necessity's being the mother of invention. This same coverup technique was used again in two of the next three math sessions that I observed. It was most blatant on May 10 when Montoya became miffed about not being promoted like his friend Dick was. He propped his score sheet up on the monitor as soon as he had read his report and went through the awkward motions of copying information from the screen onto the paper that covered it (Field notes). Behavior similar to this was observed by Turner (1984) in her research at a middle school in California. Students there would cover their low scores with their hands for the fifteen seconds that they were displayed on the screen.

Though many of Mrs. Rosemont's students obviously felt a loss of privacy when working at the computers, none of them seemed to have developed a consciousness of that fact and how it related to computer use in general. Instead of seeing the crowdedness of the computer lab or the nature of the computer as the problem, they usually personalized the problem by identifying it with a particular student who bothered them the most at the computers. Here, too, they were learning to accept another computer-based incursion into their lives.

Computer Data are Impermanent Data.

The advent of data processing has brought major changes in the sheer quantity of data produced. As Stanley Pogrow explains in *Education in the Computer Age*, the global village may drown in the sea of information that it is creating:

> The increase in the number of white-collar workers and the fact that each inquiry from a white-collar worker triggers as many as forty other messages in an organization (Strassman, 1980) mean that there has been a hypergeometric increase in the amount of information processed in organizations and in society as a whole. In 1975, the average white-collar employee handled 11 pages of text per day, a statistic that is expected to grow to 15 by 1990. The average amount of information that each employee needs to maintain is increasing from the former level of four file drawers at the start of the decade at the rate of 4,000 documents per employee year. (1983, p. 33)

Since the quantity of data is growing more rapidly than people's ability to absorb it, each piece of information is receiving less attention, and probably attributed with less value (Evans, 1979; Hamaguchi, 1985; Pogrow, 1983). Paper text is more expensive than electronic text, so we will see a rapid growth in reliance on the latter. This trend will make us a cashless society, forcing people to live without the props of paper money and paper checks (Evans, 1979). Encyclopedias, phone books and even Sears's catalogs are being transferred to data bases on computers and video disks (Pogrow, 1983).

For some people, these changes will be difficult to accept. Word processing seems alien to these traditional souls because of the strangeness of the idea that all of that information can be maintained in so many thousand tiny electronic switches ("Computers Ignite," 1987). Even for experienced computer users, this concept is hard to accept when an interruption in the flow of electricity closes those switches and sends their precious prose off somewhere into hyperspace. (One suspects that these little problems account for many of the instances when adults talk to their computers).

Though the students at Wolverine School did not use word processing during the 1983-84 school year, their use of computers still forced them to adjust to the fleeting nature of computer data. I was made aware of this fact on January 10, the day that I went to the school to seek entry as a researcher. Miss Serge and Mr. Peterson each asked me if I could help them figure out how to save the pictures that the students made on the DRAWING program (Field notes). Apparently, they had received many complaints from students who had toiled over computer pictures and then found that they could neither save nor print them. Mr. Peterson described their plaints when I asked him what the students usually said when they called him over during a computer session:

> You get the most interesting questions from kids. The first one they'll ask is--they created this super picture, "Can I keep it? Can I put it on the printer?" Well, it's not feasible. And then they ask "Why? Why can you keep a letter but you can't keep my picture?" (Interview, 2/21/84)

There was only one printer in the school, and since it was always attached to the staff's computer, the students went all year without the capacity to print their drawings. I didn't know if it was possible to save them from a slave computer back through the master to the disk drive, but I declined the opportunity to look into it (since I wanted to remain less of a participant and more of an observer).

The upshot was that the only tangible item that the students carried away from their work at the computer lab was a score sheet with their math program results recorded on it. Since fourth graders are still at the age where successful tests and drawings are proudly displayed on the refrigerator, this lack of visible proof of hard work bothered some of them. What they sometimes fell back on was the next available substitute--leaving the results of their work on the monitor for the next group to see. That was Jack's intention, of course, before Samantha pushed reset and reinforced an important lesson about the nature of computer data. Certainly in this instance, and many others, there was a pride of ownership that went unfulfilled. March 29, for example, was one of the days when I took photographs at the computer lab. Brett experimented with his computer at the end of that session and, once he had filled the screen with random letters and numbers, he called me over to see it:

> Brett: Look at this.
>
> Roessler: I want to take a picture of that.
>
> Brett: Me too . . . It's my creation. (Field notes)

I did take a picture of it, proving that ethnographers were worth something by making him the only Wolverine student all year who had an exact copy made of his computer production.

Computers Are for the Privileged.

The final aspect of the hidden curriculum to be discussed is the relationship between computer use and privilege. As was explained in Chapter 2, the question of equity is perceived by many researchers as a major concern for the educational computing movement (Sheingold, et al., 1983; Turner, 1984). The literature on equity sees sex, age, social class, ethnicity and intelligence all as potential turning points on which discrimination could be based. Neither my student informants nor my adult informants discussed this issue much, but it was prominent in the events that I observed at Wolverine School. Consequently, I have decided to add a discussion of equity to this part of the report.

The overall structure of the computer setup at Wolverine School encouraged equity. The use of a lab with 14 stations encouraged teachers to have all their students run the same program simultaneously. Furthermore, when Miss Serge set up the weekly computer schedule, her idea was for each class to come to the lab once a week. Until May, when the lab closed, that is the schedule that was generally followed. With but two exceptions that I am aware of, the students used the computers that year only when they came down as a group. The computers were not open to them before or after school, or during lunchtime.

Mr. Peterson's influences along these lines can be seen in his agenda for the inservice that he gave the Upper Pod teachers (grades four through six) on January 26. There he wrote that the future of computer education at Wolverine School would be to "to provide Drill and Practice for NON-Mastery Students - by objective" (Figure 3). In that same agenda, he stated his belief that using the computers to give extra drill to non-mastery students would insure student and teacher success. In short, his priority was to use the computer lab to help weak students and thereby decrease the gap between them and their more able classmates.

Despite these intentions, there were many aspects of the computer use by Mrs. Rosemont's class that tended to work in the opposite direction. First of all, it must be remembered that Mrs. Rosemont's class was a special group. Because of decisions that had been made years prior, whatever class had the two hearing-impaired children was given the same core of able students. In addition, Mr. Peterson believed that Mrs. Rosemont was especially good at teaching creative students. Accordingly, he had placed several such students in her class (Interview, Mr. Peterson, 6/25/87). Mrs. Rosemont was well aware of the specialness of this group, and she knew that she was able to try various special activities because of it (Interview, 5/5/84). In terms of their computer education, Mrs. Rosemont's students benefitted from having her. As was explained in Chapter 4, she was one of the few teachers who went with their students to the lab and worked with them there. Because she was taking programming courses at the community college, she was better able to answer their questions and to plan a special session where she introduced them to computer programming. In May, when Miss Serge closed down the lab, Mrs. Rosemont's students received extra computer sessions at a time when most classes were completely cut off from them.

To an extent, Mrs. Rosemont's class constituted a computer elite at Wolverine School. Within the class itself, though, there was a real division in terms of the quality and quantity of computer time that was received. This division began in September when Mrs. Rosemont first started taking her students to the lab. For the first few sessions, she just took those who were most advanced in their math work (Interview, 3/1/84). These privileged students eventually constituted the group that went to the computer lab on Tuesdays. The other group--the Thursday group--did receive equal computer trips after the first month or so, but not always the same programs. In the spring, for example, Mrs. Rosemont only allowed the Tuesday group to run the program on the states and capitals.

In addition to these small advantages, nine members of the Tuesday group were selected by Mrs. Rosemont to receive extra computer time on Wednesdays and Fridays. These students--Herm, Corina, Terry, Amelia, Cari, Jake, Jeremiah, Kate and Annie--were sent to the computer lab in small groups to teach themselves programming using a book called *TRS-80 for Kids from 8 to 80* (Zabinski, 1982). Because of my schedule, I was never able to observe this special group at the computers; but, from Mrs. Rosemont and various students, I learned that what they did was to type in programs from the book, complete the accompanying worksheets and just generally fool around with the computers, typing imaginary letters to Michael Jackson, finding ways to call up diverse character sets on the screen, making the computer count up to 1,000 and so on (Interviews with Mrs. Rosemont, 5/5/84 & 7/8/84; interview with Winnie and Malena, 5/10/84; interview with Corina, 5/24/84). Some of the techniques that they developed in these extra sessions eventually surfaced in the Tuesday sessions (e.g., their use of the big print mode discussed in Chapter 7).

In addition to these disparities in the distribution of computer time, there were others related to two discrepant cases in this class--Herm and Winnie. As was discussed in the last chapter, Winnie was given an abnormally low number of computer turns because of a schedule conflict with her Chapter I reading sessions. In this case, getting assistance in reading had a definite negative impact on her development in computer literacy. Maybe this prioritization would work out in the long run, however, because her weakness in reading was probably the major impediment to her successful use of the computers.

On the other side of the coin, Herm was given additional time at the computers, probably more than any other student in the school. The reasons for this were twofold. Mrs. Rosemont and Mr. Peterson believed that he was a gifted student who could profit from extra computer time (Field notes, 1/17/84). In addition, they knew that his desire to get extra computer time could be used to get him to behave on the playground. Consequently, Mrs. Rosemont cut a deal with Herm early in the fall. If he would avoid hitting and teasing students on the playground, he would be given an opportunity to type programs into the computer (Field notes, 1/17/84). At Wolverine, this level of privilege stood out as unusual, so much so that Miss Serge was reluctant to grant permission for the computers to be used in this way (Field notes, 1/26/84). Eventually, Herm's special trips were phased into the Wednesday/Friday sessions, as Mrs. Rosemont apparently decided that some of her other students could profit from a similar experience.

Mrs. Rosemont sometimes found it difficult to explain these and other attempts to differentiate between her students. On two occasions, I noted in my field notes, for example, that she seemed a bit uncertain and embarrassed when she explained to me how she set up her individualized classroom math program (2/9/84 & 3/1/84). She was puzzled, too, about what to do with Jake because he was working at a pace that would enable him to finish the math book early, and she knew that the fifth-grade teachers would not want him to begin the fifth-grade textbook (Field notes, 2/9/84). In explaining to me why the Thursday group didn't get to run the state capitals program, she first said that she wasn't sure they could handle it, but later said that she just had not thought about letting them run it (Field notes, 5/10/84).

In explaining the Wednesday/Friday group, Mrs. Rosemont told me that they were the ones with more knowledge and confidence. In addition, she said, they were the students who had home computers and hence would best be able to profit from the experience (Interview, 5/5/84). Actually, 3 of the 9--Amelia, Cari and Jeremiah--did not have home computers. Seven of the students not included in this group did have them, so, obviously, computer ownership was not Mrs. Rosemont's primary criterion here. Furthermore, those most concerned about equity and computer use would have urged her to take the opposite approach--give extra computer time to those who do not have access to a computer at home (Levrat, 1984).

Mrs. Rosemont's students also had a difficult time explaining her decision to provide extra computer exposure for some students. Corina thought she and the others had been selected for the Wednesday/Friday sessions because they had finished their fraction problems earlier than the others (Interview, 5/24/84). When I first asked Melody, she suggested that they were chosen because they were faster in science and spelling; but, when I pressed her on it, she said, "They just, oh, um, they just get better grades" (Interview, 5/10/84).

From my interactions with the students, it became obvious that some of the other students would have liked to participate in these extra computer sessions. Dick was one of these. When I interviewed him and Herm in March, these sessions came up for discussion. Dick asked Herm about them:

Herm: I'm programming SPACE CHALLENGE and I never get time to program it.

Dick: What do you mean you're programming SPACE CHALLENGE? . . . I wanted to ask you something. How did you get into this computer stuff? Luck?

Herm: No . . . Mr. Peterson put me in it.

Dick: I'd like to try to get into this but I don't know how.

Herm: It's easy. All you have to do is play the games. All you have to do is play with the buttons.

Dick: No, I mean . . . (Interview, 3/6/84)

Similarly, when I discussed the Wednesday/Friday sessions with Melody, she made it clear that she would have liked to join them as well (Interview, 5/10/84). From my observations, I believe that Melody and Dick (and several other students) would have profited from being included in these sessions. One, in particular, that would have profited was Jack. He was the most prominent "computer freak" in Mrs. Rosemont's class. He often talked about computers, frequently defending them when others were critical (Field notes, 1/24/84, 1/26/84, 3/1/84, 3/20/84, 3/22/84 & 3/29/84). Jack's family had two computers at home, and his older brother, Bill, was a very creative amateur programmer. From what I could tell, though, Bill spent little time teaching Jack how to use the computers (Field notes, 8/11/84). As a student whose general motivation level was marginal, Jack might have been drawn more into his schoolwork if he had been invited into these Wednesday/Friday sessions. Dick's situation was very much like this also.

It is very easy for an observer to question Mrs. Rosemont's decisions about allocating computer time, but far more difficult to state exactly what she should have done instead. Should she have provided equal time for all or compensatory time for those who were less competent at using computers? If she chose the latter option, what activities should the less capable students have given up to make room for additional computer time? Was it more important for those students to get additional time with computers or additional time with Mrs. Rosemont working on math, science, spelling and social studies? These are not easy questions to answer, even from a distance. They are much less easy for a teacher who has to make them in the middle of a busy school year, on the fly, as it were.

Chapter Summary

In this chapter, I have identified four components of the hidden curriculum of computer use as it was practiced at Wolverine School in 1983-84. These four elements constituted aspects of computing that Mrs. Rosemont's students were apparently learning to accept as they did their lessons on the TRS-80s:

1. Computers encourage quantification.
2. Using computers entails a loss of privacy.
3. Work generated on a computer can be evanescent.
4. Access to computers is a privilege.

In my discussion of these four components, I have also shown that they represent adjustments that are not always easy for adults to make.

As a way of evaluating the impact of these four factors, it is important to place them in the context of the hidden curriculum taught generally in American schools. This perspective can be achieved by referring to Philip Jackson's brilliant little book, *Life in Classrooms*

(1968). There, Jackson summarizes the elementary schools' main lessons in three words: crowds, praise and power:

> Learning to live in a classroom involves, among other things, learning to live in a crowd. . . . Most of the things that are done in school are done with others, or at least in the presence of others, and this fact has profound implications for determining the quality of a student's life.
>
> Of equal importance is the fact that schools are basically evaluative settings. The very young student may be temporarily fooled by tests that are presented as games, but it doesn't take long before he begins to see through the subterfuge and comes to realize that school, after all, is a serious business. It is not only what you do there but what others think of what you do that is important. Adaptation to school life requires the student to become used to living under the constant condition of having his words and deeds evaluated by others.
>
> School is also a place in which the division between the weak and the powerful is clearly drawn. . . . Teachers are indeed more powerful than students, in the sense of having greater responsibility for giving shape to classroom events, and this sharp difference in authority is another feature of school life with which students must learn how to deal. (page 10)

To the extent that Jackson's analysis is correct, what it means is that the hidden curriculum of educational computing that I observed at Wolverine School goes hand in hand with the hidden curriculum of elementary education generally. You learn to live closely with others, to give up part of your privacy, and to accept continuous evaluations from your teachers, your classmates and others. In this case, though, the "others" category has come to include a computer. When working with a computer, your work will be evaluated, perhaps secretly, and you may not understand all of the numbers that it prints out. "What's new?" a precocious student might ask. "Have you even seen a student's file in the counselor's office?" Based on these judgements, the teacher will decide who gets to use the computers the most, and for what purposes. "Oh, just like reading groups, huh? Or who gets to go out for recess and who has to stay in for extra help?" Yes, and with the computers, your work will be so lightly valued that it will not last much beyond the time when you finish creating it. "Yes, like the piles of worksheets, essays and pictures that we threw away yesterday when the teacher made us clean out our tote trays."

Since a school's computer system is usually chosen by the administration and teachers to serve their purposes, it is understandable why that system would be consistent with the stated goals of the school. In this instance, it also seems that the system reinforces the unstated goals of the institution. What implications does this fact have for the views of computers developed by the students who work with them in elementary schools? Perhaps they learn to accept these uncomfortable aspects of computing more readily because they seem to fit so naturally into the school's environment. In 1984, the Goodlad study found that American students have learned to accept school quite passively, reacting to events with neither excitement nor outrage but reserving emotional reactions for other arenas. One of the main results of the introduction of computers into the schools may well be an inclusion of computers into this same category, painting them with the same passive colors, as it were. By the time these young people finish their schooling, perhaps they won't be able to become upset if the boss tracks their work output with management systems or their colleagues track their love lives by breaking into the electronic mail system. Perhaps they will see no problem with replacing tellers with electronic cash dispensers, books with data bases, friends with robots. For the children at Wolverine School and their peers elsewhere around the world, this may be the essence of being socialized into the electronic age.

CHAPTER X

CONCLUSIONS

This study began with some basic questions about computer education and a set of tools with which to answer them. These tools--the standard methods of educational ethnography--have enabled me to describe the way one teacher and her 26 students used computers and how they interacted with them. In my descriptions of the events that I observed, I have strived to convey the perspectives and feelings of these participants in order to record their experiences with the first phase of computerization of our country's schools. As a way of evaluating their efforts to make this adjustment a meaningful experience, it is appropriate to begin with their self-evaluations.

Evaluation of Computer Use at Wolverine School

From the superintendent on down to the students, almost all of my informants sensed that they were participants in a society-wide experiment. Mr. Hastings, the superintendent, summarized his view of this situation when I interviewed him in August of 1984:

> Roessler: When you look back at the start that you've made with computers and what you've done so far, . . . do you see any ways that you maybe should have done it differently or any opportunities that you've missed?
>
> Mr. H.: It seems to me that we get a lot of mileage out of a small investment and, uh, I don't think anybody, I don't think anybody had, uh, and I don't think people still have the answers about exactly what should be done. In fact, there even seems to me kind of a reverse trend that's in effect right now. Uh, the only thing is computer's are here and they're obviously here to

> stay, so we'd just better be familiar with them.
>
> Roessler: So you see everyone, both within the school and within the community, as kind of muddling through a situation where you know they're important but you're not quite sure what you should be doing with them?
>
> Mr. H.: We're floundering. We don't have . . . It was fashionable to get them and we got what we could, and I think we did probably pretty darn well from the standpoint of giving people exposure. We have a number of staff members that have a good background now and a lot of kids seem to pick up on them rather easily and they're accessible in the elementary buildings and they're accessible at the middle school and they're accessible at the high school and, you know, they've received education and they've received the opportunity, I guess, to sit down and play with them if they wanted to. That's essentially where we're at, the way I see it. There is no, there is no definitive, uh, game plan, though. And what our purpose and that sort of thing is and I don't think anybody could have given you at the time. I don't know if they still can but, uh, it's the fifth core subject. (Interview, 8/21/84)

These statements reveal considerable uncertainty on Mr. Hasting's part. This uncertainty can be seen reflected in many of the events described in the preceding chapters. Would a form-generating program be an appropriate use of the office computer? Should the school set aside money to buy a robot? How much emphasis should be put on the teaching of programming? Is the Big Trak a he, she or an it? These are questions that the members of the Wolverine School community were grappling with during the school year of 1983-84, along with all the other concerns created by the press of daily life. Mrs. Rosemont thought a great deal about the educational potential of computers, and she had definite ideas about how they should and should not be used. Nevertheless, she felt that the microcomputer revolution had not progressed to the point where it offered a superior method of teaching. Remember that she was the one who felt that the teachers were just "grasping at straws" until better software became available (Chapter

5). Mrs. Rosemont believed that Mr. Peterson had a vision of where the school was going with computers, but she sensed that most of the other teachers didn't share her faith that that vision even existed (Field notes, 2/16/84).

The review of the literature provided in Chapter 2 makes it understandable that these educational practitioners should have felt somewhat tentative about the integration of computers into their school system. Though 1983-84 may prove to have been the heyday of enthusiasm for computers in general and educational computing in particular, it was not a time when any consensus had been reached about the best uses of computers. The so-called experts were still debating the nature of "computer literacy," and most major educational publishers had not yet begun to develop software. A major obstacle then, as now, was a lack of standardization of hardware. It slowed the development of software and contributed to the growth of uncertainty on the part of those who shared the burden of selecting software for purchase. This problem was particularly troubling in Grantsville since Wolverine School used TRS-80's and Spartan School used Apples. Consequently, it was almost impossible for the two elementaries to share information about their software finds.

Most researchers and software developers would sympathize with the feelings of Mr. Hastings and his crew that they were adrift in a sea of educational experimentation. After all, the educational software currently available is commonly referred to in the literature as "primitive" or "nonintelligent," compared to what should be marketable within the next ten years (e.g., Bork, 1984; Hartley, 1980). The obstacle of the keyboard will be eliminated as developments in artificial intelligence enable computers to respond to natural language inputs. The math program of the future will feature a built-in tutor that will be able to respond to all sorts of student questions. These programs will also be able to analyze a student's special problems and learning styles and respond accordingly. To spark additional interest in the program, students will be able to choose from a number of personalities that the computerized tutor would take on during the course of the session: exacting, mellow, sarcastic, humorous or whatever. Prototypes of this kind of tutorial are already in the testing stages, although their dissemination will have to await the further extension of the microcomputers' memory capacity (Gaines & Shaw; 1983; Pask, 1969).

What Mrs. Rosemont and her colleagues had to work with was considerably more limited, to say the least. Wolverine School was in its first year of schoolwide use of the computers, and it was working with only $1,200 worth of instructional software. Not surprisingly, there were a number of shortcomings in the way the computers were being used there. Many teachers received only limited training on the computers and did not yet feel comfortable with them. As a consequence, they were willing to let Miss Serge determine what their students would do at the computers each week. This arrangement meant that there was limited coordination between the computer activities and the rest of the Wolverine curriculum. By taking a more active part in her students' computer activities, Mrs. Rosemont was able to avoid this situation, but even she was unable to achieve much coordination with the activities in the regular classroom. The school just did not own enough software to make this goal a reality. As a consequence, the students' activities at the computers always had a bit of a tacked on feeling about them.

Despite these limitations, it can be seen that a number of desirable outcomes resulted from the interactions between Mrs. Rosemont's students and the computers. These youngsters thought that they were learning from the computers and went to the lab with a businesslike attitude. They accepted the programs on their own terms and tried to learn from them, sometimes showing great enthusiasm for the results. For one student--Winnie--perhaps the most uplifting communique that she received at school all year came from a computer (Chapter 8). From the point of view of the students, probably the most important aspect of the computers was that they provided a break from the usual school routine of teacher-directed discussions and worksheets.

Despite these apparent successes, my analyses of events at Wolverine School have raised a number of troubling questions about the implications of using computers to educate elementary children. The most fundamental of these questions is what students learn about computers by interacting with them. This question and related ones can now be discussed from three perspectives: their implications for teaching, for curriculum and for research.

Implications for Teaching

At Wolverine School, as elsewhere, the assumption was made that the students would acquire computer literacy as a natural result of interacting with the computers. In Chapter 7, I have demonstrated that this assumption seemed justified in terms of the first meaning of computer literacy--that the students would become competent computer users. My analysis of the hidden curriculum of computer education, conveyed in the next two chapters, reveals a less happy result. As a consequence of trusting osmosis to deliver the appropriate educational messages, the school was teaching some concepts that, had they been fully articulated, might not have been acceptable to the staff. In particular, I believe that the Wolverine teachers would have been troubled to see the trust that Mrs. Rosemont's students put in the computers and their ability to teach them math (Chapter 8). In addition, by interacting with the computers, these students were learning to accept the loss of privacy and control that the electronic revolution is foisting upon our society (Chapter 9).

Fortunately, there were some countervailing tendencies to these negative outcomes. The first of these was the reactions of the students themselves. The vignettes and quotations in this report have shown that they did not blindly accept much of anything. They questioned many aspects of the computers' mode of operation, particularly their occasional tendencies to subject the students to tedious drills. Most students also resisted yielding control to the computers. They experimented widely and found unique ways to accomodate the machines to their own purposes. In so doing, they acquired some useful concepts about the nature of the computers and how best to operate them (Chapter 8).

The second major countervailing tendency was Mrs. Rosemont herself. She had a secure sense of the place of computers in education, and she avoided the traps that sometimes catch up the adults who teach with them. She rarely made any statement that personified or glorified the computers. Rather, she treated them casually and conveyed by her tone and actions the message that "Here is another of the tools that we can use to accomplish our main goal of education." Mrs. Rosemont was careful not to denigrate students for being slow to adjust to certain aspects of the computers. She used the information gathered by the math program in a thoughtful, non-threatening way. The fact that the students took their scores more seriously than her casualness seemed to justify indicates a real potential for the abuse of this function of the computers. It was not an abuse that Mrs. Rosemont ever committed.

Another lesson to be learned from Mrs. Rosemont's actions was her willingness to explore the new technology with her students. By running the same programs that they did and by writing some of her own little programs while they worked, she probably communicated more than she realized. More importantly, she occasionally initiated classroom discussions about the new technologies. As a sensitive teacher, she realized that her students' lives were permeated with different aspects of the electronic revolution, and she encouraged them to talk about them from time to time. They discussed robots and their likely impact on society, for example (Field notes, 2/16/84). Another day, she shared with the students a short spelling program that they could type into their computers at home (Interview, 8/8/84). Several of her students went home and tried it too. Terry even experimented with a way to add sound to it.

These discussions of computers and other technologies provide a valuable clue to improving the procedure for teaching with computers. In addition to the seven stages of computer use delineated in Chapter 6, Mrs. Rosemont's occasional discussions suggest an eighth one--debriefing. Media specialists have long maintained that the proper use of a film should involve a preliminary discussion and a post-discussion (e.g., Gerlach & Ely, 1971). Similarly, role play simulationists insist that a post-session debriefing is an essential component of simulation use (e.g., Elder, 1975). The events that I witnessed at Wolverine School suggest that working with computers can be a powerful emotional experience for students. In the 21 computer sessions that I observed, the emotions evoked ranged from the joy of a student reassured (Winnie's first experience with verbal reinforcements) to the pain of a student embarrassed (Samantha's feeling trapped in Lesson 5), from the pleasure of comradery in play to the isolation of individuals in put-down competitions, from the highs of creative flights to the lows of boring repetitions. Given the potential impact of these experiences on the lives of young people, it would seem important for a teacher to plan for at least a brief discussion after each class trip to the computers. If Mrs. Rosemont had allowed for such discussions, it would have enabled her students to clarify issues that were raised by their experiences with the computers:

> What do we have to do to get promoted in the math program?
>
> Why do the Tuesday and Thursday groups sometimes run different programs?
>
> How were the students chosen for participation in the extra computer sessions on Wednesdays and Fridays?
>
> What is the idea of the carry in multiplication?
>
> Why can't we save or print out our drawings?

There are other questions that might not have occured to the students that Mrs. Rosemont could have raised for discussion. Questions about privacy, for example. Or questions about the limitations of software and whether or not Jake was right in criticizing the program as he did (Chapter 8). These discussions would give teachers additional insights into (and control over) what their students were learning at the computers, dragging the hidden curriculum out of hiding, as it were. Mrs. Rosemont's students also could have profited from a discussion of how much they were learning from the computers. Drawing comparisons between the math program and their classroom math lessons would have been illuminating to them, and perhaps to Mrs. Rosemont as well.

Ideally, these topics of discussion should have been raised to coincide with incidents that had just occurred at the computer lab. Taking advantage of the serendipitous is, in the opinion of many educators, a prime tool of the successful teacher (e.g., Bolster, 1983; Herndon, 1968). Thus, right after Ed, Samantha and Jack had experienced their jealous contentions (Chapter 9) would have been a good time to talk about the limitations of personal measurements. Similarly, the session in which Jake loudly announced all five of Al's roasting before the flames of the dragon (Chapter 7) would have been a good time to discuss computers and their impact on the right to privacy.

In these ways, regular debriefing sessions could have provided valuable supplements to the computer experiences of Mrs. Rosemont's students. Like any other class activity, however, they would have taken away time from something else. The time limitations felt by a dedicated teacher suggest an alternative method of debriefing that Mrs. Rosemont, at times, used very well: one-on-one discussions in the computer lab. When a student was distressed like Bonnie was in the session described in Chapter 6, Mrs. Rosemont was sensitive enough to lavish time on her and help her work through the problem. Sometimes she missed these opportunities, however, because she felt pressured to use the time in the lab to explore new programs or to do her homework program for her community college class. Because computers can engage a class for extended periods of time, they create opportunities for teachers to work with their students on an individual or small-group basis. In those brief but valuable sessions, a large number of misperceptions and apprehensions can be handled. Furthermore, these exchanges can serve to give feedback to the teacher as to whether or not the computers are serving their intended purposes. As large computer labs become more common, these opportunities will become more widespread. Teachers would be better able to take advantage of them if administrators would heed their pleas for adequate time to explore the computers and the available programs before they are expected to begin teaching with them.

As this first part of the concluding chapter (and the rest of the report) reveal, if a "transparent" medium was ever invented, it wasn't the computer. Given the plethora of messages that the user receives from the educational computing experience, even while running a simple math program, teachers should take advantage of critical incidents and use them to draw out cognitive and affective lessons about computers and education. In addition to this strategy, it would be desirable to create some artificial incidents to stimulate the students thinking, particularly about the elements of the hidden curriculum discussed in Chapters 8 and 9. Suppose, for example, that Mrs. Rosemont had taken each group down for a complete session and had asked them not to speak a word for the entirety of the session. Wouldn't that have created an ideal situation for discussing the home work station and what may happen as more and more clerical workers are given the opportunity (or mandate) to work at home, alone, with a terminal? Or, suppose that she had made graphs of the students' progress on the math program and posted them on the wall. How would the students have reacted to that, and wouldn't that have created an ideal opportunity for them to discuss the use of computers to measure and compare worker outputs? A third possibility would have been to begin the year by having the students run the math program and not tell them anything about the management system and the RT code. Then after two or three sessions with that program, she could have surprised them by revealing how the computer had surreptitiously kept track of their accuracy and speed. Developing activities like these enables a teacher to elicit genuine emotional reactions that can be exploited for educational purposes. If done in an appropriate way and followed by a full debriefing, this strategy enables the teacher to take part of the hidden curriculum and move it effectively into the stated curriculum. We know that, sooner or later, our students will get experiences with computers. What many of them won't get, that schools need to provide, is a thoughtful and purposeful experience with computers.

Implications for Curriculum

During the 1983-84 school year, Mrs. Rosemont's students were given short, weekly experiences with the computers, using them for drill-and-practice and the exploration of various other computer activities (e.g., simulation, drawing and programming). One could hope that, from these computer sessions, they were learning in three major areas: math skills, general competence at running a computer (applications), and appropriate knowledge and attitudes about computers. Each of these uses was discussed in the literature review (Chapter 2), and it is now possible to reflect back on them in terms of the insights that can be drawn from the experiences of Mrs. Rosemont and her class.

Learning math.

Mr. Peterson's top priority for the computers was the first use--drilling math skills. For all the classes at Wolverine School, including Mrs. Rosemont's, the dominant computer activity was running the RADIO SHACK K-8 MATH PROGRAM. This study was not set up to measure the gains in math abilities that the students achieved with this program. The effectiveness of CAI has been well documented elsewhere. As reported in Chapter 6, however, my observations indicated that this program worked the way it was supposed to. The students were engaged by it; they were allowed to work at their own levels; and most of them were able to make orderly progress through the lessons. Mrs. Rosemont, herself, thought that this program had been effective for her students (Interview, 7/8/84).

In evaluating the overall effectiveness of this computer use, however, the observer has to wonder about the way it was (or was not) integrated into the curriculum. Except for the difficult chapters like the one on fractions, Mrs. Rosemont allowed her students to work through the math book at their own pace. They also worked through the math program at their own pace, but most of them were in different places in the two systems. Generally, the skills they were practicing on the computer were two or more chapters ahead of where they were in the math book (Interview, Mrs. Rosemont, 7/8/84). To my knowledge, Mrs. Rosemont never took this information to mean that a student should skip some chapters in the textbook. As it worked out, her students were being introduced to new concepts by plunging into them on the computer and figuring them out by trial-and-error and reliance on the cues from the flashing cursor. This meant that they were relying on a drill program as a tutorial, but what should Mrs. Rosemont have done to correct this situation? If the computer promoted students from lesson 14 to 17, she couldn't really tell them to go back to 14 until they had covered those problems in their math book. Mrs. Rosemont's solution was to let them go ahead and see what happened later.

At the end of the year, what did happen was that Mrs. Rosemont's students learned how to multiply multiple-digit numbers a bit quicker than had her previous classes, due to the computer program, or perhaps the extra emphasis she had put on learning the multiplication table, or perhaps because this was a brighter than average class (Interview, 7/8/84). Then the students went home for summer break and returned as fifth graders, beginning their math lessons right where they would have begun them anyway. They did use the K-8 MATH PROGRAM that year also, but I know that their fifth-grade teachers didn't use the knowledge of what lessons they had completed on the computer program because Mrs. Rosemont did not think that information was worthy of being recorded and passed on to them.

What this all means, I think, is that Mrs. Rosemont and the rest of Wolverine School failed to resolve the sticky issues of computers and individualization that Oettinger described back in 1969. As suggested by the Educaton Turnkey study (1985), these are issues that must be dealt with soon if schools are going to make CAI a successful experience. To the computers' credit, the elevation of this issue to a greater visibility may force educators to examine their curricula as they relate to this basic problem.

Computer applications.

Mr. Hastings, the superintendent; Mr. Peterson, the principal; and Mrs. Rosemont, the teacher, all assumed that their students were acquiring computer competence as a result of their interaction with the computers. The school had no stated objectives for this goal; it was just assumed that the students would learn what they needed by osmosis. This approach was in keeping with some of the literature reviewed in Chapter 2 of this thesis. To a surprising extent, it was an approach that worked. In Chapter 7 I have described in detail the level of competence that Mrs. Rosemont's students had achieved. By mid-May, even the slower students (the Thursday group) could readily handle the difficult situation of plunging into a new program in medias res. In that session and others, most of these students gave evidence that they could confidently explore a program and learn about its operation by doing so. These skills, of themselves, would be sufficient to meet the computer literacy demands of most jobs in our society (Goldstein & Fraser, 1985). The fact that fourth graders can acquire these capabilities with such a small amount of computer experience (and a minimum of explanation) indicates that this component of computer literacy can be taught largely by allowing periodic visits to the computer lab to run a variety of programs.

Though teaching by osmosis was sufficient to give Mrs. Rosemont's students a good background in computer applications, there were a number of gaps in their knowledge that careful planning could have eliminated. They were uncertain about specific aspects of the math program, for example, like how it timed them, how it determined promotions and what its error messages meant. If these phenomena had been explained to them, they could have understood the program better and learned more from it. Furthermore, they might have used that information to acquire a higher-order computer skill that they sought quite naturally--forming a mental model of the program that they were running (Gaines & Shaw, 1985; Sime & Coombs, 1983). Another key aspect of computer literacy that specific instruction might have given these students was a better understanding of the circles of applicability problem discussed in Chapter 7--the fact that the appropriateness of strategies varies from one machine to another and one program to another.

These limitations in the students' ability to understand and use the computers suggest two solutions. One would be the debriefing sessions and the planned-incident approach described in the first part of this chapter. The other would be to do as Luehrmann (1984) has suggested--build a one-semester computer course into the curriculum. Such a course would allow for focused instruction by a teacher who is more knowledgable about computers, and it would give the students considerably more computer contact time than Mrs. Rosemont's students received all year. This course would also allow an opportunity to introduce many computer applications that the learn-while-drilling approach would tend to neglect: word processing, data bases, computer graphics and telecommunications. Such a course could supplement the learning of computer competence that was occurring in the Wolverine computer lab. The Grantsville School District has experimented with such a course at grades 6, 8 and 9 and has yet to decide the best place for it. Perhaps it belongs in fourth or fifth grade while the students are still in the mastery phase described by Turkle (Chapter 2).

Appropriate knowledge and attitudes about computers.

Looking back on the events that I observed at Wolverine School and what my informants told me in interviews, I have come to the conclusion that acquiring appropriate knowledge and values about computers deserves more attention than it has received in the literature. In Chapter 2, I listed 10 major objectives of this area as identified by Sesow and Stricker. From my report, it is clear that working with the computers created many opportunities for the students to move toward some of these objectives: analyzing one's attitudes about using computers, understanding the potential impact of computers on oneself and one's society, analyzing the attitudes and values others place on computers and evaluating ethical questions related to computers. No one planned that these issues would arise, but they certainly did. Essentally, they constituted the hidden curriculum of computer use that I described in Chapters 8 and 9. These are important issues--probably too important, to be left to chance.

Actually, whether or not to drag these elements out of the hidden curriculum and insert them into the regular curriculum by means of discussions is really a political question. From the point of view of our society's managers (including Mr. Hastings and Mr. Peterson, perhaps), this hidden curriculum is fine and it should be left intact

(Andersen & Rasmussen, 1980). What is happening, from this perspective, is that these students are being socialized into the information age. They are learning to accept the loss of privacy, the evanescence of data and the increase in managerial control that accompany the computerization of society. If they can learn to live with these inconveniences when they are young, they will not be disturbed when they encounter them as adult workers, consumers and citizens. This persective is logically correct and perfectly acceptable if one assumes that the direction technology is carrying us in is both good and inevitable. From my recommendations in the first part of this chapter, I have revealed that this is not an assumption that I am prepared to make. Just in the short history of the microcomputer revolution, it can be seen that the availability of a technology and the general acceptance thereof are distinct. Consider, for example, the apparent widespread spurning of the use of home computers as educators (Sanger, 1985; Snider, 1987) or the (at least temporary) rejection of teletext systems in the United States (Strout, 1987). Besides, reading the futurists' descriptions of our possible futures is a frightful experience. Many of them see a deeply divided society with high structural unemployment and with major decision-making turned over to computers (Dede, 1987; Frude, 1983; Nowotny, 1982). There are alternative courses, however, and if one of them is to be followed by our democracy, it will likely result from citizen understanding and involvement (Andersen & Rasmussen, 1980; Dede, 1987; Smith, 1985). Consequently, it would seem desirable to make our young people more aware of the influences of the new technologies. This goal was largely ignored at Wolverine School but, as I have shown, it could have been taught quite effectively as an integral part of the computer program there. If it is going to be taught well, though, it will have to be done consciously. To put the students on the machines and to let them learn what they learn is to yield unthinkingly to the new technology and its imperatives.

Implications for Research

In terms of what this study implies for the body of research on computer education, it is a reinforcement of the work of Hess and Tenezakis (1970) and of Turkle (1984). As these scholars have argued, there are "socioaffective outcomes" of using computers and these should command our attention.

Socioaffective outcomes reconsidered.

Like Hess and Tenezakis's Chicano students, Mrs. Rosemont's students did accept the computers' authority and put too much faith in their teaching abilities (Chapter 8). Is this true of other groups as well? When young people move into and beyond high school, do they outgrow this attitude? If so, what attitude replaces it? Does educational computing combine with television watching to reinforce the idea that truth is something which emerges from a cathode-ray tube? If so, what is the best way for the schools to counter this tendency? These are critical questions emerging from my study.

A related set of questions arises out of Mr. Hastings and Mr. Peterson's desires to use the computers to manage instruction. If schools use computers increasingly as a way of tracking instructional progress, what effects will this practice have on schools and on the students themselves? Will the level of learning increase? Will there be an increased emphasis on those skills which can be quantified and measured on the computer? Will the computers lose the second half of the work/play image that they now have with the students?

Many of the vignettes reported in this study reveal what Turkle maintained in *The Second Self* (1984)--that computers and electronic toys are powerful media that elicit strong emotional reactions from young people. The reactions of these fourth graders were evident even though they showed themselves to be in Turkle's middle phase of child-computer relationships--the mastery phase. They didn't openly philosophize about the computers, but does that mean that they were oblivious to these issues or just shy about discussing them? What results would occur if a teacher did as I have suggested and put these issues on the table for her fourth-graders to discuss? Given that most students will probably pass through this mastery phase in fourth and fifth grades, what are the optimal lessons about computers to teach them at that level?

Equity.

The other major research area spoken to by this report is the question of equity--who learns what from interacting with computers and with what degree of differentiation? As described in Chapter 9, Mrs. Rosemont fell into the trap of providing richer and more extensive computer experiences to the "better" students in her class. The resulting differences did not seem to be sufficient to cause a significant loss of computer skills for the other students (except for Winnie). Nevertheless, in making these decisions, Mrs. Rosemont may have missed some opportunities to use the computers as a bridge to keep some of her weaker students from drifting away from the schools. In the same way that extra computer time seemed to keep Herm from becoming alienated from the school; Doris, Brett, Dick and Jack might have been so influenced. Fourth grade is a time when many students begin turning off to school (Torrance, 1963), and so this opportunity may have opened up at a critical time for these students.

This possibility suggests that school computers and other electronic media could potentially solve more equity problems than they create. According to Willis et al. (1985), students become alienated from education because they are products of the visually-oriented electronic age while the schools (and most teachers) are products of the age of print. These differences explain a large number of the delinquency and drop-out problems that schools experience. Surely there are ways that the new technologies--themselves products of the electronic age--could be used to bridge this gap, particularly as Willis et al. argue, if schools would be willing to restructure themselves. This restructuring, of course, should include a solution to the individualization problem. The question is, how can this goal best be accomplished?

My research suggests that, as the less capable students could find their needs better served by the computer revolution, so could another disadantaged segment of the student population--the girls. In this report, I have treated sex equity only briefly because handling it properly would require a second report of equal length to this one. I hope eventually to accomplish this task by coupling my data from the 1983-84 school year with follow-up data gathered as these students pass through the Grantsville Middle School. Many of the girls in Mrs. Rosemont's class received almost all the advantages possible in their computer education. They were placed in the Tuesday (higher) group; they got to go to the computers on Wednesdays and Fridays for special sessions; and they had two strong, computer-using women as role models--Mrs. Rosemont and Miss Serge. Nevertheless, it was apparent that the computers did not work emotionally for them as well as they did for the boys. The reasons, it seems, emanated from the differences in the boys' and girls' subcultures. The boys' world revolved largely around action-oriented movies and television shows, and the computers fit right into that world. The imaginary names that they used at the computers and the games of exploration that they played there made that clear. The girls, on the other hand, were more socially-oriented. Their involvement with the mass media revolved around popular music and family-oriented television shows. At times, they tried to use the computers as a bridge between education and their private worlds, by carrying a stuffed animal to the lab and placing it on the monitor or by typing a letter to Michael Jackson into the keyboard. But, given the configuraton of hardware and software used in the Wolverine lab, these attempts generally failed. The stuffed animal seemed unwelcome on the cold, steel-gray monitor (Field notes, 4/17/84), and the letter to Michael couldn't be printed because the school's only printer was hooked up to the staffs' computer (Interview, 5/24/84).

These differences suggest that computers could be used to lessen the normal drift of girls away from science, math and technology, but the question is, how? The answer, I think, lies in the minds of fourth-grade girls and the confidences that they exchange during lunchtime and recess. Somehow, the presentation of the machines has to be changed in way that is more consistent with their subculture. The use of simulations, writing programs and more subtle, socially-oriented software would seem to be part of this solution.

Chapter Summary

During times of rapid change, people and institutions are forced to make adjustments in their values and actions. Schools are given the double burden of absorbing those changes and, at the same time, teaching their students how to cope with them. As this report documents, the microcomputer revolution has pushed yet another of these double responsibilities upon the schools. It came at a time when schools were already coping with similar shocks generated by the changing American family and the declining American economy. Happily, the microcomputer revolution bears many opportunities along with its responsibilities. If schools can master the best and most appropriate uses of microcomputers, then they will have a powerful new tool for educating students. By using school computers in a well-prepared context, students can sharpen their basic skills and, simultaneously, begin confronting the information revolution and how it is changing our lives.

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