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Teacher discourse and cultural amplification in technology-saturated schools

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in Technology-Saturated Schools

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ABSTRACT

TEACHER DISCOURSE AND CULTURAL AMPLIFICATION
IN TECHNOLOGY-SATURATED SCHOOLS

by Kenneth E. Shears

This study investigates the cultural dimensions of technology-saturated learning environments at two California Model Technology Schools. Interviews and observations were utilized to identify dominant assumptions and rationalities regarding the educational use of new technologies guiding teacher discourse and amplified in the learning culture.

The findings revealed an underlying conceptual framework orienting participants' understandings of the nature and value of technology in education. For example, teacher discourse exposed common beliefs that technological development is inevitable and technology a neutral, value-free tool. New technologies were valued as a means to promote general "technological awareness" and increase communication of and access to information. Observations of technology-intensive classrooms suggest four areas of cultural amplification: (a) technicist-modernist conceptions of education and a standardization of instructional practice, (b) "information-processing" models of learning and cognition, (c) instrumental thinking and technical skill mastery, and (d) technology-mediated forms of experience and interaction.

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Lastly, I would like to dedicate this work to my wife Jette and my two daughters Helen and Esther, whose sacrifice and love made it all possible.

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A Personal Reflection

During my first year as a high school history teacher I spent a lot of time thinking about how great it would be to have computers and other new technology in my classroom. It was 1989 and I was frustrated, as many teachers are these days, in my attempts to generate some interest and enthusiasm for learning in my students. I knew that the "sage-on-the-stage," "stand-and-deliver," "drill-and-practice" models of instruction were a dead-end. In technology I saw a way to motivate my students and also to make it possible for them to have a more meaningful learning experience.

When the director of curriculum and instruction for the school district asked me to help write a technology grant for the social science department, I jumped at the chance. Weeks later word came that we were awarded the grant. I was elated! Soon, I was busy ordering computers, laserdisc players, software, and miscellaneous other high-technology gadgets (including a hand-held remote for controlling the computer) that I deeply believed would make me a better teacher and my classroom a more exciting place for students. When the shipment first arrived from Apple Computer that next fall, I could barely contain myself. I even earned the scorn of the school's maintenance supervisor when I prematurely distributed the equipment before he had a chance to "I.D." them.

During the next four years I worked diligently to make my dream of a technology-enhanced curriculum a reality. And it happened! It was slow at first. In the beginning I only had one computer for my room and a limited amount of software. I used the computer and a liquid-crystal-display system to project notes and instructions. I designed classroom activities around computer-based simulations. Eventually, as other teachers "donated" their unused computers and our department purchased a few more, I was able to pull together several "Macs" for a permanent mini-lab in my classroom. By my fourth year, my history curriculum had been radically transformed into a project-oriented, technology-enriched, and more active-learning experience. In an article for a "computing-educator" newsletter I wrote:

> The other day I caught a glimpse of how computers are truly revolutionizing teaching and learning; you know, like the advertisements say.
>
> My principal strolled into my sixth-period U.S. History class and dropped her jaw. The classroom was a quiet buzz of activity: some students clustered around computers; others worked independently at their seats writing or reading; a few were heading off towards the library to do some research; some just simply sat and discussed what they were working on; classical music played in the background. I surveyed the situation from the corner of the room and noticed that few students were aware that the principal had just walked in.
>
> "Wow!", she said. "This is great!"
>
> I went on to explain to her that teams of students were in the process of designing and producing their own multimedia "histories" of the Progressive Movement. She left a few minutes later saying "It's exciting to see this kind of involvement and motivation. Keep up the good work!!" I smiled nonchalantly, but inside I was ecstatic. Someone finally noticed that this computer stuff really does work!! (Shears, 1993, p. 1)

As I experienced what I thought to be a revolution in learning within my own classroom, I became an outspoken advocate for technology in the classroom. My district designated me as "technology-mentor" and I soon found myself setting up computer labs, training teachers, and developing "technology-enhanced" curriculum. I was known at my school as one of the "technology gurus" who was on the "cutting-edge."

My experience in trying to spread enthusiasm for technology to my colleagues, however, was often a frustrating and dispiriting experience. I encountered various forms of resistance: technophobia, logistical problems, allegiance to obsolete ideas about teaching, and just plain sloth. One teacher continually amazed me with his ability to forget how to set up and turn on his computer. Along the way I also discovered the obvious truth that teachers can use technology in meaningless and inappropriate ways as well as good. I even began to resent teachers who I believed were misusing the equipment, like one of my colleagues who had his students spend precious classroom time typing their homework on the computers set-up in the back of his room.

In addition to all of this, I became aware of something even more curious and interesting about technology in the classroom. As my teaching became more technology-intensive, I noticed other aspects of classroom life were changing along with the learning activities. For instance, I was now interacting with students more often, one-on-one, and more as partners than adversaries. I also saw how the technology altered the physical arrangement of the classroom, how it became less clear where the "front" and the "back" were. As I listened to myself and my students talk, I noticed that even language was changing, as words like "mouse," "stack," "scan," "button," and "script" took on new meanings and importance. In other words, I began to see that while I was focusing on how I would use technology to help my students learn, technology was reshaping the physical, social, and mental environment of my classroom.

Eventually I began to wonder if, in fact, technology could be influencing the way my colleagues and I thought about the core ideas of our profession, like what it means to teach and learn. In the spring of 1993 I arranged a meeting for social science teachers in our district to share ideas about how technology could be used to improve the social science curriculum and instruction. I remember, in particular, one history teacher who was enthusiastically describing an elaborate student project he had designed. Students used technology, he explained, to gather historical "data" and "compile" it in large binders filled with charts, graphs, primary source documents, and other "information." Proudly, he passed some of these binders around. His colleagues were impressed. I recall one teacher exclaiming "Wow, look at all that stuff!"

As I thought about this meeting later it occurred to me that, at least among the group of teachers I was working with, getting students to process and memorize mounds of "stuff" (i.e., data, information, facts) was considered to be the essence of teaching history. Realizing that many history teachers, with or without technology, get caught up in this line of thinking, I still wondered if maybe there was something about technology itself that somehow reinforces this view. In other words, I wondered if perhaps technology, *because of what it is,* encourages a particular epistemological orientation.

These ideas about technology in education (i.e., that technology can alter social interactions, language, even our ideas about knowledge and thinking) intrigued me enough that I decided to spend some time reading about them. Whenever I read an educator's perspective on technology, however, it focused on how technology affected student test scores or "attitudes" about the content. I did find a few books, usually written by philosophers and social critics, that helped to expand my understanding of the nature of technology and the cultural experience. The ideas I found in those books have greatly influenced the discussion that follows.

I began this introduction by describing some of the excitement and enthusiasm that I felt for technology in education. I still feel that many good things can come from integrating computers and other technology into the classroom experience. Through the course of this investigation, however, I have become convinced that educators must take a hard look at what technology brings to the classroom, beyond the obvious effects on test scores or technical skills. As Davy (1985) has stated, "tools create a culture of tool-users," and I believe a major issue facing education today is in understanding the cultural dimensions of technology.

Background

Over the years new technologies have been embraced by schools on promises of "revolutionizing" education. From blackboards to film projectors to VCRs, new artifacts of learning have been installed in classrooms amid much fanfare and optimism. Consider, for example, the following claim written in 1932 about a new technology introduced to schools:

> The central and dominant aim of education by radio is to bring the world to the classroom, to make universally available the services of the finest teachers, the inspiration of the greatest leaders . . . and unfolding world events which through the radio may come as a vibrant and challenging textbook on the air. (Cuban, 1986, p. 19)

It has now been more than ten years since another technology, the personal computer, began appearing in significant numbers in classrooms across America. Like new technologies that came before, computers have been hailed as the most radical innovation in education since Guttenberg's printing press (Bork, 1979). Grandiose claims of the computer's potential to transform education have proven to be a temptation that few politicians and school officials have been able to resist. Consequently, billions of dollars have been invested in bringing the classroom into the "computer age" (The Heller Report on Educational Technology, 1993). During the 1980s, the number of computers in American schools swelled from fewer than 50,000 to roughly 2.4 million (Becker, 1991). The Office of Technology Assessment estimated in 1988 that 95% of American schools had one or more classroom computers (United States Congress, Office of Technology Assessment, 1988).

The current push to equip schools with new interactive technologies can thus be seen as a continuation of a historical pattern in the field of education (Cuban, 1986). It must also be understood in a broader cultural context. Many contemporary scholars and social critics, including Mander (1991), Marx (1987), Postman (1992), and Winner (1986) have argued convincingly that we live in a society that tends to glorify technology, equating technological development with general progress. Such a mindset can be traced to the emergence of the modern, scientific worldview and the embracing of a positivistic philosophy in areas of human and social development. In the field of education this positivistic orientation has been the basis of nearly all major reforms in this century, including the earliest efforts to develop a "science" of learning and a "technology" of teaching (Skinner, 1968). With history as a guide, it would be reasonable to expect teachers, administrators, and the general public to continue to seek a "technological-fix" to educational problems. Witness the recent educational restructuring movement, which features technology as a cornerstone upon which a new, more effective, more competitive school system will be built (Collins, 1991; Sheingold, 1991).

Technology in education, therefore, is not a new issue. Questions regarding what we do with technology in education, and more importantly, *what technology does with us*, however, are perhaps two of the most significant questions of our age.

With regard to the first question, educational researchers have already given considerable attention to the task of determining which application of computer technology holds the key to increased skill-mastery, fact-retention, or "critical thinking" (Scott, Cole, & Engel, 1992). A multitude of technology-use models have been tested for various outcomes at different grade-levels. All the while, new "cutting-edge," "state-of-the-art" developments in educational technology are touted in the latest issues of professional journals and magazines. A recent issue of Electronic Learning, for instance, features a multi-page "Guide to Multimedia" that includes newly-released-product lists, buyers' tips, and flashy advertisements for the latest "learning systems" (Bruder, 1991).

Unfortunately, the question of what technology does with us (how it shapes our experience and thought, our way of looking at the world) has been largely ignored by the educational community and society at large. As educators and researchers scramble to find and implement the best technological solutions for their educational needs, disturbingly few pause to critically consider the underlying assumptions and cultural implications of a "high technology" curriculum. While many attempt to measure the effects of technology on student outcomes, few question the rationalities and assumptions (about learning, knowledge, and culture) that technology fosters in the classroom.

Bowers (1988, 1993a) and others have noted this "tunnel vision" that has limited research and discourse illuminating the field of educational computing. Sloan (1985) summed up the dominant response to the idea of high-technology schooling in this way:

> American educators have made no concerted effort to ask at what level, for what purposes, and in what ways the computer is educationally appropriate and inappropriate, in what ways and to whom we can count on its being beneficial or harmful. The overall picture has been one, instead, of educators vying to outdo one another in thinking of new ways to use the computer in all manners and at every level of education possible. (p. 1)

To further illustrate this point, in a recent compilation of 111 articles in Canning and Finkel's The Technology Age Classroom (1992) a critical analysis of fundamental beliefs driving current efforts to restructure schools with technology is virtually absent. In chapter four, entitled "Technology Use Issues for the Teacher," topics include how to use Integrated Learning Systems, how to advocate and fund technology programs at the district level, how to train faculty in the use of technology, and how to teach elementary students keyboarding. In other words, the primary issues facing technology-using educators, according to the editors, are questions of *how* best to implement and support computerized learning. Questions about whether or not computers *ought* to be used, or about the ideological and cultural implications of technology-mediated learning, are ignored.

This lack of critical questioning about the appropriateness of technology in education, coupled with an overriding emphasis on technical, "how to" questions in the literature, underscores the degree to which a technocratic mindset dominates the field (Apple 1986; Bowers, 1988; Sloan, 1985). This mindset is expressed in the assumptions that technological advances are central to educational progress, and that new technologies must be exploited to bring education into the 21st century. As a result of this uncritical stance towards technology, there has been an undervaluing of the need to understand the philosophical and ideological dimensions of educational computing, or, as Maddux (1988) argued, a neglect in developing an axiology of educational computing.

Focus of Inquiry

The intent of this study is *not* to assess the effectiveness of new technologies as tools for learning, but to better understand the phenomenon of computer technology in schools and how the use of such technology alters the symbolic-cultural dimensions of the classroom and school. In one sense, this study seeks to uncover the "hidden curriculum" (the set of guiding metaphors and assumptions) that is transmitted through what Postman (1989, 1992) has called the "technological thought-world of computers." In the field of education, the technological thought-world, or what Habermas (1972) described as *technocratic rationalities*, has dominated the discourse that guides policymaking and teacher practices since early in this century.

Generally speaking, this investigation seeks to understand how new information technologies, properly understood as culturally-biased and non-neutral, influence the complex patterns of language, thought, and social interactions that comprise classroom culture. By examining technology-mediated learning, not in isolation or abstracted from context, but as embedded in a broader cultural ecology, a more grounded, comprehensive portrait of technology in education will be unveiled. This portrait will attempt to capture the subtle ways in which technology shapes the ideological and epistemological landscape of the learning culture.

More specifically, this investigation will focus on the experiences and perspectives of teachers at two Model Technology Schools in California.[1] How those teachers bring their experiences and perspectives to language as they talk about technology and teaching will be the primary basis for understanding how technology may be influencing the cultural-transmission process in these unique, technology-saturated contexts. Through an analysis of the teacher discourse generated through conversations, the guiding metaphors and theoretical biases that frame participant's understandings of their experiences will be identified. The identification of these assumptions about the nature of technology and the

[1] The California Model Technology Schools (MTS) program began in 1987 with legislation that provided approximately a half million dollars per year for each of six demonstration sites throughout California. A more complete description of the MTS program and the specific research context will be presented in Chapter Four.

educational process will then serve as a starting point for analysis of the technology-language-culture dynamic occurring at these schools.

Theoretical Perspectives

Orienting this inquiry is the notion that technology is not a neutral tool, but a force that shapes language, thought and culture (Bowers, 1988; Mander, 1991; Postman, 1992). In this sense, technology is not "value-free," rather, it amplifies or reduces certain aspects of human experience, certain forms of expression and understanding (Ihde, 1979). Technology itself, therefore, carries a particular ideological bias. As the role of technology expands in society, technology increasingly mediates and transforms the nature of human experiences. Thus, the task of discerning the influences of technology on social institutions and national life become all the more urgent.

For the purposes of this study, the word technology is to be understood in two ways. From a practical standpoint, the generic use of the term "technology" by the participants in this study most often refers to the new generation of computers and computer-based information and communication tools (i.e., CD-ROM, laserdisc, telecommunications). However, the concept of technology itself can be approached from a more theoretical perspective as any human system, technique, or tool used to satisfy ends, or, stated another way, the organization of knowledge for practical purposes (Mesthene, 1993). Technology can also be understood in terms of Ellul's (1964) *la technique*, the "totality of methods rationally arrived at" (quoted in Winner, 1977, p. 9). These broader definitions allow us to view technology as more than mere tools and machines (i.e., a computer), but also as rationalities and cultural patterns that such tools and machines embody (i.e., what "kind of thinking" is represented in a computer). The task of assessing the impact of technology is therefore expanded beyond a simplistic framework of isolated causes and effects. Rather, as Strain and Goldberg (1987) have suggested, technology and culture must be treated as "mutually determining," multi-dimensional variables that vary "simultaneously and in subtly interconnected ways" (p. 7). In the midst of this complexity, this study follows a framework for understanding technology in education that recognizes the complex relationships between the uses of technology, the rationalities embedded in the technology, and the way technology alters or reframes language and thought patterns.

From this perspective, language becomes a focal point for understanding the subtle ways in which technology mediates and shapes classroom culture. Language, itself a technology, is not just a conduit for transmission of ideas, but an ever-changing interpretive framework (schema) that generates meaning (Bowers & Flinders, 1990). Words spoken in a classroom, therefore, not only transmit information but shape and direct the formation of ideas and beliefs that constitute one's worldview. Wittgenstein claimed that language is "our most fundamental technology. . . not merely a vehicle of thought but also the driver" (quoted in Postman, 1992, p. 14). In this sense, language is constitutive, shaping the preunderstandings that guide our interpretations of experience. Language, like other technologies, is not neutral, but becomes our "conceptual guidance system" (Mueller, 1973). This guidance system plays a primary role in influencing the patterns of social interaction, communication, perceptions, and ideas that become the classroom culture (Bowers & Flinders, 1990).

The concept of classroom culture can be understood as a complex "ecology" of communication processes and cultural patterns (Bowers & Flinders, 1990). Traditional models of classroom interaction have tended towards a "management" approach, where complex dynamics are reduced to observable indicators, stimulus-response patterns, and decontextualized behaviors (Hunter, 1982; Skinner, 1968; Tyler, 1950). This overtly technicist[2] perspective on learning and instruction has led to an oversimplified, one-dimensional view of a highly complex environment (Apple, 1986; Bowers & Flinders, 1990; Freire, 1970; Giroux, 1988). Understanding the influence of computer technology in education requires a more comprehensive, holistic model that recognizes the interconnectedness of language, thought and culture.

Research Questions

As part of a growing effort to tell the story of *what technology does to education* while educators go about the business of using technology, this study examines what scholars have identified as the cultural, ideological, and epistemological dimensions of educational technology and how they manifest themselves in the ecology of the technology-saturated learning environment. Specifically, in combining document analysis, observations, and interviews with teachers at two California Model Technology Schools, this study endeavors to answer the following research questions about technology use in education:

> RQ1: What are the dominant assumptions and theoretical orientations regarding the nature and role of technology in education contained in the teacher discourse at two Model Technology Schools?
>
> RQ2: How are these assumptions manifested in the cultural-transmission process occurring within the broader ecology of the Model Technology School?

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2 Throughout this paper, the term "technicist" is used to describe the general influence of Cartesianism and positivism in the field of education. Bowers and Flinders (1990) used the label "technicist" to denote the "growing importance given to reducing every aspect of experience, including the dynamics of the classroom, to technique that can be rationally formulated for the purpose of improving prediction, control, and efficiency" (p. 5).

These questions and the research described in this document are intended to provide another perspective on the topic of classroom computing, one that is concerned about the subtle changes that occur when technology, language, and culture interact in a specific context. That context, the Model Technology School classroom, is a complex ecology of thought and relationships and, therefore, a rich source of insights for understanding the nature of technology in education. In the next chapter, a review of relevant literature will provide a historical and theoretical frame for the study.

CHAPTER TWO: A CULTURAL-HISTORICAL PERSPECTIVE ON EDUCATIONAL COMPUTING

> Man, like an ant, is quite simple.
>
> Herbert Simon, computer scientist
> (cited in Weizenbaum, 1976, p. 260.)

> We are at the onset of a major revolution in education . . . . The computer will be the instrument of this revolution . . . By the year 2000 the major way of learning at all levels, and in almost all subject areas will be through the interactive use of computers.
>
> Alfred Bork, physicist
> (1979, p. 5)

The cover of a recent issue of a popular education magazine asks "Can technology improve student learning?" This question, and variations of it, has taken a prominent place in the discourse of educational policy in America. Reformers, researchers, administrators, and teachers have focused their attention on the new information and communications technologies and the role they can play in bringing about greater student learning.

The nature of the question itself reveals fundamental assumptions about how our culture views technology, progress, and the process of learning. These assumptions have influenced the evolution of educational computing and have manifested themselves in the public discourse about the role of technology in education.

That the question "Can technology improve student learning?" is still being asked is quite remarkable given the number of times it has been answered in the affirmative over the years. Educators at the turn of the century dreamed of new machines that would revolutionize learning in the same way they had revolutionized the production and distribution of material goods. The history of technological innovation applied to educational settings since then is a testament to the social belief that technology would work a miracle in schools. As a result of this belief, many of our schools and classrooms are now equipped with highly sophisticated "learning tools."

In the sections that follow, a cultural-historical perspective for understanding educational computing will be presented. This historical situating of the topic will provide a necessary basis for an analysis of recent trends related to technology use in education. In addition, the findings of a pilot study that analyzed California policies regarding the classroom use of new technologies will be summarized. Lastly, a brief overview of related research on "technology-saturated" classrooms will be presented.

Science and the Modern Vision of Progress

What do Descartes, Galileo, and Newton have to do with educational computing in the 1990s? Perhaps more than one would think. Apple (1990), Bowers (1988, 1993a), Doll (1993), Robins and Webster (1989) and other scholars have concluded that the cultural and historical forces that created our technological and educational systems provide a necessary perspective for understanding those systems and the rationalities and assumptions embedded in them.

The worldview that has highly influenced the way educators now think about knowledge, learning, and technology can be traced to what scholars have called a megaparadigm shift that started during the Renaissance and came to fruition during The Enlightenment (Bowers, 1988, 1993a; Doll, 1993). The Scientific Revolution, spawned in part by the thinking of Descartes, Galileo, and Newton created a new cosmology that situated the Earth as a cog in a vast, mechanized universe and placed man as the measure of all things. This shift in perception radically influenced the epistemological underpinnings of the emerging culture. The Cartesian-Newtonian paradigm became the perceptual lens through which all experience was now viewed (Capra, 1982). This new, "scientific" way of looking at things was grounded in basic assumptions about truth, knowledge, nature, and humanity: (a) Truth is arrived at through a systematic method of thinking; (b) knowledge exists outside of and separate from the knower; (c) truth is discovered (objectively), not created (subjectively); (d) nature can be explained in terms of mathematical, cause-effect equations; and (e) mathematical principles (Laws) discovered in nature can be applied universally (Capra, 1982; Doll, 1992). These assumptions make up the bedrock of the modern worldview. The history of the growth of scientific knowledge and the apparent success of scientific inquiry in uncovering universal principles governing the natural world came to be regarded as proof of the supremacy of modernity.

With each new scientific breakthrough, and (often) subsequent technological innovation, humanity extended its control over the natural world. Investigations into the nature of vacuums contributed to the invention of the light bulb. The study of magnetism yielded the principles used in constructing electric generators (Burke, 1978). The modern vision of progress cast science and technology in the leading roles of a perpetual drama in which the betterment of humankind was assured through rational investigation and technical breakthrough. According to Winner (1977), the belief in the inevitability of human progress through science and technology led Francis Bacon to declare mankind's "noble ambition:" to "establish and extend power and dominion of the human race itself over the universe" (quoted in Winner, p. 22) . With the development of new household conveniences, instruments of war, and medical treatments, faith in science spread beyond the scientific community to society at large.

In time, the methods and rationalities of physical science were adopted by a new breed of philosophers who were concerned with social development. According to Bowers (1993a), Doll (1993), Postman (1992) and others, these founding fathers of "social engineering" and the philosophy of positivism, men like Auguste Comte and Claude-Henri de Saint-Simon, sought to develop a social science that would employ scientific methods to discover the "truths" by which to guide the social world. They imagined that society could be perfected through rational, systematic, efficient planning based, not on moral wisdom or religious precepts, but on technical expertise possessed by the scientific and industrial elite. Thus, social progress was reformulated to be dependent upon what Schön (1983) has called "technocratic rationality," the "instrumental problem solving made rigorous by the application of scientific theory and technique" (p. 21).

The assumptions behind the technocratic utopianism of Comte and Saint-Simon are based upon a mentality that has elevated a narrow and distorted conception of science to the source of all legitimate knowledge. Habermas (1970), Postman (1992) and others have persuasively argued that this misapplication of scientific methodology and technocratic values to social concerns resulted in a form of scientism that has remained a dominant ideology of the Western world. This deification of science is expressed in a collective faith in the infallibility of scientific method and a reliance on scientific and technical experts to discover knowledge in all domains for the benefit and use of humankind.

This naive belief in the "ideal of science" rests on three interrelated ideas summarized by Postman (1992): (a) The methods of a natural science can be applied to the study of human behavior, (b) social science generates principles that can be used to organize society on a rational and humane basis (which implies the application of techniques to control human behavior), and (c) faith in science can serve as a comprehensive belief system that gives meaning to life. The influence of scientism in the development of Western institutions, including public education, must be explored in order to fully understand how technology came to be used in educational settings.

Scientific Management in Education

The success of the scientific model in explaining the workings of the physical world was a source of great inspiration to nearly all who beheld it. It was especially inspirational for Frederick Taylor, who wondered if scientific principles could be applied to the problem of producing pig-iron. In 1911 he observed that if a more systematic approach was applied to the managing of labor and resources, there would be a corresponding increase in efficiency and output (Boorstin, 1974). Taylor's philosophy of task management centered on a few key tenets, among them: (a) There is always one best method for doing any particular job and this method can only be determined through scientific study; (b) the best method necessarily involves a systematizing, standardizing, and quantifying of the process under question; and (c) the best method is the one that is most efficient (productive) and yields the most uniform results (Boorstin, 1974; Callahan, 1962).

The success of Taylor's "Principles of Scientific Management" in industry created a tremendous wave of enthusiasm for the "gospel of efficiency" in other areas of life as well (Boorstin, 1974; Gilbreth & Carey, 1948). Callahan (1962) recounted that Taylor himself claimed his method could be applied to all institutions with equally beneficial results. During the years of the Progressive Movement, industrial success and practices were elevated as models to emulate wherever possible. Reformers battling waste and corruption in local government were attracted to scientific management and its rational, systematic, and "objective" approach to solving problems (Haber, 1964). By the mid-1920s, Taylorism had become a way of life as corporations, government agencies, churches, even families sought to ferret out the evils of inefficiency and uncertainty and usher in a more orderly, productive, and ultimately prosperous way of life.

Of course, the American education system was not immune to this new national obsession. During the early years of this century, the public school system was coming under increasing criticism and public scrutiny. Muckraking articles claiming to have uncovered tremendous waste, corruption, and ineffectiveness in the nation's school system began appearing in popular journals. An editorial in a 1912 issue of the Ladies' Home Journal, entitled "The Case of Seventeen Million Children -- Is Our Public-School System Proving an Utter Failure?," attacked the "low productivity" of American education (cited in Callahan, 1962). The author argued that in spite of massive public investment in education, drop-out and illiteracy rates remained high . Other critics of the school system questioned a traditional emphasis on the liberal arts and "scholasticism" and called for a more practical, utilitarian curriculum (Kliebard, 1986).

As criticism of American schools reached a fever pitch in the early-1910s, educators began to respond to public demands for better management and more efficiency. An early example of the influence of Taylorism and the industrial model in education occurred in New York City schools in 1911. There, a well-known "efficiency expert," Harrington Emerson, advised the teacher's association to incorporate the four "essential elements" of scientific management into education: (a) definite and clear educational goals, (b) an organization capable of attaining the goals, (c) equipment adequate to achieve the goals, and (c) "a strong executive who can carry them out" (Callahan, 1962, p. 56). As Callahan reports, by 1912, "evidence of the increasing impact of the public criticism of the schools and growing influence of business and industry upon all aspects of education was abundant" (p. 58-59). This influence generally took the form of increased use of business-like organization, time schedules, record-keeping, cost-cutting techniques, labor-saving devices, and standardized instruction and evaluation.

The mania for quantifying and systematizing the educational process in the name of efficiency rapidly took on absurd dimensions. Soon, students, teachers, even entire schools were subjected to a barrage of "efficiency tests," productivity "rating sheets," and financial surveys. An influential administrator even developed a system to measure education in "relative values" so as to render it more manageable. He proposed that:

> 5.9 pupil-recitations in Greek are of the same value as 23.8 pupil-recitations in French; that 12 pupil recitations in science are equivalent in value to 19.2 pupil-recitations in English; and that it takes 41.7 pupil-recitations in vocal music to equal the value of 13.9 pupil-recitations in art. (Callahan, 1962, p. 73)

This valuing scheme enabled him to conclude that "we ought to purchase no more Greek instruction at the rate of 5.9 pupil-recitations for a dollar. The price must go down, or we shall invest in something else" (p. 73). One wonders if perhaps this educator was indeed a frustrated Wall Street trader.

Many scholars have argued that this impulse to "scientifically" manage schooling has dominated the educational vision throughout this century (Apple, 1986, 1990; Bowers & Flinders, 1990; Doll, 1993; Giroux, 1988). Earlier countermovements to this trend, such as the child-centered, humanist, and progressive agendas, ultimately "succumbed to the allure of this 'scientific' framework . . . with its emphasis on control through standardization and progress through efficiency" (Doll, p. 51). As a result, the assumptions of the modern ideal of technocratic, utilitarian progress have been the primary force behind some of the most influential educational programs of this century, including "scientific curriculum-making" in the 1920s, Tyler's "Principles of Curriculum and Instruction" in the 1950s, "behavioral objectives" in the 1960s, "competency-based curriculum" in the 1970s, and "outcome-based" and "mastery" learning in the 1980s and 1990s (Bowers & Flinders, 1990; Doll, 1993; Kliebard, 1986).

Many educational historians have stressed how the "Age of Efficiency" brought on by Taylorism shaped education in America. The point to emphasize here is that the push to "scientifically" manage the public school system did not emerge in an historical vacuum but was in fact another manifestation of the modern worldview that took root during the seventeenth century and blossomed in the Industrial Revolution. That worldview privileged scientific models of inquiry and knowing, regarded knowledge as objective and existing separate from the knower, and emphasized the abilities of humankind to measure, manipulate, and control processes of the natural and social world. The Industrial Revolution, as "the concrete embodiment of the modern vision," became the source of new, powerful metaphors that shaped the language and culture of American institutions (Doll, 1993, p. 39). The result of this vision, as many scholars have argued, was the development of an educational model based, by and large, on an industrial factory system (Apple, 1986, 1990; Doll, 1993). Cubberley (1916) reflected this mindset when he wrote "Our schools are, in a sense, factories in which the raw products (children) are to be shaped and fashioned into products to meet the various demands of life" (quoted in Doll, 1993, p. 47). During this time, the classroom increasingly came to be viewed as a kind of assembly-line where the raw material (students) interacted with various production techniques (the curriculum) to be transformed into the finished product (an educated person). In this way, educational issues were seen as essentially "management" problems that required scientific and technical solutions. Thus, the dual concerns of efficiency and utility began to dominate educational discourse (Apple, 1990; Doll, 1993; Kliebard, 1986). This discourse has persisted throughout this century and has greatly influenced the way new educational technologies have been conceptualized and appropriated by schools (Bowers, 1988).

Behaviorism and the Technology of Teaching

Just as scientific management grew out of a desire to duplicate the successes of the natural sciences in the social, political, and economic spheres, a new science of the mind was being developed that promised to unlock the mysteries of the human intellect. Early cognitive and behavioral theorists, in the tradition of the positivism of Comte and Saint-Simon, sought to construct a general theory of human behavior that could be used to control and predict learning processes (Steinberg, 1980). Similarly, instructional theorists, inspired by the scientific model, embarked on a quest to discover a science of teaching guided by immutable laws.

Saettler (1968) claimed that the idea of a universal method (technology) of instruction can be traced at least as far back as Johann Amos Comenius' (1592-1670) Great Didactic which introduced his idea of *pansophia*, a "system of universal knowledge in which a methodological procedure could be applied to all problems of mankind" (quoted in Saettler, 1968, p. 21). The application of Comenius' method consisted of the systematic teaching of knowledge and assumed that "instructional process had to be analyzed and improved inductively, according to science" (p. 21). Although the work of Comenius had limited influence in his day, he represents an early example of the general trend towards developing systematic, linear instructional methods based on standardized rules and learning theory, a trend that continued in the work of Friedrich Froebel, Johann Friedrich Herbart, and Joseph Lancaster, to name but a few.

Meanwhile, the fields of cognitive science and educational psychology were emerging from the work of Kurt Lewin, John Watson, and the enormously influential E. L. Thorndike. According to Saettler (1968), Thorndike, in his quest to develop a "rational science of learning," proposed several laws as a basis for developing a technology of instruction, one of which was: *The law of exercize or repetition* which stated that the more times a stimulus-induced response is repeated, the longer it will be retained (Saettler, p. 50). The work of Lewin, in particular, is especially useful in illustrating the extent to which the reductionism and mechanism of the Cartesian paradigm influenced the development of a theoretical framework for cognition and learning. Lewin endeavored to construct a behavioral theory that could be expressed in a mathematical model representing broad concepts to be universally applied. The result was a formula that Saettler expresses as B = *f*(P,E): "Behavior depends on the interaction of the Person and Environment within a psychological field, or life space" (p. 69).

The focus on human behavior by these modernist educational theorists reflects the assumptions of the Cartesian-Newtonian worldview, described above, that reduces reality to observable (and therefore measurable) phenomenon. Since the only reliable source of knowledge within this paradigm is that which can be empirically studied and experimentally verified, a science of learning must focus on external behavior and not on the unobservable activity of the mind. The systematic study of human behavior must ultimately lead to, according the Newtonian model, the discovery of universal laws of learning that would guide educational practice (Doll, 1993).

The tradition of radical behaviorism, behaviorism as a social and intellectual movement destined to solve social problems through the application of technological systems, is most often linked with the work of B.F. Skinner, arguably one of the most influential educators in recent times (Prilleltensky, 1992). Skinner, building on the ideas of Thorndike and Watson, proposed a "technology of teaching" based on the principles of "operant conditioning" (Skinner, 1953, 1968). He argued that learning, properly understood as "behavioral changes," could be effectively controlled through a carefully planned system of reinforcing sequences. Believing that the learning processes of rats, pigeons, and children are guided by the same underlying principles, Skinner concluded that the "behavior of the individual organism [can] be brought under precise control [through] designing techniques which manipulate reinforcement with considerable precision" (1968, p. 14). Doll (1993), Steinberg (1980) and others have argued that Skinner's theory of instruction reflects a fundamental assumption that learning can be described in mechanistic, cause-and-effect terms and that instruction, therefore, can be designed as a systematic, linear (technological) system.

With a growing cultural emphasis on applying what were perceived as "scientific" methods of efficiency, standardization, and quantification to general social concerns, and the parallel development of a behavioral psychology dominated by mechanistic models of learning, interest in applying technological solutions in education grew. The concept of "instructional technology" conceived in the minds of early instructional theorists came to fruition during the Communication Revolution that occurred in late nineteenth and early twentieth-century.

The Technological School

As Cuban (1986) and others have documented, the story of American education in this century is largely one of how the use of new machines has been promoted in "the insistent quest for increased productivity and efficiency" in schools (p. 3). Starting with the audio-visual instruction movement that became popular in the years after World War I, new information technologies were seen as not only a means of making learning less abstract and more experiential, but more technologically up-to-date and therefore cost-effective (Callahan, 1962). For educational administrators concerned with maintaining the image of the modern, efficient, technically-sophisticated school, the appeal of the new technologies as symbols of modernization was especially powerful. As the new technologies of film, radio, and television were introduced into American society, an influential coalition of manufacturers, school administrators, and reformers quickly promoted their educational uses (Cuban, 1986). A new class of experts in the instructional use of technology, the "educational technologists," were christened and given the charge of leading American schools into the Industrial Age.

An analysis of the history of educational uses of film, radio, and television reveals the extent to which the related themes of scientific management and behaviorism have influenced the way teachers and administrators view the role of technology in schools. Cuban (1986) found that early efforts to place new communications technologies in the hands of teachers, lauded by many progressive educators seeking alternatives to traditional rote instruction, were nonetheless "anchored in the enthusiasm for scientific management" that characterized the times (p. 11). As a result, instructional film was promoted as a means of communicating "every branch of human knowledge" in "far less instructional time" (p. 11). Later, radio, marketed for education as "textbooks of the air," appeared to magically transport knowledge with amazing efficiency. In the 1950s, advocates of instructional television envisioned replacing textbooks and other "conventional methods of instruction" (i.e., teachers) with more cost-effective "telecasts" (p. 33).

As indicated, the dream of revolutionizing education with machines was based on a technocratic ideology inspired by the successes of industrialization. New technologies were viewed primarily as a means of making learning more efficient, productive, predictable, and standardized. The idea of developing a "teaching machine" that could be programmed to deliver a series of stimulus-response cycles, therefore, was especially attractive to a growing number of behaviorists, technologists, and school administrators. According to Saettler (1968), the development of the first teaching machines was grounded in a Skinnerian theory of instruction and guided by the belief that "the most efficient control of human learning requires instrumental aid and that steps should be taken to rectify the shortcomings of traditional instructional practice by developing a scientific technology of instruction" (p. 72). An analysis of Saettler's statement, and the metaphorical language it contains, clearly reveals behaviorist and technicist assumptions driving the development of educational technologies in America. Here, the learning process is to be "efficiently controlled" through the use of "scientific technology." One is unlikely to find a more succinct statement reflecting the ideology of control and manipulation that has so greatly influenced educational theory in this century.

The earliest efforts to mechanize classroom instruction took place long before the advent of the modern, electronic computer. In the 1920s, Sidney Pressey, a psychologist at Ohio State University, conceptualized and developed a teaching machine that would "automatically" administer classroom exams (Willis, Johnson, & Dixon, 1983; Skinner, 1986). Pressey's machine would provide immediate, "right/wrong" feedback to students as they pushed buttons corresponding to multiple choice answers on test items. In spite of the efforts of Pressey and other pioneers of automated teaching, these early forms of mechanized instruction were not widely accepted, in part because of the relatively lower costs of other new communications technologies (i.e., film and radio) then available to schools (Cuban, 1986).

In the 1950s, B. F. Skinner contributed to the development of a new generation of more sophisticated, yet still essentially mechanical, instructional technologies. Skinner introduced his first teaching machine in 1954, and within four years he had developed a "self-instruction" lab at Harvard where several machines were programmed to "teach" his natural science class. Interest in automated instruction grew, but Skinner found there were several barriers to the widespread application of teaching machines in public schools, not the least of which were the prohibitive costs associated with program development and equipment acquisition (Cuban, 1986).

During this time, programmed instruction *without machines* offered a less costly alternative to Skinner's vision of mechanized instruction. Employing the Skinnerian technique of breaking down the learning process into discrete, observable behaviors, programmed texts containing many carefully sequenced "frames" (units of information-plus-questions) were presented to students in various curricular contexts (Calvin, 1969). While it is generally acknowledged that programmed instruction enjoyed only brief popularity, the assumptions about learning and knowledge that it embodied lived on in the educational community (Osguthorpe & Zhou, 1989). As we shall see, the spirit of programmed instruction was reborn with the development of the first programmable electronic computer.

The general cultural-historical trends outlined thus far offer an important perspective for understanding the dominant rationalities and assumptions influencing the use of educational technology in America. The dual forces of scientific management and behaviorism in educational thought provided the theoretical and conceptual backdrop to the development of early teaching machines and more recent instructional technologies like Computer-Aided Instruction systems.

Computer-Aided Instruction and the Computer Literacy Movement

The first attempts to transfer electronic computer technology (initially developed for military training) to educational settings occurred at large universities during the late 1950s and early 1960s. In 1959, for example, the University of Illinois developed a computer-based learning system called PLATO

(Merrill, et al., 1986). Although the technology was very expensive and clumsy by today's standards, the project grew over the years and became probably the best-known computer-instruction center in the world at the time. It was not until the late 1970s and early 1980s, when further technical breakthroughs led to the development of relatively inexpensive desktop computers, that computer technology began to appear in schools on a significant scale (Cuban, 1986).

By the mid-1970s, Computer-Aided Instruction (CAI) had become an educational movement in its own right (Price, 1989). Led by an influential group of educators, computer scientists, and cognitive theorists, and fueled by technical innovations and a growing social awareness and interest in computers, CAI promised to fulfill Pressey's and Skinner's dreams of a "technology of teaching." At times during the early days of CAI the promise reached grandiose proportions. "We are at the onset of a major revolution in education," proclaimed Bork (1979),

> . . . a revolution unparalleled since the invention of the printing press. The computer will be the instrument of this revolution . . . By the year 2000 the major way of learning at all levels, and in almost all subject areas will be through the interactive use of computers. (p. 5)

Similar statements, reflecting the technological optimism of the times, abound in the early literature on CAI.

In spite of the initial enthusiasm surrounding the potential for CAI to revolutionize K-12 education, actual implementation occurred at a snail's pace. As Price (1989) and others have noted, substantial economic barriers prevented the wide-spread implementation of CAI during the period from 1965 - 1975. The early excitement about the potential of computers as an instructional device was eventually tempered by a recognition of the difficulty and expense involved in developing quality CAI programs. A study by Bukoski and Korotkin (as cited in

Price, 1989) revealed just how limited the influence of CAI was during the 1970s. In 1975, the median number of students in computer-using schools was about 1,350, while the median number of terminals available was two. Classes in mathematics and computer science accounted for almost all this use. While PLATO and a few other mainframe-based systems continued to develop on a limited scale, educators and administrators began to explore other uses of computers.

During this time, the concept of Computer-Managed Instruction (CMI) emerged on the educational scene. CMI focused on the capabilities of computers to assist in administrative and management tasks associated with classroom teaching such as recordkeeping, test generating, test scoring, and student diagnosis (Merrill, et al., 1986; Willis, Johnson, & Dixon, 1983). In the spirit of the "efficiency-experts" of the 1920s, a contemporary description of CMI emphasizes the value of automated management: "Good instructional management decisions are based on accurate and up-to-date information on the performance and progress of each student. CMI applications can be used to gather, store, retrieve, analyze, and report such information" (Merrill, et al., 1986, p. 214).
By 1970, about 31% of nation's secondary schools were making administrative use of computers, while only 13% used computers in instruction (Price, 1989). Again, one can see that, as was the case with CAI, the use of computers in CMI was inspired by the alluring dream of automation and efficiency in education.

It is briefly noted here that a significant amount of research has challenged the assumptions, effectiveness, and implications of CAI in education. For example, Becker (1987) concluded in his analysis of the "best evidence" regarding the effectiveness of computer-aided instruction that "together [the findings] do not come close to providing prescriptive data for deciding whether and how to use computers as adjuncts for instruction" (p. 23). Other scholars have criticized CAI on pedagogical grounds, citing the tendency of CAI systems to reduce learning to mechanical, drill-and-practice models (Dreyfus & Dreyfus, 1985; Scott, Cole, & Engel, 1992). Simpson (1985) has argued "CAI programs tend to encourage the convergent, atomistic view of education that is characteristic of some conventional teaching," where knowledge is represented as a body of decontextualized, objective "facts" to be memorized (p. 86). Other researchers have contended that CAI applications reinforce broader social and economic inequities (Scott, Cole, & Engel, 1992). Ascher (1984) cited a study by Watt that concluded that students in less-affluent, inner-city schools are more likely to receive computer-assisted instruction (drill-and-practice), therefore learning "to do what the computer tells them," while students at wealthier, suburban schools learn "to tell the computer what to do."

With CAI in public schooling amounting to nothing much more than a couple of computers gathering dust in the mathematics and science departments of some well-to-do schools, by 1980 it appeared that the computer revolution in education had stalled. In the early 1980s, however, several factors converged to breath new life into the educational-computing movement (Cuban, 1986). Technical innovations, particularly in the area of miniaturization, and an increasingly competitive market accelerated the trend towards declining relative costs of hardware. For example, in 1982, a popular Tandy 33 megabyte hard disk system sold for $14,980.00. Today, external hard drive systems that have *five times* the amount of storage capacity as the early Tandy system sell for around $200.00 (Yeaman, 1991). Coupled with this, the development of more "user-friendly" operating systems and interfaces designed to make computing more palatable to the "common person" (Apple's introduction of the Macintosh computer in 1984 being the most notable example), and a concurrent boom in educational software development and marketing, further attracted administrators and teachers looking for the latest high-technology solutions (Cuban, 1986).

In addition to these trends in high-technology industries, long-standing concern about the health of the nation's public school system suddenly exploded into a near panic. In the early 1980s, a series of documents reporting on the status of education in America, most notably the influential A Nation At Risk report, sent shock waves through the educational community. Warning that "a rising tide of mediocrity" was undermining the public school system and threatening "our very future as a Nation," A Nation At Risk became the bugle call for the educational "excellence" movement of the 1980s (National Commission on Excellence in Education, 1983). Sprinkled with cold war metaphors ("We have . . . been committing an act of unthinking, unilateral educational disarmament" - p. 23), and linking declining United States industrial productivity to a failing educational system, A Nation At Risk called for increased academic requirements, more rigorous standardized testing, and more curricular emphasis on scientific and technical literacy. It is significant to note that A Nation At Risk was the first document of its kind that proposed computer literacy as a component of a comprehensive curriculum and as a requirement for educational progress (Scott, Cole, & Engel, 1992).

Responding to both favorable trends in technological development and a the intensifying cry for technical literacy, reformers and technologists began reasserting the argument for computers in schools. Various reform proposals and educational think-tanks recommended computer science as a "new basic" that should take its rightful place in the standard high school curriculum

(Griesemer & Butler, 1985). In addition, many states, including California, began to mandate some form of computer literacy requirement for prospective teachers. The term "computer literacy," originally coined by John Nevison at Dartmouth College in the 1970s, began to be invoked with great regularity as the new focus and rationale for computer technology in education (Scott, Cole, & Engel, 1992).

During this early phase of the computer-literacy movement, students were mainly taught *about* the computer and the principles of programming (Roszak, 1986; Scott, Cole, & Engel, 1992). In the early 1980s, a survey conducted by the Center for Social Organization of Schools revealed that the most frequent use of microcomputers at both elementary and secondary levels was in developing computer literacy, then defined as introducing students to computers as an object to be studied from a scientific and technical standpoint (Merrill, et al., 1986).

The arguments put forth for educational computing during this period tended to revolve around a few popular themes. Often, computer studies was linked to the perceived need to promote scientific and technical education for national security and economic interests. For example, Deringer and Molnar (1982) stated that,

> Due to the decline in national productivity, the increase in foreign trade competition, and national defense and safety needs, computers have emerged as the major force for ameliorating these conditions. Consequently, the shortage of computer specialists and knowledge workers has raised the problem of computer literacy to the level of a national crisis. (p. 4)

Others argued that computer literacy was a new requirement for the increasingly technological workplace. According to Pogrow (1983),

> We no longer have an industrial economy; it is now an information economy . . . the percentage of the labor force employed in manufacturing will continue to decline now that we have become an information . . . economy. Blue- and white-collar work is going to shift away from literal

> or repetitive tasks toward more flexible and logical interactions with electronic forms of information and information workers. (p. 53-54)

An alternative perspective promoted the universal cognitive benefits of computer programming as a means for improving student intellectual performance and self-esteem. For example, Papert (1980) argued,

> The child programs the computer. And in teaching the computer how to think, children embark on an exploration about how they themselves think . . . Thinking about thinking turns the child into an epistemologist, an experience not even shared by most adults. (p. 19)

Perhaps the most common argument put forth in favor of computer literacy in the curriculum is the somewhat nebulous explanation that the world was entering a new "age" that required new sets of life skills. For example, Hay (1985) proposed that,

> We are in a decade of change, one that will take us from the industrial age to the age of information. As a result, all institutions are changing to adjust to this new era . . . We in education should recognize that what is basic to kids today has already expanded beyond the three Rs. (p. 220)

Critics of the computer literacy movement point to a number of flaws in the conceptual rationales and practical implementations of computer literacy programs (Mangan, 1992; Noble, 1985; Olson, 1987). Roszak (1986) has exposed the "wave of commercial opportunism" that has accompanied calls for computer literacy. Citing corporate campaigns for "a computer on every desk," he raised concerns about the aura of hucksterism that has surrounded the latest frenzy to upgrade schools with computers. Shapiro (1985) and others have argued convincingly that the job market of the "Information Age" is not creating highly skilled, information-based, technical jobs to the degree that the proponents of high-technology schooling would have us believe. Rather, a strong case has been made that with the advent of the so-called "smart machine" in the workplace, technical literacy needs will decline as workers are relegated to the more mundane tasks of turning the computers on and off. A report by Levin and Rumberger (as cited in Mander, 1985) stated:

> The evidence suggests that high tech is not the place where most new jobs will be found, nor will high tech require a vast upgrading of the skills of the American labor force. To the contrary . . . the proliferation of high technology industries is far more likely to reduce the skill requirements for jobs in the U.S. economy than to upgrade them (thereby lowering wages). (p. 15-16)

Researchers have also raised questions about the implications of unequal access to computer technology based on socio-economic barriers. Computers are an expensive technology that, in spite of government and industry efforts, have not been equally distributed between wealthy and poorer communities (Ascher, 1984; Piller, 1992). Other studies have noted varying computer-use patterns between socio-economic groups, even among schools with similar resources, which suggests that "computer literacy" comes to mean different things for different students. For instance, Cole and Griffin (1987) reported cases where poor and wealthy schools had relatively equal numbers of computers but poor children spent their time on drill-and-practice exercises while economically well-off students spent their time on more meaningful technology-based activities.

In summary, an analysis of the cultural-historical context of the emergence of CAI in the 1960s and 1970s and the computer literacy movement of the early 1980s further reveals the degree to which a technocratic ideology has shaped the educational development and use of computer technology. Many scholars have concurred with this analysis, including Apple (1986), Bowers (1988, 1993a), Hlynka & Yeaman (1992), Postman (1992, 1994), and Roszak (1986). The first electronic computers were valued by the educational community primarily in terms of their potential to automate and standardize instruction (Cuban, 1986). Often, these goals have been camouflaged with claims about how computers could make learning more "individualized" and "interactive." In reality, CAI systems, recently repackaged as Integrated Learning Systems (ILS), have almost exclusively taken the form of mind-numbing drill-and-practice programs that emphasize rote-learning and basic-skill acquisition (Scott, Cole, & Engel, 1992). Likewise, the computer literacy movement was heavily influenced by the beliefs that the problems of education are fundamentally technological ones, that more technical literacy will be required of tomorrow's workers and citizens, and that formal-operational problem-solving associated with computer programming represents the highest level of human cognition and knowledge.

Technology and the Educational Restructuring Movement

By the late 1980s, the failures of the "excellence" movement renewed the debate about educational reform in America. Claiming that the reforms implemented were either misdirected or not radical enough, many educators and reformers began to reframe the discussion of educational improvement towards the need for more systemic change. As we shall see, the discourse on the role of technology in education was both reframed by and influenced the new agenda of restructuring the public school.

The educational reform movement of the early 1980s was characterized primarily by a call for a return to "basics" and an increased focus on traditional educational benchmarks (i.e., academic requirements, classroom hours per year, standardized testing, etc.). However, by the late 1980s it had become clear to many that the results of the excellence movement were mixed at best. Critics argued that the problems facing public schools were so deep and complex that they could not be fixed by "tinkering" around the edges of the educational system. Echoing the alarmist calls for reform that instigated the excellence movement earlier in the decade, Reigeluth (1987) warned:

> As we enter deeper into a highly technological, rapidly changing, information-oriented society, the present structure of our educational system will become more and more inadequate! With our entire nation still at risk, we are forced to reevaluate and restructure the entire way schools operate, the approaches we use in teaching, and the way students learn. (quoted in Bagley & Hunter, 1992, p. 22)

As this quote suggests, advocates of educational restructuring at this time believed that unless the system changed in profound and fundamental ways, efforts aimed at improving schools and learning would ultimately fail. Arguing that radical change called for a basic questioning of the traditional assumptions about instructional practices and the curriculum, Sheingold (1991) stated "the goals [of restructuring] rest on a quite different model of what teaching and learning should be about. Effective learning hinges on the active engagement of students in constructing their own knowledge and understanding" (p. 18-19).

As evidenced in the quote above, the restructuring movement has been heavily influenced by constructivist learning theory. In general terms, constructivism is the belief that knowledge is "personally constructed from internal representations by individuals using their experiences as a foundation" (Jonassen, 1990, p. 32). Among educational reformers, constructivism has come to be loosely associated with "active-learning," "student-centered," and "project-based" approaches to curriculum and instruction.

Educational technologists and reform-minded computer enthusiasts have been quick to jump on the constructivist bandwagon. Recent literature in the field of educational technology has revealed a growing interest in reformulating the link between technology and learning based on constructivist theory (Bagley & Hunter, 1992; Strommen & Lincoln, 1992). For example, Jonassen (1990) called for a "constructivist approach to IST [instructional systems technologies]" and argued that "database, hypertext, and expert systems" should function as "mindtools" to help learners "construct knowledge, that is, to think more productively" (p. 34).

With the recent shift in the reform agenda to school restructuring and constructivist models of instruction, both reformers and educational technologists have once again forged an alliance that is committed to maintaining the central role of technology in educational change (David, 1991; Peck & Dorricott, 1994). Just as educational computing enthusiasts promoted technological literacy as a necessary ingredient for reform in the early 1980s, many are now arguing that school restructuring will be incomplete without a technological upgrading of the school system (Ahearn, 1991; Collins, 1991). For example, Sheingold (1991) argued:

> [R]estructuring will not succeed unless its ambitious goals for student accomplishment and for radical approaches to reorganizing the educational enterprise are met with equally ambitious and radical approaches to altering learning and teaching in the classroom . . . [I]t is unlikely that these ambitious goals for learning and teaching can be met on a large scale *without* widespread, creative, and well-integrated uses of many technologies. (p. 27)

Computers and other new information technologies (i.e., CD-ROM, Laserdisc, telecommunications networking) are now seen as vital catalysts in the process of change, a disturbing element that will force teachers and students to reconsider what it means to teach and learn. David (1991) explained that "technology can invite change by signaling the need for change and by compelling organizational and instructional changes in the classroom" (p. 78).

Another feature of the current restructuring-with-technology movement has been the emergence of "computer saturation" experiments in the school and classroom environment. Scott, Cole, & Engel (1992) have reported that these programs are driven by the belief that the full benefits of computerization cannot be evaluated without some "utopian" experiments that give students and teachers access to technology on a mass scale (i.e., one computer per child at school and home). One of the more notable examples of a saturation experiment is the Apple Classroom of Tomorrow (ACOT) project. (Findings from ACOT research will be presented later in this chapter.)

Apple's ACOT program and other public and private saturation initiatives have been driven by a number of assumptions. For example, it was assumed that a "critical mass" of technology (i.e., a more favorable computer-student ratio) was necessary in order to validate cause-effect impact studies. Also, it was believed that to the degree the students possessed a "proprietary" relationship with the technology (i.e., a sense of ownership) they would gain an increased sense of control over their learning situation and that this would lead to increased student performance. Furthermore, saturation experiments like ACOT assume that a "catalyst effect" will take place when a critical mass of technology occurs in a classroom. That is, it was believed that the mere presence of new technology would "refocus the instructional process toward the development of higher order thinking skills, problem solving, and thematic- and project-oriented approaches to the study of various subject" (Scott, Cole, & Engel, 1992, p. 223).

In spite of this belief that the new generation of computer technology is inherently equipped to usher in a new age of "active" and "student-centered" learning, a closer examination of the recent discourse on technology in education reveals many of the same assumptions and rationales that drove earlier efforts to enhance learning through the use of "teaching machines." A recent analysis of various state and local policy statements about the role and use of technology in secondary social science instruction in California public schools has found that technicist assumptions about learning and teaching continue to inform current policy initiatives (Shears, 1994). This analysis of the "official discourse" of educational computing, which was conducted as a pilot study for this investigation, will be summarized briefly below.

Pilot Study: An Analysis of Recent Policy Statements on the Role of Technology in Schools

As part of an investigation into the nature of the official discourse on technology in the social science curriculum, several documents were analyzed to identify both explicit and implicit assumptions regarding the value and role of technology in education (see Chapter Four for a more detailed description of the methodology of the pilot study). Specifically, texts were analyzed in relation to three thematic categories: (a) explicit statements about the role of technology in education and rationales for use in the social science classroom, (b) explicit statements about recommended uses and models for integration of technology into the social science classroom, and (c) implicit assumptions and theoretical biases that guide the discourse and policymaking of technology use in social science education.

One purpose of this study was to assess the institutional vision of technology use in California schools and the underlying assumptions about technology and education guiding that vision. To simplify the reporting of this investigation, a brief summary of the dominant rationales, roles, and examples of use contained in the texts will be presented.

Rationales for Technology Use in the Classroom

Four dominant rationales for furnishing social science classrooms with computers and other new information technologies emerged in the documents. These rationales will be presented in the following sections.

New Technologies are Effective Tools for Delivering Content

Numerous statements in the documents reviewed cited the "attention-grabbing" way that technology can "deliver" course content to students. For example, California's Technology in the Curriculum: History-Social Science Resource Guide explained that "[Technology can] increase learner's attentiveness to the content being delivered" (Far West Laboratory for Educational Research and Development, 1986, preface) and "can present . . . historic events in ways that capture and hold the attention of students" (p. 14). Also, computer technology was viewed as a valuable instructional "delivery system" because of its information storage and retrieval capabilities. "The storage capacity . . . of the microcomputer make it a powerful tool for delivering content," reported the curriculum guide (preface). It was also noted that "[computers provide] access to data bases that consist of various classroom resource materials" (p. 15).

The ease and efficiency with which technology can be used to store, retrieve, and deliver information was emphasized in many of the documents reviewed. For example, the California Master Plan for Educational Technology (1992) enthusiastically predicted

> . . . long-term increases in the productivity of learners and faculty through effective instructional delivery. Further cost savings should be realized through economies of scale brought about by consolidation of resources and increased numbers of users of the technologies. (California Planning Commission for Educational Technology, p. 8)

The use of industrial metaphors and concepts (i.e., "productivity," "delivery," "cost savings," "economies of scale," "consolidation") in this statement on the educational uses of new technologies is striking.

Because instruction was framed primarily as the "delivery" of information, the Strategic Plan for Information Technology (1991) promoted technology as a "partial solution to the teacher shortage" (Advisory Committee on Information Technology, p. 7). Presumably, the architects of the policies recommended in these documents believe that computers can be programmed to deliver the "knowledge" directly to students, bypassing the need for teachers.

The Need for Technological Literacy

The belief that student exposure to hi-technology is necessary for developing "technological literacy" was also emphasized in the discourse. In Building the Future: K-12 Network Technology Planning Guide (1994), this technological literacy was seen as a requirement for the economic survival of the individual, as well as a necessity to "ensure that California is a leader in the global economy of the 21st century" (K-12 Network Planning Unit, Educational Technology Office, p. ix). Another document claimed that a technology-based education is crucial for "preparing the next generation of workers to take their place in the information society" (Advisory Committee on Information Technology, 1991, forward). In addition to this emphasis on developing workplace skills, it was argued that technology should be included in the curriculum because students live in a technological society. A high-technology classroom, therefore, will "provide students with experiences in the world of technology" (p. 3) and help "California's students become consumers and [sic] technology" (forward).

Technology is an Interactive Instructional Tool

Several of the documents reviewed identified the interactive nature of computer technology as a rationale for promoting its use in the classroom. For example, one document argued that "technology is involving" and that students get "drawn into decisionmaking . . . and [can] play with if-then statements, examine cause and effect, compare, and contrast" (Far West Laboratory for Educational Research and Development, 1986, p. 12). In Second to None: A

Vision of the New California High School (1992) it was suggested that with technology, "students can examine and analyze results, deal with multiple variables, and thus apply important concepts more effectively" (California High School Task Force, p. 31).

Technology is a Necessary Requirement for Educational Reform

Another rationale for incorporating new technologies into the classroom links the use of technology with the success of educational reform. "Technology has the potential to redefine the educational system of the early twenty-first century," argued the Strategic Plan for Information Technology (1991, p. 1). Throughout the policy statements reviewed, reform was seen as only attainable through massive technological support. For example, one document claimed that "Without the support of technology, California will be hard pressed to achieve [the] goals of school reform" (Far West Laboratory for Educational Research and Development, preface). No explicit reasons for this conclusion could be found in the documents except for the statement that ". . . school and curriculum reform require communication that has heretofore been minimal or nonexistent" (K-12 Network Planning Unit, p. 33).

The Role of Technology in the Classroom

The most prevalent statements regarding the roles or functions of technology in the classroom can be summarized as follows:

Delivery of Content

As documented above, technology was valued as an instructional tool primarily for its ability to assist the communication of content-related information to students. It is not surprising then that the dominant role of technology promoted in the documents was that of a "delivery system" for course content. The Technology in the Curriculum: History-Social Science

Resource Guide (1986) stressed that the "first role [of technology] is to deliver content . . . through drills, tutorials, simulations, and the direct presentation of reality" (Far West Laboratory for Educational Research and Development, p. 9). It also stated that "The storage capacity and interactive capabilities of the microcomputer make it a powerful tool for delivering content" (preface). Throughout the official discourse, technology was described as a an efficient "tool" to assist teachers in the presentation of material. As a local Model Technology School brochure explained, technology-based instruction can "increase [teacher] productivity and . . . enhance their methods of classroom delivery" (Cupertino/Fremont Model Technology Schools Project, n/d).

Information Resource and Research Tool

Related to the function of information delivery is the idea that technology should be used in classrooms as an alternate source of information or as a research tool. The documents contained numerous statements about the potential of technology to provide classrooms with vast amounts of information and data, seen as the key resources needed for learning. The Technology in the Curriculum: History-Social Science Resource Guide (1986) emphasized that an important role for technology is to "retrieve and analyze information" and to provide "rich collections of visual and auditory information about societies, cultures, events, and time periods" (Far West Laboratory for Educational Research and Development, p. 9). Another document explained that with technology, "[Teachers will have] access to data base information resources anywhere in the world . . . . [and] will be able to access the latest research on topics presented in class" (Advisory Committee on Information Technology, p. 22). Still another source touted the fact that technology will provide students with "information on demand and immediate feedback"(K-12 Network Planning

Unit, p. x). The Building the Future: K-12 Network Technology Planning Guide (1994) cited a national report entitled Achieving Educational Excellence by Increasing Access to Knowledge that proposed: "[Technology] offer[s] student access to more information than teachers can possibly master, as well as an immediacy and currency of information that textbooks . . . can never maintain" (K-12 Network Planning Unit, Educational Technology Office, 1994, p. 23).

Critical Thinking and Basic Skill Development

Technology was also seen as a means to teach basic skills and critical thinking. Virtually all of the documents analyzed argued that students using technology will improve their research and information processing skills (i.e., retrieving, organizing, and manipulating data). The California High School Task Force, in its report Second to None: A Vision of the New California High School (1992), argued that "technology use also enhances students' verbal and computational capabilities" (p. 31). In addition, technology was promoted in various documents as a vehicle for reinforcing social and critical thinking skills. According to one text, "Computer problem-solving exercises also emphasize and permit practice in individual thinking skills, including: clarifying issues and terms, judging and utilizing information, and drawing conclusions" (Far West Laboratory for Educational Research and Development, 1986, p. 10). It was also noted that "[Technology] is stimulus for interaction in both small and large groups and can be the starting point for building critical thinking skills" (p. 12).

Classroom Management

Finally, in addition to enhancing curriculum and instruction, technology was promoted as an efficient classroom management tool. Through the use of wordprocessing, database, and computer-grading applications, teachers can increase their "productivity." As one source explained, "[Technology] can be used to develop and print vocabulary exercises and student newspapers, and to develop, score, and organize tests and test information. Record keeping of all kinds can also be managed by computer" (Far West Laboratory for Educational Research and Development, 1986, p. 10). Another recommended that new information technologies "[can] contribute to the management efficiency of administrators and staff" (K-12 Network Planning Unit, 1994, p. ix).

The documents reviewed also contained hypothetical examples of technology use that further clarified the institutional vision of technology-enriched learning. For example, in the Strategic Plan for Information Technology (1991), a "technology scenario" was offered that contained examples of how technology might be used in the classroom. In one sixth-grade math class, Mr. Arnold was "following a five-step lesson plan to present a new idea in division of decimal fractions." The classroom was described as follows:

> At his workstation he prepares each problem and projects it on a large screen for all the students to see. The students log in on the computer-connected keypads from their seats and then enter their answers as they work through each step of the new concept. On the computer screen Mr. Arnold can view a display of the answers given by each student. On the basis of this display, he can pace the lesson throughout the direct instruction. (Advisory Committee on Information Technology, p. 13)

Other examples from this source included:

> Today, Kelli's group is assigned to work in the library, using a computer data base designed for this project. Kelli uses the computer to access the school library's card catalog, media collection, and a CD-ROM encyclopedia. The students in Kelli's group will create a multimedia report that will present the information they collect for others in their class. (Advisory Committee on Information Technology, p. 13)

> Ms. Truewell is following a lesson plan recommended by her mentor teacher and accessed through the state's CEN [Communication Education Network]. Throughout the presentation students were kept on task with questions that she interspersed throughout the visual presentation on the

> projection screen. (Advisory Committee on Information Technology, p. 14)
>
> Today, Ms. Ellison's students will spend the first part of the period working on a lesson on preparing data-base cards for a bibliography. As they finish the assignment, they can practice work [sic] processing skills or use their laptop computers to exchange messages with students in another sixth grade language arts class . . . . (Advisory Committee on Information Technology, p. 14)

These examples of technology-integrated learning all reflect the dominant roles suggested above of technology as a tool for delivering subject matter content, monitoring student performance, presenting graphic information, accessing data-base information and generic lesson-plans, and reinforcing basic skills. Several other examples in this "technology scenario" illustrated the role of technology in assisting classroom management tasks, such as "preparing a memo," "entering grades in [a] computer-based gradebook," posting "electronic and voicemail" messages for parents and students, and "printing out individual homework assignments" (Advisory Committee on Information Technology, 1991, p. 12-15).

To summarize the results of the pilot study reported above, the dominant rationales and roles for technology that emerged in the documents emphasized technology as a tool for delivering course content and for accessing, transferring, and manipulating information. The institutional vision for technology use that is promoted tends to support models of curriculum and instruction that stress covering of pre-determined content, information-processing, skill-development, and teacher-directed instruction.

The primary value of technology emphasized in the documents is its ability to store and present vast amounts of information quickly and efficiently. "Technology makes it easier for [students] to collect, analyze, and report the information they collect," explained one source (Far West Laboratory on Educational Research and Development, p. 13). This fixation with "information" and "access to data" as the basis for learning is clearly evident in the following phrases identified in one classroom example: "[technology] allows students to manipulate economic data". . . ."[students will be able] to manipulate national economic statistics". . . ."[students will] seek out current economic statistics". . . . "[students will be] guided through the appropriate data manipulations". . . . "[students will] enter the data". . . ."students help make up tests from the data" (Far West Laboratory on Educational Research and Development, 1986, p. 13-14).

The examples above reveal a strong bias in the official discourse of technology use in California schools towards what Roszak (1986) has called the metaphor of "student as information processor." Information, now increasingly equated with knowledge, is seen as the key element in the learning process. Computer technology is therefore seen as a "natural" way to enhance learning because it is the ultimate information-processing tool. Throughout the documents, teachers and their technological systems tended to be cast in the role of information-dispensers, presenting captivating, up-to-date, and expert-generated data for students to digest, manipulate, and analyze. This vision of technology use communicated by policymakers is one where technology transforms the classroom into an information-rich, perhaps one could argue information-glutted, environment.

As pointed out earlier, the current discourse on educational computing views technology as a necessary tool for bringing about "radical" school restructuring. Computers and other new information technologies are seen as a perfect match for the general move towards a more constructivist learning model that now characterizes the school reform movement (Means & Olson, 1994). In a sense, it is ironic that technology is now regarded as an agent of radical change when a brief analysis of the history of educational computing clearly shows the degree to which technology has reinforced fundamentally technicist-modernist conceptions of teaching and learning. In addition, as this document analysis reveals, even the discourse contained in the most recent official policy statements guiding technology use in schools is still largely influenced by a set of assumptions about technology and education that date back to the early 1900s. Those assumptions include viewing technology as a "neutral" transmitter of content information and education as the inculcation of culturally-free fragments of "objective" knowledge.

With the emergence of more "technology-saturation" programs like ACOT and California's Model Technology Schools, it appears that the trend towards committing substantial funding to technological solutions in education will continue in the face of shrinking state and local resources. In the next section, a brief review of some of major research conducted on "computer-saturated" classrooms and schools will be presented. This discussion will serve to further situate this investigation in a research context and shed additional light on the implications of high-technology learning experience.

Research on Technology-Saturated Classrooms

The growth of technology-saturation experiments in education has led to a corresponding increase in the amount of research done in those contexts. In addition, whereas earlier research on computers in education tended to focus on a particularly narrow range of concerns (i.e., the effects of the computer on student skill acquisition, fact-recall, and miscellaneous "performance indicators"), one can detect a general trend towards understanding the broader dimensions of classroom and school life that are altered when technology becomes prevalent in the learning environment (Scott, Cole, & Engel, 1992). However, in spite of this growing interest in "hi-access" environments and in assessing the impact of technology in a more holistic manner, the research on computer-saturated learning remains rather limited in scope and generally lacks a deeper examination of the cultural and ideological dimensions of classroom computing (Bowers, 1988). Another problematic aspect of this field of study, as Scott, Cole, & Engel (1992) have noted, is that many saturation experiments (and the subsequent research) are funded fully or in part by private corporations who have a vested interest in the success of these experiments. As a result, research credibility can be a legitimate concern in some cases. Nonetheless, it is important to present this research and what it has contributed to the growing body of knowledge about what is occurring in technology-saturated learning environments. These studies are also useful for understanding the nature of the questions that are being asked about technology in education and the critical areas that have been left unexamined. A review of the research on the most well-known and perhaps most investigated saturation experiment to date, the Apple Classroom of Tomorrow (ACOT) project, will be summarized below.

The Apple Classroom of Tomorrow Project

Begun in 1985, the ACOT experiment was implemented as a collaborative research project that involved public schools, universities, research agencies, and Apple Computer, Inc., in exploring, developing and demonstrating the educational uses of new technologies (Ringstaff, Sandholtz, & Dwyer, 1991). Classrooms of different grade-levels were selected at various sites around the country to participate in the research. ACOT classrooms were then furnished with computer equipment and software, and teachers and students were given computers for home use. In addition, Apple provided each ACOT classroom with a "computer coordinator" to offer technical support.

The ACOT program has embraced a constructivist approach to education and is guided by the belief that technology should be used as "knowledge-building tools" (Sandholtz, Ringstaff, & Dwyer, 1991, p. 1). In addition, the ACOT program has aligned itself with the current restructuring-with-technology movement and therefore views technology as a "necessary and catalytic part" of the reform agenda (p . 1). The ACOT philosophy can thus be characterized as reflecting the dominant cultural beliefs, described throughout this chapter, that tend to favor technical solutions to educational problems and regard new technologies as ideologically and culturally neutral learning tools.

Teaching and Learning in an ACOT Classroom

A review of the ACOT research portfolio can be approached through an exploration of broad themes regarding the changes in teaching and learning that are occurring in technology-saturated classrooms. Apple Computer has identified the "Big Questions" that ACOT research seeks to answer as:

> 1.) How does high access to technology affect curriculum and instruction?, 2.) How can computers be used to empower students to take responsibility for learning?, 3.) How do students organize and use information when they have constant access to computers?, and 4.) How can the learning outcomes of high computer environments be fairly assessed? (Apple Computer, Inc., 1991)

What follows, then, are some of the answers to these questions. It should be noted that this discussion is not intended to be an exhaustive accounting and analysis of ACOT research, but rather a limited overview of the themes relevant to this investigation.

Research on Teaching in ACOT Classrooms

Several studies attempted to uncover some of the changes and issues that affect teachers as they encounter the radically altered environment of an ACOT classroom. For example, Dwyer, Ringstaff, and Sandholtz (1990a) reported that teachers experienced an evolution of their beliefs and practices as they struggled to "accommodate the new technology" into their daily teaching routine. The authors have identified the stages of evolution as entry, adoption, adaptation, appropriation, and invention. In addition, they made recommendations for administrators to "help speed and ease the transformation" from the early stages to the latter stages.

Regarding instruction, the authors noted that during the early stages of this model, "text-based curriculum delivered in a lecture-recitation-seatwork mode is *strengthened* through the use of technology," but then observed that teachers eventually began implementing "far more dynamic learning experiences" as they progress through the stages (Dwyer, Ringstaff, & Sandholtz, 1990, p. 8, italics added). They concluded that teachers' deeply held beliefs about the nature and teaching and learning are "an important factor that underlies the institution's resistance to change," and suggested that "implementing change in education must include changing teachers' practices and beliefs" (p. 15).

David (1991b) has summarized the major changes that ACOT teachers have seen in their practice. Based on interviews with teachers, she reported that "the way they plan, organize, and deliver instruction has changed significantly," including: more project oriented work, more group work and cooperative learning, more efficient drill and practice, more ways to get information, faster lesson preparation and revision, and more individualized attention (p. 6).

In a related study, Sandholtz, Ringstaff, and Dwyer (1990) reported on the issue of classroom management in high-access-to-technology environments. Involving thirty-two elementary and secondary ACOT teachers in a qualitative investigation, the researchers found that teachers' initial concerns about student misbehavior, technical problems, and perception of the classroom being too "technology-centered" ultimately gave way to a belief that technology helped them "manage" the classroom and make it more "learner-centered." This process hinged on the teachers' ability to use technology to their advantage, such as "optimiz[ing] the computer's ability to provide immediate feedback," "develop[ing] strategies for increasing the amount of material they could cover during the school day," and using technology as "a motivational tool" to "combat student misbehavior" (p. 12-14).

Sandholtz, Ringstaff, and Dwyer (1991) have also investigated the relationship between collegial interaction and technological innovation. They reported that "high-access-to-technology classrooms drove teachers to more collegial interaction" as they progressed through the instructional phases of technology accommodation (p. 12). Specifically, the authors concluded that technology had a direct influence on the way teachers worked with one another in that there was more emotional support, more sharing of instructional ideas, and more teacher interaction due to the common interest of "adapting" to the new tools (p. 13). It was also noted that as teachers began to use the new technology for instruction, their interactions increased but also tended to revolve around technical issues (i.e., how to use software). Later, when teachers reached more "advanced" stages of technological integration, their interactions began to focus more on the "sharing of instructional strategies" and "collaboration on instructional topics" (p. 7-9). The authors concluded their study by calling for "structural and programmatic shifts in the working environments of teachers" that include "on-going support" in the form of training and technical support (p. 13).

Research on Learning in ACOT Classrooms

Other ACOT studies focused on the impact of high-access-to-technology environments on the students' learning experience. Dwyer (April 1994), an Apple Computer executive and Project Manager for the ACOT program, has recently summarized these findings and concluded that (a) Cooperative and task-related interaction among students in ACOT classrooms was spontaneous and more extensive than in traditional classrooms; (b) test scores of ACOT students indicated they were doing as well as they might without technology, and in some cases better; (c) children's engagement with and interest in technology did not decline with routine use; and (d) ACOT students wrote more, and more effectively. Citing an example of a sixth-grade math class who completed the curriculum by the beginning of April, Dwyer also reported that "student productivity increased" (p. 6).

In contrast to Dwyer's optimistic analysis of the ACOT research, a study conducted by Baker, Gearhart, and Herman (1989) determined that (a) "There is inconclusive evidence for ACOT contributing to students' achievement at a level beyond that of conventional instruction," and (b) "the ACOT project neither undermines student interest and motivation, nor enhances affective aspects their school experience." In addition, they concluded that "assessment of ACOT requires new documentation and evaluation tools capable of measuring the complexities of ACOT effects" (ERIC on-line abstract).

A recent study by Tierney, et al., (1992) attempted to get beyond traditional indicators of student success with technology by following six ACOT students through four years of high school and documenting their thoughts on ways of knowing, sharing, and collaborating. The authors sought to understand "computer literacy in terms of its symbolic, cognitive, and social dimensions" (p.

1-2). Among other things, they reported that students communicated an "awareness of the computer as a powerful tool which gave them a way to achieve their ends" and a belief that "using computers involved complex social dimensions" (i.e., working collaboratively, assuming and changing roles). Furthermore, the authors identified a changing "view of text" among the students, from linear, non-layered, "static" representations to more non-linear, multi-layered, "dynamic" representations (p. 3-4). They summarized their study by claiming that the ACOT environment encouraged significant shifts in students' thoughts about how knowledge may be represented, how to experiment with and communicate ideas, and their own understandings of themselves as "learners with different dispositions, varied aspirations, interaction styles, backgrounds, and desires" (p. 11).

Other ACOT studies have focused on the social dimensions of technology-saturated classrooms. For example, a report by Ringstaff, Sandholtz, and Dwyer (1991) examined how the roles of teachers and students were altered as classroom instruction shifted towards more collaborative, student-centered models. They found that as technology was introduced into the curriculum, "the teacher's traditional role as 'expert' was undermined" as students took more active roles in training their peers in the use of technology and teaching the subject matter content (p. 7). The researchers noted that, over time, teachers began to take advantage of students' "technological expertise" and relied on peer teaching as an integral part of their instructional strategies.

This brief overview of some of the studies conducted on ACOT programs serves to illustrate the degree to which mainstream research on technology-saturated classrooms offers a somewhat myopic view of the subject. While some studies attempted to focus on the broader implications of a high-technology learning environment (i.e., student-teacher interactions, teacher collegiality), they neglected important aspects of the technology-language-culture relationship that profoundly influence the socialization processes occurring in the classroom (these will be addressed in the next chapter). In addition, the majority of ACOT studies, sponsored in part by Apple Computer, Inc., tended to reflect the dominant cultural posture towards technological innovation in education identified in the early literature on CAI and more recent policy statements. This stance assumes technology to be a neutral learning tool and educational improvement to be dependent upon the application of technical systems. In this respect, the overall tone of much of the ACOT research reflected a technocratic ideology: teachers "adapt" to technology, students become more "productive," classrooms are better "managed," and learning is "optimized." As a result of this modernist and technocratic perspective, ACOT research has ignored or glossed-over problematic aspects of technology-mediated learning that relate to issues of equity, appropriate use, and the ideological-epistemological dimensions of computerized-learning.

CHAPTER THREE:
ALTERNATIVE PERSPECTIVES ON TECHNOLOGY AND EDUCATION: RE-ORIENTING THE RESEARCH AGENDA

> [E]mbedded in every tool is an ideological bias, a predisposition to construct the world as one thing rather than another, to value one thing over another, to amplify one sense or skill or attitude more loudly than before.
>
> -N. Postman (1992, p. 13)

As we have seen, the effort to equip educators with tools of the modern age has been a persistent feature in American education since the turn of the century. The push to bring American education into the industrial age (and, more recently, the "information age") has been largely guided by an ideology of control rooted in a Cartesian-technicist worldview and expressed in the field of education as the dual impulses of scientific management and behaviorism. The development and evolution of the field of educational computing has also reflected a strong bias towards technicist conceptions of teaching and learning. The promise of computer technology in education has been represented in the early enthusiasm for CAI's "programmed instruction" and, more recently, the popularity of Integrated Learning Systems.

We have also seen how the architects of the school restructuring movement have embraced technology as a necessary ingredient for school reform. Technology is currently being re-conceptualized as a catalyst for creating an "active-learning" environment, where students are connected to an "information superhighway" that will enable them greater access to "knowledge." While this most recent vision of technology-intensive learning may represent a shift away from teacher-directed, mechanical models of learning and instruction, it remains, fundamentally, a vision of educational progress through technology.

An analysis of the evolution of educational computing, therefore, reveals underlying assumptions about the nature of technology, the idea of progress, and the nature of learning and knowledge that have shaped the discourse and practices of educators (i.e., technical innovation brings progress; technology is a neutral "delivery system" for knowledge). In the sections that follow, these assumptions will be examined in relation to alternative perspectives on technology, culture, and education. By making explicit some of these taken-for-granted ideas and ideals that have dominated the discourse on educational computing, and by offering more critical understandings into the technology-culture relationship, the focus of this investigation can be situated in a theoretical context.

Part I: Technology and Culture

It has become commonplace to hear that the world is entering a new era of high-technology. Popular culture has become saturated with messages about how rapid advances in information technologies are redefining what it means to live, work, and learn. We are told that we are entering a new "Age of Information" that will bring greater economic opportunities, new medical advances, and a better quality of life.

Technology and the Ideology of Progress

The popular conception of science and technology as an unqualified blessing to humankind is deeply ingrained in the modern American psyche. This belief is not new, of course. In 1847, Daniel Webster exclaimed:

> It is an extraordinary era in which we live. It is altogether new. The world has seen nothing like it before . . . [E]verybody knows that the age is remarkable for scientific research into the heavens, the earth, and what is beneath the earth . . . We see the ocean navigated and the solid land traversed by steam power, and intelligence communicated by electricity. Truly this is almost a miraculous era . . . The progress of the age has almost outstripped human belief . . . . (quoted in Marx, 1993, p. 8)

Mander (1985), Norman (1993) and Postman (1992) have recounted that by the mid-twentieth century, a technology-centered view of society and human progress dominated the national psyche. An unrestrained enthusiasm for the wonders of science and technology characterized both popular and professional culture. A corporate advertising slogan promised "Better Living Through Chemistry." "Progress" became General Electric's "Most Important Product." The 1933 Chicago World's Fair featured exhibits based on the theme *Century of Progress* and proclaimed the motto for a new age: "Science Finds, Industry Applies, Man Conforms" (Norman, 1993). The guidebook to the Fair further elaborated on the theme, explaining that "Science discovers, genius invents, industry applies, and man adapts himself, or is molded by, new things . . . . Individuals, groups, entire races of men fall into step with science and technology" (cited in Balabanian, 1991, p. 249).

Today, few actively question the fundamental belief that technology in general is an instrument of progress (Mander, 1991; Postman, 1992). Even in the face of growing environmental, economic, and social problems brought about in large measure by the technological development of the past two hundred years, society turns increasingly to technology for solutions. The phrase "faith in technology" is often invoked to characterize the temper of the times. Marx (1993) has identified the assumption underlying this worldview as the belief that "history is driven by the steady, cumulative, and inevitable expansion of human knowledge of and power over nature" (p. 5). This meta-narrative of human progress and technological possibilities is based on a set of core ideas that Winner (1977) has identified as:

> 1.) men know best what they themselves have made, 2.) the things that men make are under their firm control, and 3.) technology is essentially

> neutral, a means to an end; the benefit or harm it brings depends on how men use it. (p. 25)

Mander (1991) and Winner (1986, 1991) have called attention to the general cultural passivity that characterizes Western, particularly American, responses to technological development. Winner has warned that society is engaged in a form of "technological somnambulism" (technological sleepwalking) that renders it incapable of assessing the costs of technological innovation. Mander, similarly, has maintained that as a society we have given our tacit approval to all forms of technological innovation. "[We] are now embedded in a system of perceptions," he argues, "that make us blind and passive when it comes to technology" (p. 8).

Reconsidering Technology and Culture

Contemporary critics of society's "blind faith" in technology have based their work in varying degrees on earlier theorists who sought to offer a more comprehensive explanation as to the nature of technology and cultural change. Winner (1977), for example, cited the arguments put forth by Karl Marx that as society adopts new modes of production (technologies), those technologies necessarily bring about changes in broader social patterns. To put this idea in Marx's own words, "The handmill gives you a society with the feudal lord; the steam-mill, society with the industrial capitalist" (quoted in Winner, p. 79). In 1934, Lewis Mumford, in his seminal work Technics and Civilization, considered the theme of how technology re-orders society's basic perceptions of reality. For example, the invention and wide-spread use of the mechanical clock brought about a new concept of time and served as a powerful metaphor for the structure of the universe and the nature of the Divine. Mumford explained that the clock contributed to an emerging worldview that perceived time as linear and reconceptualized God as "the Eternal Clockmaker who . . . conceived and created and wound up the clock of the universe" (1963, p. 34). Later, Ellul (1964), expanding on Mumford's discussion of the "autonomous" nature of technology, posited that technology itself has come to dominate human experience to the point that the values and means of technology supersede all other possibilities. Ellul argued that "Technique has become autonomous; it has fashioned an omnivorous world which obeys its own laws and which has renounced all tradition" (p. 14).

The central idea shared by these diverse thinkers is that technology is a kind of "force" that changes social patterns and individual perceptions in very complex, subtle, and profound ways. In this sense, technological development should be understood as a dynamic social and cultural phenomenon (Winner, 1993). This perspective runs counter to the dominant cultural view of technology as "mere" tools (i.e., steam engines, automobiles, nuclear reactors, computers) controlled and rationally applied by humanity for practical purposes.

The theoretical position of Ellul (1964, 1990), in particular, occupies a place on the extreme opposite pole from the dominant cultural belief that technology is a neutral instrument of progress guided by human will. Ellul's bleak vision of technology out-of-control represents an extreme form of technological determinism that views modern technological systems as fundamentally de-humanizing forces that cannot be resisted. In a recent work, Ellul himself admitted "I think the game is lost. With the help of computer power, the technical system had definitively escaped from control by the human will" (1990, p. 101).

Other scholars have criticized both Ellul's position and the "technology-as-blessing" myth as overly simplistic. Mesthene (1993) and others have proposed that technology should not be regarded solely as an evil force beyond our control, just as it should not be regarded solely as an instrument of "progress" that has no socio-cultural side-effects. An alternative to understanding the complex interactions of technology and culture might recognize the elements of truth in both of these positions.

Goldberg & Strain (1987) have offered a tentative framework for understanding the technology-culture paradox. They suggested that modern technology should not be understood simply as a tool, "something consciously chosen to achieve a predetermined end" (p. 7). Rather, a model for understanding the cultural implications of technological change needs to recognize that technological systems "can delimit the field of possibilities for thought and action" (p. 7). Therefore, they concluded "Technology is not neutral because it embodies the choices made by society, but for the same reason it cannot be treated as an autonomous, impersonal force over which mankind has no control" (p. 7). In this sense then, technology and culture must be considered as mutually determining, multi-dimensional variables that vary "simultaneously and in subtly interconnected ways" (p. 7). Echoing this same line of thinking, Postman (1992) recently offered an alternative metaphor for understanding technological change, suggesting that "technological change is neither additive nor subtractive. It is ecological . . . one significant change generates total change" (p. 18). The complexity of the technology-culture dynamic suggested here presents enormous difficulties in assessing the impact of technology's intrusion into a culture, whether that culture is a nation, a community, or a classroom. As Postman stated, "[C]hanges wrought by technology are subtle if not downright mysterious, one might say wildly unpredictable. Among the most unpredictable are those [changes] that might be labeled ideological" (p. 12).

To summarize briefly, alternative perspectives or "narratives" about the interaction between technology and culture have attempted to challenge the dominant cultural (modernist) posture that regards technology as merely an instrument of "progress" controlled by human intention. But if technology and culture are more properly understood as forces that act upon each other, what can be said about the degree to which technological change has reconstituted culture? Or, to put the question another way, *how has technology developed society as society has developed technology*?

The Technocratic Culture

A growing number of contemporary scholars and social critics have suggested that Western, industrialized cultures built upon a vast array of complex technical systems have elevated the interests of science and technology to a privileged position in public discourse (Apple, 1986; Glendenning, 1990; Habermas, 1970; Roszak, 1986; Winner, 1986). Increasingly, Western societies have come to define their social, economic, and political goals in technical, quantitative terms (Postman, 1989, 1992). As a result, economists are focusing their attention on "economic indicators," politicians are reacting to "opinion polls," and educators are basing their decisions on "standardized test scores."

As previously discussed, the privileging of the technical ideals of efficiency, control, and objectivity can be traced to the rise of modern science and, in particular, to the technocratic utopianism associated with Auguste Comte and other positivists. This perspective has become the dominant outlook guiding social policy and professional practice since the late nineteenth century (Doll, 1993; Marx, 1993; Postman, 1992; Schön, 1983). The idea of a "technical fix" to social, economic, political, and environmental problems has displaced other forms of social action based on dialogue, moral vision, and community involvement.

In his analysis of science, technology, and progress, Leo Marx (1993) has argued that the notion of progress has undergone a transformation during this past two centuries. The Enlightenment ideal of progress regarded the new scientific and technical knowledge as instruments to be used in the service of greater social, economic, and political goals. For example, Marx cited Thomas Jefferson's rejection of the idea of developing an American factory system on the grounds that it would lead to social and economic conditions "incompatible with republican government" as an instance of attempting to constrain technology to preserve a political vision (p. 6). This idea of progress guided by emancipatory, humanitarian ideals ultimately gave way to what Marx has called the technocratic concept of progress, where scientific discovery and technological innovation are seen as the sole basis for general progress. In this view, the advancement of science-based technologies becomes the paramount concern: "Turning the Jeffersonian ideal on its head, this view makes instrumental values fundamental to social progress, and relegates what formerly were considered primary, goal-setting values (justice, freedom, beauty, or self-fulfillment) to a secondary status" (p. 9).

The idea that technocratic values have come to dominate our culture can be loosely correlated with Habermas' (1972, 1974) theory of "knowledge-constitutive interests." Habermas has identified three basic cognitive interests around which knowledge is constructed and organized in our society: technical, practical, and emancipatory. Roughly speaking, these three interests represent "ways of knowing" and interacting with the world. The technical interest is expressed in empirical-analytic science, the practical interest is expressed in historical-hermeneutic science, and the emancipatory interest is expressed in critical science. Habermas has argued that in modern, industrialized states, the technical interest, defined by Grundy (1987) as "a fundamental interest in controlling the environment through rule-following action based upon empirically grounded laws," has come to dominate knowledge-creation in nearly all aspects of cultural life (Grundy, p. 12).

Postman (1989, 1992) has argued that the technocratic ideals or interests represented in new technology now dominate cultural life in America so totally that society has become "technopolized." In a technopolized society the symbolic thought-worlds of traditional culture must give way to an ever-expanding, self-justifying "technological thought-world." That is, the assumptions and rationalities embedded in technical systems monopolize all public discourse and force collective perceptions about education, community, and politics to be redefined to fit the requirements of those rationalities. As Postman (1989) explained:

> Technopoly . . . is the state of culture and the state of mind in which the only ends that survive are the ends technology can accomplish; the only questions worth asking are the questions technology can answer; the only problems worth solving are the problems technology and its experts can solve. (p. 9)

The Non-Neutrality of Technology

Central to our understanding of how technology influences culture, how it "reweaves the fabric of society" (Winner, 1993), is the notion that technology is not merely a "neutral" object awaiting human directives, but a force that shapes language, thought and culture (Balabanian, 1980; Bowers, 1988; Ellul, 1964; Ihde, 1979; Mander, 1991; Mumford, 1963; Postman, 1992). As a new technology is introduced into a culture, it often redefines "the roles, rules, relationships, and institutions that make up our ways of living together" (Winner, p. 27).

Building on the work of German social theorist Martin Heidegger, Ihde (1979) has contributed much to the important yet historically neglected field of the philosophy of technology. In Technics and Praxis (1979), Ihde introduced the concepts of "amplification" and "reduction" to explain how the use of technology transforms human experience. Ihde proposed that when humans make use of technology, from simple tools to the most complex systems, certain aspects of experience are amplified (or heightened) while other aspects are reduced (diminished). Using a simple example of a man who uses a stick to reach a piece of fruit in a tree, Ihde explained how technology (the stick) *mediates* (transforms) the experience of interaction between the man and nature. Ihde argued that technology therefore must be considered "non-neutral" simply because "with every amplification, there is a simultaneous and necessary reduction" (p. 21). Put another way, the very *essence* of the stick is what enables the man to extend his reach (amplification), but at the same time it is the stick that necessarily reduces the man's ability to physically touch the fruit on the tree (reduction). Because technology transforms experience in this way, it must be properly understood as "non-neutral."

Ihde's (1979) analysis of the nature of how technology mediates human experience implies that there are amplification-reduction characteristics inherent in any technology. Other scholars have explored this theme of the non-neutrality of technology. For example, Ellul (1964) spoke of technology having a "peculiar force" independent of humankind's predetermined objectives. Bush (1983) suggested that technologies have a "valence" or "charge" analogous to that of atoms (i.e., guns are valenced to violence). Postman (1992) claimed that all tools reflect an "ideological bias" that favors the construction of some social, economic, and political arrangements over others. Mander (1985, 1991) and Winner (1986,

1991) spoke of the inherent "tendencies" within technologies to either centralize or diffuse power, inhibit or extend freedom, and stratify or equalize opportunities. These perspectives illustrate how alternative metaphors are being explored in an effort to understand the non-neutral nature of technology.

Another aspect of technology-mediated experience that Ihde (1979) has noted is that the amplification-characteristics of a particular technology tend to be "dramatic" and therefore are recognized and understood much more readily than its reduction-characteristics (p. 21). In other words, the introduction of a new technology into a culture tends to be accompanied by an enthusiasm for the obvious benefits without much regard for or awareness of what might be diminished or displaced through the use of technology. As Mander (1991) has reminded us, one need only ponder the history of the automobile or television to get a sense of how technologies have been quickly embraced by a culture with little forethought as to the broader social, economic, and political consequences.

It is the subtle and unpredictable nature of the changes that are associated with the reduction-characteristics inherent in technology that make assessing the true costs of technological development so problematic. But as Postman (1989, 1992) and others have noted, it is often those changes that bring about the most profound, long-term changes in a culture. Because technology alters experience in the most fundamental ways, its influence extends into the very structure of language, thought, perception, in short, the basic elements that constitute one's worldview. As Postman explained: "New technologies alter the structure of our interests: the things we think about. They alter the character of our symbols: the things we think with. And they alter the nature of community: the arena in which thoughts develop" (1992, p. 20).

Mander (1991) offered an example that illustrates how technology can influence the language (and therefore worldview) of a particular culture. He reported how the Inuit of northern Canada began to reconceptualize their traditional understandings of nature and the environment when given computers and computer training to track wildlife patterns. According to Mander, it is likely that "this mode of reckoning the environment will sacrifice many dimensions of information formerly used by Native people." He speculated that:

> Now the language will be in terms of "cost benefit," "sustainable yield," and "animal units." The more powerful mythical, sensory, historic, and spiritual dimensions with creatures and the land, the dimensions which sustained them the Inuit for thousands of years and make them different from you and me, will be amputated. (p. 13)

This story emphasizes the subtle, yet powerful, connection between the rationalities embedded in tools, the metaphorical dimensions of language, and the evolution of the symbolic foundations of culture.

To summarize, an understanding of the phenomenon of technology in education must be grounded in a theory of technology *and* culture. It has been argued here that the dominant cultural response to technology is guided by a technocratic view of progress that views technological development in simplistic terms (i.e., technology brings "progress," technology is "neutral" and "value-free"). As an alternative to these taken-for-granted cultural myths, scholars have proposed more comprehensive frameworks for understanding the nature of technology and the interactions of technology and culture. The inherent tendencies of technology to reshape aspects of cultural life must be recognized as an integral part of the technology-society phenomenon. Indeed, this idea has tremendous implications for educators who are currently being encouraged to use ever-increasing layers of technological systems in their classrooms and schools.

Part II: Critical Perspectives on Technology in Education

To this point, it has been argued that the dominant assumptions and rationales that have guided both the general discourse on and implementation of programs to technologically upgrade schools (dating back to the early 1900s) are based on a modernist-technicist set of beliefs about the nature of technology, culture, and progress. In addition, the current discourse on the role of technology in the educational restructuring movement is heavily influenced by a technocratic mindset that frames educational problems in primarily technical terms (Shears, 1994). Again, it is emphasized that the roots of this technocratic approach to education run deep, as has been presented in the previous chapter.

Recently, some scholars and researchers have begun to address the problematic aspects of technology in education and have sought to uncover the "hidden curriculum" of the educational computing phenomenon. These critiques tend to revolve around the themes of equity and access, appropriate use, and the cultural-ideological implications of educational computing. The latter of these three will be addressed at length later in this section. First, however, a brief highlighting of the equity, access, and appropriate use issues will be presented.

Issues of Equity and Access

Recent research on gender and race issues of classroom computing has revealed a disturbing side of the educational technology "revolution." For instance, several studies have shown that there are considerable differences between the computing experiences of boys and girls. In general, research has indicated that females are (a) less likely to be enrolled in computer labs, classes, and camps; (b) likely to link computer use with a masculine image; (c) likely to see themselves "less capable than boys" with respect to computer studies; and (d) more likely to have overall more negative feelings towards computers and computer science than males (De Remer, 1989; Scott, Cole, & Engel, 1992).

Researchers and scholars have also raised questions about the implications of unequal access to computer technology based on socio-economic barriers (Apple, 1986; Olson, 1987; Shor, 1985). Computers are an expensive technology that, in spite of government and industry efforts, have not been equally distributed between wealthy and poorer communities. A John Hopkins University study reported that public schools in poorer districts are least likely to own computers (cited in Ascher, 1984). It should be noted that public and private sector grants have made many computers available to low-income schools. However, in his article, Separate Realities: The Creation of the Technological Underclass in America's Public Schools, Piller (1992) concluded that computer-based education in poorer inner-city and rural schools is a farce. Because of inadequate funding, training, and support, computers are not being effectively maintained and utilized in poorer districts. As a result, computers are seen as simply perpetuating a two-tier system for the technologically advantaged and disadvantaged. Piller also noted that, all too often, the emerging technological underclass is composed of ethnic minorities for whom the promise of educational computing is a cruel joke.

Issues of the Appropriate Use of Classroom Technology

Even if truly equal access to classroom computers was a reality, some scholars have stressed the obvious point that computers do not necessarily translate into good instruction in the classroom. Historically, educational institutions have tended to invite a "technological revolution" and yet ultimately use the new technology to maintain or restore the pedagogical status quo (Cuban, 1986). The continued popularity of "drill-and-practice" software, particularly in low-income, minority communities, seems to reinforce this view (Scott, Cole, & Engel, 1992). In an analysis of a 1989 survey, Becker (1991) noted the dominant use of drill-and-practice programs and concluded that "except for secondary school English teachers, the majority of computer-using teachers in our survey indicated that a primary function of their use of computers . . . was to help students master basic facts or skills" (p. 401). Unfortunately, research has indicated that many teachers are using computers as nothing more than "electronic worksheets" to promote fact recall. This type of use is an example of a new technology reinforcing a traditional model of instruction that emphasizes rote memory, fact-oriented knowledge, and the passive role of students.

Furthermore, Callister and Dunne (1992) reported that teachers can succumb to the "mythology" of computers and unconsciously use them to validate poor instructional practices. For example, one teacher was proud to show off a program he designed that yelled, through a digitized voice, "Wrong! Wrong! Wrong! You dummy!" at the students whenever they answered a question incorrectly (p. 326).

Technology and Cultural Amplification in the Classroom

These critiques on the phenomenon of educational computing, though important, tend to reflect the dominant cultural assumption that computers are essentially "culturally-neutral" tools that can be put to good or bad uses. This perceived neutrality of educational technology is consistently reflected in the literature of the field. For example, a recent editorial in Electronic Learning contained the statement, "Today, researchers in artificial intelligence (AI) are developing tutoring and coaching systems embedded with human expertise in a *neutral*, endlessly patient machine" (Dede, 1990, p. 8, italics added).

However, as noted above, a growing body of critical-philosophical research on educational computing, and the role of technology in society in general, has challenged the validity of the myth of "neutral" technology. In general, these scholars have argued that no technology is "value free" in the sense that the introduction of a new technology into a culture reshapes language, thought, and social patterns (Mander, 1991; Postman, 1992; Winner, 1986). Every technology has "built-in biases" that amplify certain patterns of thinking and diminish others (Bowers, 1988; Ihde, 1979). In this sense, classroom computers, as well as other instructional technologies, are not "neutral" tools but cultural artifacts that reflect powerful ideological assumptions.

Bowers (1988, 1993a, 1993b) is one of the few educators who has exposed the "tunnel vision" that has characterized the research on educational computing, in which the technical "how-to" questions have been emphasized to the exclusion of other lines of inquiry. Bowers has called for a reframing of the question of technology in education to include a more holistic understanding of how technology mediates the cultural-symbolic world of the classroom. Rather than isolating or abstracting one aspect of the phenomenon from the broader context of relationships, he has argued for a re-situating of the classroom computer as a cultural artifact embedded in a complex web of language, thought, and social interactions. Invoking the metaphor of an "ecology" to describe these cultural dynamics, Bowers suggested that "A knowledge of the educational uses of computers . . . should also involve an understanding of how this new technology alters the cultural ecology of the classroom as well as influences the larger culture" (1988, p. 2).

According to Bowers (1988), technology can play an important role in the cultural transmission process that occurs in the classroom. If the classroom is to be understood as an ecology of language, thought, and culture within which the computer plays a part, then the significant question facing educators is "How does the use of the microcomputer . . . influence the student's experience of culture?" (p. 58). Borrowing the "amplification-reduction" framework from Ihde (described on p. 66-67), Bowers has confronted the dominant ideology of educational computing that views technology as a neutral tool to be applied to educational problems. He has argued that computer technology used in classrooms amplifies (legitimizes) certain cultural, ideological, and epistemological orientations and diminishes (de-legitimizes) others. For example, Bowers explained how the computer amplifies forms of knowledge that "can be reduced to discrete bits of data [and] stored on a massive scale" and diminishes "tacit-heuristic forms of knowledge that underlie commonsense experience" (p. 33). Furthermore, he argued that "the binary logic [of the computer] that so strongly amplifies the sense of objective facts and data-based thinking serves, at the same time, to reduce the importance of meaning, ambiguity, and perspective" (p. 33).

Bowers (1994) has identified eight cultural amplification-reduction characteristics of computers that influence the classroom ecology, including these four that are particularly relevant to this study:

> 1. The computer amplifies only forms of knowledge that can be made explicit and represented in digital form. It reduces forms of cultural knowledge that are tacit, contextual and based in memory (analog forms).

> 2. The computer amplifies the cultural orientation (epistemology) that represents thinking as based on data. It reduces (misrepresents) awareness that language/thought is cultural in nature.
>
> 3. The computer amplifies a conduit view of language (allows for data, information, knowledge as culture/context free). It reduces an awareness that language/thought are metaphorical in nature.
>
> 4. The computer amplifies a tendency to use the metaphors derived from machines (e.g., computers) as a basis of representing and understanding human life. It reduces ways of representing humans as situated in and defined by the meta-narratives of cultural groups. (Bowers, 1994, unpublished manuscript)

These cultural amplification-reduction characteristics of computers are not recognized in the current discourse on educational computing, yet they carry enormous implications for educators. As teachers increasingly employ various forms of technology to teach, they need to be critically aware of how those technologies influence the way students formulate their ideas about the nature of thought, knowledge, and learning. Unfortunately, as Bowers (1988) and others have pointed out, most teachers have accepted the myth of the computer as a culturally-neutral "knowledge tool" and focus their efforts solely on socializing students to the uses and value of technology.

To summarize the argument put forth so far, the introduction of computer technology into the classroom ecology mediates the transmission of culture and therefore should not be regarded simply as neutral educational tool. As the discussion above suggests, the inherent tendencies of different technological systems to amplify or reduce (emphasize or diminish) certain forms of thought and knowledge therefore profoundly influences the epistemological and ideological orientations of the learning culture.

Computers, Language, and Thinking

The classroom can be thought of as a complex environment of language, thought, and interactions where students come in contact with the cultural-symbolic codes upon which they build their understandings of the world (Bowers & Flinders, 1990). As suggested above, two very important dimensions of the cultural ecology of the classroom that are altered through the use of technology are the epistemological and linguistic-metaphorical foundations of culture. To paraphrase Postman (1992), technology not only changes the things we think *about* (the forms of knowledge created), it changes the things we think *with* (the symbolic world of language through which we generate meaning).

Language occupies a central role in influencing the nature of thought (Bowers, 1988; Gadamer, 1975; Habermas, 1972, 1974; Mueller, 1973; Postman, 1992). In contrast to the dominant cultural understanding that views language as merely a "conduit" or objective medium for the transmission of ideas, language should be understood as an ever-changing interpretive framework that helps to organize and direct the formation of thought itself (Bowers & Flinders, 1990). According to Postman (1992), The metaphorical nature of language is what Wittgenstein had in mind when he declared that language is "our most fundamental technology . . . not merely a vehicle of thought but also the driver (p. 14). In other words, language not only serves as a means of transmitting ideas, but it also directs the constitution of ideas and beliefs that make up our worldview. In this sense, language, itself a kind of technology, is not neutral, but becomes our "conceptual guidance system" (Mueller, 1973).

Understanding the non-neutrality of educational computing and its potential for re-directing thought (amplifying or reducing aspects of culture) therefore includes an awareness of how technology enters into and alters the metaphorical-symbolic dimensions of language. Bowers (1988) discussed this relationship between technology, language, and culture and noted that "we borrow from our technologies the metaphors that direct (frame) our thought" (p. 37). Just as the mechanical clock became a source of metaphors that altered conceptions of time, the universe, and the nature of God (i.e., God the "cosmic watchmaker"), and the industrial factory became the generative metaphor for educational policy at the turn of the century (i.e., students as "raw material"), the electronic computer is now providing the conceptual model for understanding the nature of intelligence, memory, thinking, and knowledge (Bowers, 1988, 1993a; Roszak, 1986; Weizenbaum, 1976). As the computer becomes the dominant icon of a new technological age, the language and rationalities associated with that technology gain new status in the metaphorical and symbolic underpinnings of our culture. As a result, technical language like "input," "output," "program," and "feedback" become metaphors for understanding the nature of non-technical areas of human experience such as education.

In recognizing how technology can reframe the metaphorical and symbolic schema (language) that influences our basic thought processes, we can begin to see how technology can be thought of as altering the epistemological foundations of culture. Roszak (1986) has called attention to how new technologies may be reshaping the cultural understandings of what it means to think and learn. His critique of the hyping of the "Information Age" raises a number of important questions about the social, political, and economic problems brought about by a culture blinded by its enthusiasm for powerful new machines. Roszak also revealed a deeper cultural phenomenon occurring as the word "information" quickly becomes the new "godword" of our time.

Roszak (1986) persuasively argued that perhaps the most profound influence of the computer revolution is the way the computer itself is becoming the dominant model (metaphor) for our understandings about the nature of thought, knowledge, and learning. As evidence of this, he points to the fact that the word "information" is increasingly substituted for the word "knowledge," and that the term "information-processing" is increasingly being used to describe the inner workings of the mind. Roszak observed that "we are confronted by sprawling conceptions of information that work from the assumption that thinking is a form of information processing and that, therefore, more data will produce better understanding" (p. 165). As a result of this reduction of all forms of knowledge to mere "information" or "data" (a necessary reduction in order to program the computer), Roszak warned that our culture is in danger of losing the important distinctions between information, knowledge, judgment and wisdom. He argued:

> . . . to call everything the mind does information processing seems to me deeply misleading and simply warps the art of thinking. It would be a great danger to teach students, for the sake of some manipulation of a computer, that their minds are essentially computers and that when they think they are processing information. (1992, p. 48)

Roszak (1986) was especially concerned about the ramifications of this form of cognitive reductionism in the area of early childhood education, a field particularly susceptible these days to the allure of "the cult of information." He cited the growth of the computer literacy movement and in particular the popularity of Seymour Papert's LOGO-based curriculum programs as examples of how education has increasingly adopted the notion that computers, as information-processors, are ideal tools for teaching children to "think." Programming environments like LOGO are promoted as tools that encourage young children to "think about thinking" as they program the computer. While

Roszak agreed that LOGO does encourage students to think, he carefully pointed out that LOGO promotes a "certain kind of thinking," which he described as "procedural," rule-following, formalized thinking (p. 75). A problem therefore arises when educators begin to regard the computer as a general "cognitive tool," when in fact the kind of cognition represented in and amplified by a computer is but a narrow slice of the broad spectrum of intellectual activity.

This situation is further exacerbated by the desire to extend the instructional use of computer technology to nearly every discipline and subject-matter (Apple, 1986; Bowers, 1988). Citing the use of a LOGO program that generates "poetry" for a language arts class, Roszak (1986) raised concerns about the underlying cultural and epistemological assumptions that are being transmitted to students. According to Roszak, educational technology enthusiasts, in their quest to computerize across-the-curriculum, are in danger of "cheapening whole areas of intellect" as they formalize intellectual activity into rule-following analogs that the computer can mimic (p. 86). Using computers to create poetry, for instance, teaches children that "creating literature is nothing but filter[ing] vocabulary through linguistic formulas . . . The lesson hastens to teach the data processing model of thought. This leads inevitably to the conclusion that the human mind and the computer are functionally equivalent" (p. 81). Furthermore, Roszak added, "The children learn the grand reductive principle: If the computer cannot rise to the level of the subject, then lower the subject to the level of the computer" (p. 78).

Other scholars have criticized the educational computing movement along similar lines. Davy (1985) argued that computers "embody a mechanized version of thinking" and that instructional uses of computers therefore tend to promote "mechanical thinking" (p. 11). Broughton (1985) challenged the increasing educational emphasis on computer literacy on the grounds that it further elevates instrumental reasoning as a privileged form of knowledge. Sloan (1985) suggested that computers reinforce the "mechanistic imagery" that has guided scientific inquiry and, in particular, the fields of cognitive and behavioral science. These concerns about a computer-based education all reflect the notion that technology influences the epistemological framework of a culture, the "master ideas" about what constitutes knowledge, thought, and learning.

Bowers (1988, 1993a, 1993b) has provided the most comprehensive analysis of how computer technology, embedded with a particular set of ideological and epistemological assumptions, mediates the student's experience of culture. He explored the connection between the metaphorical nature of language and the socialization processes that involve a student's acquisition of basic conceptual templates (worldview). Bowers argued that the iconic and generative metaphors students encounter in the educational setting frame their understandings (establish "the boundaries that separate the relevant . . . from the irrelevant"), especially when students are being introduced to some aspect of the culture for the first time (p. 48). With regard to the use of technology (i.e., computers, textbooks, video) in the classroom, cultural assumptions and guiding metaphors encoded into the technology by hardware designers, programmers, or publishing companies are transmitted to students. For example, students experiencing the learning process through computer-aided-learning *programs* that *drill* them on the *recall* of decontextualized *facts*, and who are given *feedback* through computerized *scoring printouts*, are coming into contact with a language environment that becomes the source of metaphors upon which they build their tacit understandings of what it means to *learn* and *know*. Similarly, as students learn how to "think" with LOGO or other programming tools, they are socialized to a Cartesian form of thinking that assumes knowledge can be broken up into "mind-size bites," that problems are solved through linear-logical procedures, and that understanding is essentially a process of organizing decontextualized bits of information.

Bowers (1988, 1993a, 1993b) has also explored the metaphorical nature of language and thought to explain how computer-mediated learning amplifies a "digital" (information-based) form of thinking over "analogic" (idea- or metaphor-based) thinking. Echoing the ideas of Dreyfus and Dreyfus (1985), Roszak (1986), Winograd and Flores (1986) and others, he argued that the computer, as a "Cartesian-machine," is "incapable of being programmed for forms of knowledge that cannot be made explicit and organized into discrete components or that have operational rules that cannot be formally represented" (1993a, p. 72). Therefore, the computer "can only deal with what has been abstracted from context and made explicit, like the date of an event, the parts of the body or a machine, the events of a historical period" (1988, p. 63). In other words, the computer can only "deal" with forms of knowledge that can be decontextualized and reduced to binary code. As an educational tool, it represents (amplifies) digital thinking, which is "linear, componential, and abstracting" (1988, p. 64). Analogic knowledge and thinking, which is comprised of the tacit-heuristic understandings that digital computers are ill-equipped to communicate or represent, is consequently reduced (de-legitimized) in the culture.

Bowers' (1988, 1993a, 1993b) analysis of the cultural transmission characteristics of computers in the learning environment has revealed a profound irony about the educational uses of computer-based technology. Although the microcomputer is now regarded by many in the educational community as the harbinger of fundamentally new ways of teaching and learning, it nevertheless represents a form of technology that, by design, reinforces an epistemology rooted in the Cartesian-Newtonian worldview born centuries ago. That is, educational applications of computer technology tend to promote information-processing models of the human mind, represent knowledge as culturally neutral and abstracted from context, and elevate instrumental-procedural-digital forms of thinking over analogic-metaphorical forms of thinking. To summarize the point in Bowers' words, educators are unwittingly "teaching a nineteenth-century pattern of thinking through a twentieth-century machine" (1993a, p. 67).

In conclusion, the discussion presented above has served to reframe the issue of technology in education as a broader cultural phenomenon that involves very profound implications for educators and reformers concerned with the quality of learning experiences offered in schools. An awareness of these implications is dependent upon a re-examination of some dominant cultural beliefs about the nature of technology and the idea of progress, as well as an understanding of how technology, language, and culture interact to alter the ecology of the learning environment.

CHAPTER FOUR: METHODOLOGY

As discussed in previous chapters, the current discourse about educational computing is characterized by a troubling lack of awareness of the cultural transmission process that occurs as technology is used in the classroom. As a result, scant research has been done on the issue of how computer technology influences, for good or ill, the language, culture, and thought patterns that make up the classroom ecology. Some scholars, therefore, have suggested a re-orienting of the research agenda towards these important issues (Bowers, 1988; Sloan, 1985).

In this chapter, the methodology used in this investigation of technology-saturated learning environments will be presented. First, the general theoretical orientation of the methodology will be discussed, with particular attention given to how questions regarding the cultural dimensions of technology-intensive learning require a qualitative, ethnographic approach to research. Then, the research context will be defined and data collection and analysis techniques will be summarized.

Theoretical Orientation of Methodology

The phenomenon of computer technology in schools has been studied in many different contexts and from many different perspectives. The questions that this study poses and attempts to answer suggest a critical-interpretive orientation to research. Rather than seeking to uncover, through decontextualized analysis, generalizable explanations of the effects of computer use in schools, this study endeavors to understand how teachers in a particular context have come to understand the role of technology in education. This study is therefore grounded in the tradition and principles of human science scholarship found in the works of Gadamer (1975), Kincheloe (1991), Siedman (1991) and Van Manen (1990).

Human science research is oriented towards understanding complex issues related to culture and value and therefore recognizes the role of qualitative research techniques and analysis. Questions about the interactions between technology and culture in a specific context, as this study addresses, are more appropriately suited to research methods that "avoid simplifying social phenomenon" and "are able to show the complexity, the contradictions, and the sensibilities of social interactions" (Glesne & Peshkin, 1992, p. 6-7). According to Kincheloe (1991), qualitative research provides an avenue for considering "social and cultural patterns of experience, or relationships among various occurrences, or the significance of such events as they affect specific human purpose" (p. 145).

This investigation is therefore situated within the qualitative research paradigm. Denzin and Lincoln (1994) have loosely defined qualitative research in this way:

> Qualitative research is multimethod in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (p. 2)

The naturalistic and interpretive orientation of qualitative research suggests a multi-method approach that allows for the collection and analysis of a variety of empirical materials, such as personal accounts, historical texts, and observational records. These materials in turn become the basis of constructing a rich account of the phenomenon, problem, or relationship being investigated. Nelson, Treichler and Grossberg (1992) have suggested that the choice of techniques to be employed in qualitative studies is not pre-determined, but arises out of the situation and depends on the nature of the questions and context being explored (cited in Denzin & Lincoln, 1994, p. 2).

The critical perspective in the methodological approach to this study is a belief in the importance of examining the taken-for-granted rationales and assumptions behind educational practices (Apple, 1986, 1990; Giroux, 1988; Kincheloe, 1991). Certain elements of critical theory contribute to the theoretical stance for this investigation: (a) the assumption that "theory and practice are indivisible, that there is always theory underlying, and embedded in, any practice;" (b) recognition of the inherent limitations of traditional (positivistic) approaches to social research; and (c) belief in the centrality of language in the "conduct, determining, and understanding of all social life." (Gibson, 1986, p.1-19).

The Research Context

The context of this study is the Vista Model Technology Schools project in the San Francisco Bay Area.[3] The California Model Technology Schools (MTS) program began in 1987 with legislation (Assembly Bill 803) that provided approximately a half million dollars per year for each of six demonstration sites throughout California. According to an MTS Collaborative brochure, the purpose of the funding was to "explore the full potential of educational technology in a range of classroom settings" (California Model Technology Schools Collaborative, 1994). The MTS program was designed as a research project to assess the uses and effects of new information technologies in schools. The Vista Model Technology Schools project is based in three schools: Silvercrest Elementary School, Glenview Junior High School, and Oakmont High School.

[3] In the interests of protecting the confidentiality and anonymity of the participants in this study, psuedonyms have been used in all references to the district, schools, faculty, and interviewees.

Oakmont High School and Glenview Junior High School were selected as sites for this investigation. Preliminary contacts were made with the school officials, who invited me to visit the campuses and explain in more detail the nature of the study. After subsequent telephone conversations and meetings with school officials, I was granted long-term access to the two sites.

The rationale behind choosing these particular sites, and the Model Technology School Program context in general, was that these schools represent a unique commitment to technological solutions in a traditional school setting. That commitment, made possible through a special relationship between the school district and the California State Department of Education, elevates the MTS experience to a symbolic level. Model Technology Schools can be seen as symbols of a broader cultural trend where high-technology solutions are sought for social problems, a recent example being the suggestion by House Speaker Newt Gingrich that all welfare recipients be issued a laptop computer ("Gingrich Suggests Laptops for Poor," 1995). They are, more specifically, emblematic of the growing reliance on technology to remedy problems in the educational system. The symbolic nature of the Vista MTS program is further enhanced by its geographic and cultural ties to the high-technology companies located within the boundaries of the school district. The campuses of Oakmont and Glenview are located in the heart of the fabled Silicon Valley, virtually within the shadows of the corporate headquarters of Apple Computer and other high-technology giants. These schools, therefore, offer a unique perspective on and context in which to better understand the phenomenon of educational computing.

Following site-selection and access negotiation, individual teachers were selected to participate in interviews. Since I was interested in understanding the experiences and thought processes of teachers who regularly use technology in their instruction, it seemed appropriate to identify prospective participants who were making significant use of new technologies in their daily practice. Initially, I relied on school administrators at both sites to assist me in finding candidates for the study. This first "screening" process yielded a list of teachers that I then proceeded to contact. In some cases, the principal or vice-principal of the school made the initial contact with the prospective interviewee.

After a period of a few days, six teachers from this first list had agreed to participate in the study. Others who had been initially identified by the administrators chose not to participate in the study. At that point I requested that I be allowed to identify additional participants through informal conversations and visits to classrooms. Shortly thereafter, I was able to identify six additional participants who were both interested in the issue of technology in education and willing to make a commitment to the study. All twelve participants were informed of my intentions and obligations as a researcher, and each signed a human-subjects consent form (see Appendix A).

The twelve participants, eight women and four men, included six faculty from Oakmont High School and six faculty from Glenview Junior High School. Interviewees selected for the study were full-time classroom teachers employed by the school district with the exception of two: a student-teacher from a nearby university and a school librarian. It is noted here that my concern was not to gather and investigate a "representative sample" of faculty at these schools. Rather, I sought to better understand, through a dialogic process with members of a unique learning culture that value technology as an instructional tool, the assumptions and rationalities informing teacher practices (Siedman, 1991).

My intention to focus on the experiences and perspectives of teachers at Model Technology Schools was informed in part by Bowers and Flinders' (1990) argument that teachers occupy a central role in the cultural-transmission process that occurs in the classroom. They have contended that the role of the teacher is that of a "gatekeeper" of the symbolic environment of ideas and language students encounter in the classroom. That is, teachers "influence which aspects of the culture - ideas, values, social practices, technology, and so forth - will be made available to the individual who is having a first-time experience" with those areas of culture (p. 107). Bowers and Flinders maintained that the teacher's gatekeeper role is particularly potent in the area of language socialization:

> The words and concepts made available by the teacher establish the boundaries of what is to be thought about; they also provide the schema, or interpretive framework, for how the part of the culture that is being introduced is to be understood. (p. 108)

In other words, the way teachers discuss experiences and ideas, especially ideas that students are encountering for the first time, powerfully influence students' acquisition of the cultural templates they use to make sense of their own experiences. For example, the metaphors used by teachers when describing the use of technology in the educational process can amplify an orientation that views technology as "neutral" learning tools and teaching as the transfer of "objective" knowledge. In that sense, as Bowers and Flinders have noted, "language reproduces the thought processes of others" (p. 108).

Profiles of the participants

Carol Hutchins

A veteran mathematics-computer science teacher and department chair, Carol has taken a leading role in the school's MTS project, involving herself in various training seminars and workshops as both a participant and organizer. Carol's low-key demeanor becomes noticeably more animated when she talks about how technology has changed her experiences as a teacher. The internet seems to be the focus of her interest and enthusiasm. She feels proud to have been a part of the MTS project and also in increasing student enrollment in computer programming courses at her school.

Anne Turner

Also a veteran teacher in the district, Anne has been teaching in the science department at her school for several years. Like Carol, Anne has been a leader in the MTS project from its inception, an original "cohort" in charge of teacher preparation. She is a popular colleague and teacher; energetic, funny, fast-talking, opinionated, and very bright. She confesses that she doesn't speak "techie," but feels very strongly about the value of technology in the curriculum. She is often asked to speak at seminars and workshops held at various schools in the area. Anne says that technology helped "energize" her career just when she was feeling burned-out.

Linda Larkin

An instructor in the foreign languages department, Linda has been at her school for several years and is also well-liked by staff and students. She became one of the "cohorts" in the early part of the MTS project and in that respect has been an advocate for technology at her school. Linda admits that she "knew absolutely zero" about computers before the MTS project. She projects a strong professional image, dresses well, has an up-beat personality, and a good sense of humor.

Michael Dooley

A relatively new teacher at his school, Michael teaches math and computer science. Michael worked in the private sector as an engineer before starting his teaching career. He feels positive about the MTS project and sees student awareness of and exposure to technology as necessary part of school curriculum.

Michael is matter-of-fact, logical, confident, casually dressed, and highly regarded among his peers and students.

Maria Friedman

Maria teaches in the foreign languages department and has been at her current position for several years. She is thoughtful, intellectual, demanding of her students, articulate, yet soft-spoken. She has supported the MTS program from the beginning and is one of the more innovative teachers in her department, but admits she is "pretty non-technical."

Donna Rodriquez

A student at Stanford University, Donna is currently completing her student-teaching program, teaching courses in mathematics and computer science. Donna has more of an outsider's perspective and possesses only limited knowledge of the MTS project. She is young, thoughtful, reflective, excited about how technology is changing education, but not unaware of some problematic issues that technology presents. Donna is highly focused on the demands of the student-teacher program and concerned about the stress, evaluations, planning, and preparation that come with that territory.

Janet Fujimoto

Janet is a social studies teacher and has been in the district for several years (her first year in her current position was also the first year of MTS funding at that site). Janet is well-dressed, personable, and approachable. She is frequently asked by the principal to present at various technology workshops and to receive guest visitations. She is favorable towards the MTS project and feels that she is "lucky" to be at her school and have access to new technologies.

Sarah Marsh

Sarah is fairly new to her school and has only been teaching for about six years. She teaches mathematics and was hired during the final phase of MTS funding. She is very warm, sensitive, low-key, committed to what she is doing, and possesses a generous laugh. She states that she felt a little overwhelmed by the MTS project upon her arrival but now is considered a leader in her department with innovative uses of technology. Sarah was in the private sector before going into teaching.

Steven Furtado

Steven is a science teacher who was hired the first year of the MTS project at his school. Young, energetic, loved by students, and an original MTS project "cohort," he is considered the resident "techie" or "whiz-kid" by other teachers. Steven said that it felt "natural" for him to become a leader in the use of technology. He has been an strong advocate of technology in the curriculum, loves to talk about computers in education, and enjoys helping other teachers with technology.

Alan Rowe

Alan is a veteran language arts teacher, but relatively new to his school. An innovative teacher, he takes pride in the fact that he has continued to learn and grow over the years. In spite of feeling a little intimidated by the technology he confronted when he first arrived, Alan views the MTS project in a positive light. He is also more acutely aware than others about the "downsides" to technology in schools and broader social issues. Generous, articulate, warm, humorous, Alan loves teaching and understands kids.

Dan Stevenson

Relatively new on staff at his school, Dan's current position as a science teacher has been his first and only teaching job. He feels fortunate to be teaching in a MTS school, and, like Mr. Furtado, represents a new generation of teachers who place great value on technology as a means of "revolutionizing" school. Dan talks in grandiose terms about the possibilities of technology in education. He is articulate, bright, well-liked by students, and an innovative teacher who is already well-respected by colleagues.

Barbara Ross

A librarian in the district for many years, Barbara moved to her current post a few years ago when the MTS project was just beginning. The library now houses two computer labs, so she is involved daily with the new technology and in helping students and teachers use it. She juggles her regular librarian duties with the new responsibilities of troubleshooting network "bugs," broken equipment, and various technical glitches. Barbara is very friendly, patient, and relaxed. She embraces the move to convert her library into a high-technology media center.

Data Collection and Analysis

Qualitative research calls for data collection techniques that situate the observer in a dialogic relationship with the observed and immerse the researcher in the "texts" of human experience (Glesne & Peshkin, 1992; Van Manen, 1990). Those texts, in turn, serve as a basis for interpreting the essential meanings of the phenomenon studied. Thus, the methodology proposed here relies heavily on the hermeneutic tradition in the human sciences (Gadamer, 1975).

In this study, three modes of data collection were used: document analysis, open-ended conversational interviews with the participants, and on-site observations of technology-mediated learning activities. Through interaction with these formal and informal texts (i.e., policy statements, conversations, classroom observations), I sought to gain a deeper understanding of how teachers come to understand the role of technology in education, as well as how those guiding assumptions manifest themselves in the classroom and school ecology.

Document Analysis

In the pilot study summarized in Chapter Two, document analysis was conducted on various state and local policy statements concerning the use of computer technology and information systems in the classroom. According to Glesne and Peshkin (1991), a pilot study can be a valuable tool used by researchers to clarify research questions, test the rationale and design of the research project, and, in general, prepare themselves for the study. The pilot study focused on official statements guiding the use of technology in the social science curriculum. However, many of the documents reviewed were "generic" guidelines addressing the entire educational experience. The results of this pilot study can be considered as representative of general assumptions and rationales that inform educational technology policies in California.

The documents reviewed in the pilot study included the following policy statements and information resources published by the California State Department of Education: (a) Technology in the Curriculum: History-Social Science Resource Guide (1986), (b) Strategic Plan for Information Technology (1991), (c) The California Master Plan for Educational Technology (1992), (d) Second-to-None: A Vision of the New California High School (1992), (e) Building the Future: K-12 Network Technology Planning Guide (1994), and (f) miscellaneous California Model Technology Schools brochures and promotional materials.

The purpose of this analysis was to identify the explicit guidelines and implicit assumptions that comprise the institutional vision that guides educational use of technology in California public schools. Glesne and Peshkin (1991) have discussed the importance of document analysis as a means of providing both historical and contextual dimensions to stories and experiences encountered through observations and interviews. In assessing the philosophies of technology, curriculum, and instruction embedded in these official documents, one can begin to understand the rationalities and guiding assumptions that inform the Model Technology School experience. (See Chapter Two for a presentation of the findings of the pilot study.)

Interviews

After the pilot study was completed and participants for this study selected, the focus of the investigation turned to the interview process. Following the guidelines for interviewing in educational research outlined by Seidman (1991), two interviews were arranged with each participant, one at the beginning of the research period and one towards the end. (All but one participant were interviewed twice. I was unable to conduct a second interview with Barbara Ross due to a family emergency. She was unavailable during the final days of the study, and I was unable to reschedule a second interview before the conclusion of my time at Glenview.) These interviews were approximately forty-five minutes to one hour in length and consisted of open-ended, semi-structured questions. Interviews were conducted in a convenient, comfortable area, most often in the participant's classroom, the teachers' lounge, or in a vacant office on campus. With the permission of the interviewees, I recorded all conversations on audiocassette, thus enabling me to fully participate in a natural dialogue with the participant without the need to record comments by hand. In addition, these audiotape recordings allowed me to capture these conversations more precisely and, through transcriptions, share those texts for reflection with participants.

The purpose of these interviews, in keeping with the tradition of qualitative inquiry, was to generate a "text" that provided additional perspectives on the complex phenomenon of technology in education (Gadamer, 1975). The interview process itself was based in part on Kieffer's (1981) "dialogic retrospection." This strategy is grounded in the theory and technique of existential phenomenology and dialectical psychology. That is, dialogic retrospection is an approach that seeks "to capture the qualitative and relational aspects of the phenomena studied" and "strives to maintain the holistic character of the life-world" of experience and thought that is the focus of the inquiry (p. 8, 11). Giorgi (1975) has articulated five principles of human scientific psychology that serve as a conceptual foundation for Kieffer's method of dialogic retrospection: (a) affirmation of the primacy of the everyday life-world as the ground and context of research, (b) fidelity to the phenomena studied as they are lived, experienced, and described, (c) reliance upon the descriptive language and personal viewpoint of the subject as its primary data points, (d) a view of assessment and articulation of personal meanings as its central measurements, and (e) the assumption that the researcher is engaged and plays an active role in the constitution and interpretation of the data of research (cited in Kieffer, 1981, p. 11-12).

Simply defined, dialogic retrospection is a method of inquiry that relies on interviews with participants and their active participation in the construction of meanings through a dialogic process. While the limitations of this study prevented a more complete collaboration with participants (as to the questions, design, and implementation of the research), it is emphasized here that this study was conceived of and valued as a participatory endeavor. Kieffer (1981) has described participatory research as one where "its participants are engaged in personally meaningful critical reflections upon individual growth experience" (p. 3).

Dialogic retrospection involves essentially four steps after participants for the study have been recruited and the research focus has been clarified: (a) conducting initial interviews, (b) preliminary analysis of data, (c) conducting follow-up interviews, and (d) final integrative analysis.

Interviews were conducted as a process of "dialogic exchange" in an open-ended, flexible, and conversational manner (Kieffer, 1981, p. 26). In this way, the interviews allowed for both the participant and the investigator to engage in the joint-construction of meanings. Interviewees were asked to describe their experiences and thoughts about integrating new technologies into their curriculum and instruction (see Appendix B). My intention was to ask questions that would illicit a discussion of the role and value of technology in general terms, as well as prompt a sharing of personal experiences and specific examples. Participants were encouraged to elaborate on brief answers and explain their thought processes and choice of words, but I was careful not to "lead" the interviewee to a predetermined set of conclusions or observations. Subsequent to each interview, usually immediately following the interview, I recorded my thoughts and impressions of the conversation. These reflections became the basis of my preliminary analysis of the interviews and also an important element of my research field journal.

After the first round of interviews, audiotapes were transcribed, and these transcriptions became the focal point of a preliminary analysis. Transcribed interview texts were read several times, significant statements were noted, distinctive words or phrases were underlined, and possible meanings or themes contained in the text were tentatively identified. Glesne and Peshkin (1992), Kieffer (1981), Mishler (1986), Seidman (1991), and Van Manen (1990) all have stressed the importance of this "theme-generating" phase as a critical stage in the interpretation of the text. Kieffer (1981) described this process as "sifting for kernels of meaning" and notes that the researcher must guard against prematurely "imposing" a "conceptual elaboration" on the data (p. 34-35).

This phase of preliminary analysis was followed by the second interview. Prior to this interview, each participant was given an unedited transcription of their first interview and encouraged to read and reflect on it before meeting for the second interview. Kieffer (1981) noted that this opportunity for participant review and reflection on the first conversation is a key element in the dialogic process. During the follow-up interviews, I asked participants to respond to the accuracy and thoroughness of their prior descriptions, provide elaborations of meanings already shared, and join me in the interpretation and analysis of their "stories." As Kieffer emphasized, these follow-up conversations contribute to the validity and rigor of the analytic process by "explicitly provid[ing] participants with an opportunity to present their own reactions to and interpretations of the earlier conversations" (p. 36). Thus, the process of dialogic retrospection itself serves to validate emerging interpretations as the researcher and the participant engage in a cooperative dialogue. Vandenberg explained that this dialogic modality provides "the intersubjective test appropriate to a humanistic methodology" and therefore a "means to avoid subjectivism" (cited in Kieffer, p. 13).

The last phase of this process involved an integrative analysis of both interviews. I reread all transcriptions and revisited my preliminary themes, checking them against the clarifications and elaborations that participants provided in the second interviews. After a period of refinement and continual dialogue with the texts, a set of primary themes emerged as the basis for interpretation.

Observations

Observations of selected technology-saturated contexts were also conducted to gain insights into the nature of the cultural transmission process that shapes the learning experience at these Model Technology Schools. Initially, I had intended to observe, on regular basis, the classrooms of the interviewees. However, it became clear early on in the investigation that most participants did not use new technologies (i.e., computers, CD-ROM, etc.) for instructional purposes on a daily basis *in their classrooms*. I learned that both schools had decided at the inception of the MTS project to concentrate the majority of the computers and other technology in centrally-located "labs." Most teachers, therefore, were required to schedule class time in the computer labs in order to conduct technology-based lessons or activities. As a result, it became apparent that continual observations of participant classrooms would yield little in the way of understanding the cultural dimensions of technology-enriched learning. At that point I decided to conduct most of my observations in the schools' computer labs where I would encounter significant teacher and student interaction with technology. Simply put, I had to go to "where the action was."

"Where the action was" at Oakmont High School turned out to be four computer labs located in one building. The labs all housed networked Macintosh computers and printers. One lab was used almost exclusively by keyboarding and wordprocessing classes. Another lab was used predominantly by the Mathematics-Computer Science Department for computer programming and the new Internet classes. The newly opened computer lab in room six was the showcase of the school, containing approximately twenty recently purchased color Macintosh systems with internet access and full networking capabilities.

While Glenview also decided to house most of the MTS-acquired equipment in a central location, I found their situation to be somewhat different. Instead of setting up isolated computer labs, Glenview opted to locate approximately thirty-five Macintosh computers in two separate areas of the school's library. Like Oakmont, these computers were networked, had extensive internet access, and were served by several high-quality printers. Similarly, teachers at Glenview were required to sign-up in order to have their classes use the computer labs in the library.

Both of these computer lab areas became the focus of most of my observations throughout the course of the study. For a period of about six weeks from late January to early March 1995, I visited the computer labs at both schools (approximately six to nine hours per week at each site), often encountering classes from various curriculum areas engaged in some form of computer-based learning activity. These observations most often involved the interviewees, but occasionally other faculty as well. When that situation arose, I introduced myself to the instructor and asked permission to observe the activity in the lab.

The observational phase was generally based on the ethnographic techniques described by Levine (1990) and Woods (1986) for the field of education. I approached observations from the point of view of a cultural anthropologist encountering a complex ecology of language, communication patterns, social interactions, and physical objects and arrangements. Bowers and Flinders (1990) provided examples of classroom observations that successfully uncover the tacit dimensions of the primary socialization that occurs as these elements of an ecology interact. For instance, they offer an illustration of how language and non-verbal communication features of a teacher's lesson can be analyzed to reveal the "network of metaphorical understanding" guiding (reframing) the cultural transmission process (p. 30-31).

Throughout the observation process I sought to maintain a heightened level of awareness and curiosity needed to recognize the "hidden," taken-for-granted dimensions as well as the explicit or "obvious" events that make up the experience (Glesne & Peshkin, 1991; Van Manen, 1990). Even though I have had extensive experience with technology in the classroom, I sought to "make the familiar strange" as I observed teachers, students, and technological systems interacting with one another (Erickson, 1973).

During these observations I maintained a fairly detached presence, although at times I found myself being drawn into a more participatory role as teachers and students inquired about my project, asked me to assist them with the computers, and shared their thoughts and ideas in informal conversations. In general, I felt that these observations required a high degree of concentration and focus on the multi-dimensional interactions taking place in the classroom, and I therefore concluded that a more non-participative role would allow me the most flexibility and breadth of vision. In that sense, I functioned primarily in what Glesne and Peshkin (1992) called an "observer as participant" mode (p. 40).

Descriptive and analytic field notes were used to record my observations concerning the kinds of conversations and interactions taking place, the role and meaning of the technology in the classroom, and the ecology of relationships and communication patterns that characterize the classrooms and computer labs at Oakmont and Glenview (Glesne & Peshkin, 1992; Woods, 1986). These field notes tended to be anecdotal in nature, as I focused not on any one specific category of events but on capturing an overall impression of the scene as it unfolded moment by moment.

Finally, in keeping with my focus on the cultural dimensions of the technology-saturated environment, a variety of artifacts found at Oakmont and Glenview were collected and analyzed (i.e., school publications, computer print-outs, examples of student work). Hodder (1994) has argued that the study of material culture can be an important aspect of a qualitative study that is oriented towards anthropological analysis. I found these artifacts to be rich source of insights into the values, beliefs, and rationalities that make up the mental ecology of the MTS culture.

In summary, this study utilized qualitative research approaches, including elements of dialogic retrospection, ethnography, and critical hermeneutics to construct a narrative about technology in secondary classrooms. The data generated in this investigation consisted of information and understandings garnered from the document analysis, observations (field notes), participant interviews (transcripts), and artifacts found at the sites. The collected data was analyzed and interpreted as texts of lived experience that contain patterns of thought, metaphorical language, and conceptual frameworks (Gadamer, 1975; Van Manen, 1990). This interpretation arises out of a descriptive account that, as Geertz (1973) has suggested, "goes beyond the mere or bare reporting of an act

. . . but describes and probes the intentions, motives, meanings, contexts, situations and circumstances of action" (quoted in Denzin & Lincoln, 1988, p. 39). In this sense, the texts were viewed as part of the cultural discourse about the phenomenon of educational computing. That discourse was analyzed for insights into the nature of the ecology of a Model Technology School classroom.

CHAPTER FIVE:
DATA PRESENTATION AND ANALYSIS

In this chapter, the discourse on technology, teaching, and learning that occurs among teachers at Model Technology Schools will be presented and analyzed as a means to understand what technology has come to mean for educators in those contexts. In particular, dominant assumptions regarding the nature of technology and role of technology in education contained in the discourse will be identified. This analysis will serve as a starting point for a more in-depth exploration of how those assumptions are manifested in the broader ecology of the MTS experience. In Part II of this chapter, observations of cultural-amplification occurring in these contexts will be presented in an effort to better understand the cultural, ideological, and epistemological dimensions of technology-mediated learning.

Part I: Assumptions That Guide Teacher Discourse on Technology, Teaching, and Learning

As articulated earlier, this investigation seeks to uncover the assumptions and theoretical biases that influence the way teachers at Model Technology Schools think and talk about the role of technology in education. By focusing on how teachers bring to language their personal experiences and perspectives, I was able to identify the more general beliefs that constitute the conceptual lens through which they view their own experiences as teachers in Model Technology Schools, as well as the general technology-in-education movement.

Dominant assumptions about the nature of technology and technological change

A set of taken-for-granted assumptions about the nature of technology and technological change are greatly influencing the way participants in this study frame their perceptions about the role and value of technology in schools.

These core beliefs can be summarized as: (a) Technological development is inevitable, (b) technological change is inherently progressive, and (c) technology is culturally and ideologically neutral.

Technological development is inevitable

The teachers interviewed at Glenview Junior High School and Oakmont High School tended to subscribe to the dominant cultural belief that further technological development is an unalterable fact of life. In many of these conversations, technological change was referred to in fatalistic, matter-of-fact terms, as if technology was an unstoppable force that proceeded on its own terms, regardless of human and ecological consequences. Carol, echoing the point of view held by virtually all the interviewees, said simply "Technology is here to stay. It's not going to go away. . . My husband won't touch a computer, he's afraid of them. But the generation [of students] we have now, [they] can't be that way." Dan invoked a rather common metaphor to describe technological change by saying "I think it is inevitable. You know, you can't put the Genie back in the bottle. It's out. It's going to spread. It's going to proliferate like anything. And [students need to be] ready for that."

With technology being referred to by many of these educators as something virtually beyond limits or control, as something that will "spread" and cannot be contained, it is no surprise that they subscribed to another dominant cultural belief: the only appropriate response of individuals and institutions to rapid technological change is to adapt to the technology as quickly as possible. This remark by Dan is dramatic, yet typical of the attitudes towards technology that I encountered at Oakmont and Glenview:

> I'm not really sure that we can stand in the face of this tidal wave that is coming. I mean, I really think that it's just a tidal wave, and it's just going to hit us. And we can either . . . say "Just reject it! Reject the tidal

> wave. Just pretend it's not coming! Just keep going towards this other stuff." Or, we can prepare our students for the tidal wave when it hits, so that they can ride it. Because they are either going to get buried by it, or they are going to ride it, they're going to be able to surf it.

The metaphorical language used here clearly reflects the degree to which technological development is seen, at least to this participant, as a force that one cannot resist. Only a foolish person would stand in the way of a tidal wave! The only rational alternative is to ride the "wave" of technology and hope that it takes you to a place you want to go. This either-or mentality (either individuals adapt to technology or "get buried by it") dominated how the teachers interviewed at Oakmont and Glenview framed their relation to technological development in education and within the broader social context.

Participants often expressed a general dissatisfaction and anxiety about schools being slow to keep up with the latest technological developments. As I talked with teachers, I got the sense that as a group, they were concerned about their own ability, as well as that of their student's, to cope with life and work in a technological age. At the same time, however, they were excited about the new opportunities they believe new technologies will bring. For instance, Michael remarked:

> I would hope that all students coming out of [this school] would at least have a taste of that world that is being created because, you know, *it's the way things are going to be.* And I think that a school that doesn't have [technology] . . . the students will not be aware of the possibilities out there. [italics added]

Here again, one detects the underlying assumption that technological development is inevitable, a taken-for-granted aspect of the future. Technology represents "the way things are going to be," and symbolizes a world of "possibilities." One implication of this perspective is the belief that technological innovation, because it is inevitable, is beyond a critical examination of both the appropriateness and consequences of change.

The assumption that technological development is inevitable raises a number of important questions for educators that are largely ignored in the mainstream discourse on technology in education. For example, what are the implications of regarding the technological upgrading of schools as inevitable and therefore beyond critical questioning? What might be the dangers in assuming that education must appropriate the latest information technologies in the interest of "modernization?"

Technological change is inherently progressive

Another distinctive feature of the discourse relates to the teachers' belief that technological change is inherently progressive in nature. Participants generally framed their comments about technology in positive terms, and few openly questioned the dominant cultural orthodoxy that technological development has a generally positive impact on society. When referring to the rapid proliferation of technological breakthroughs, a large number of which originate from the dozens of electronics and communications firms located in the area, teachers used words like "amazing," "wonderful," and "awesome." In a characteristic statement that links technological development with progress, Donna remarked:

> To me it's just sort of the ever-developing present of what we are doing as a global community . . . and I feel that the progress that we are making in this world, I think we are doing O.K. . . . It's just a continual learning process and people are always building on the progress made by those before them . . . and it's just a continual development.

These comments appear to represent technological development as something of a global project unifying the nations of the world around a common vision of technical progress. This "continual development" was assumed to be "O.K.," with the ecological and cultural consequences of that "learning process" seemingly ignored or unrecognized. It is significant to note that throughout my conversations at Oakmont and Glenview participants rarely initiated any discussion about the limitations or negative consequences of technological development.

Technology was primarily regarded as an agent of positive change to make life easier and offer new opportunities. Teachers tended, therefore, to express a belief that they and their students must accept and become knowledgeable about these new technologies. As Michael explained,

> The more that students are comfortable working with technology and adapting to the new technologies that come in, it's going be a benefit to them . . . And just being comfortable with anything new that comes along . . . [Employers] want to [see] that you have that knowledge base.

The assumption that individuals must adapt to technology, must be "comfortable with anything new comes along," and not resist or question continual technological development was echoed in a similar line of reasoning expressed by Sarah:

> I think students need to be flexible that way. They need to see technology as what the world out there is using, and that they are a part of it. And that *when something new comes along, they have to embrace it and use it and learn it,* and then incorporate it into the rest of their lives. And so, if we are not using it in the classroom, we are going to throw these kids out there . . . [with knowledge of] old technology. [italics added]

Here, it is taken-for-granted that technology must be "embraced" and fully integrated into an individual's life. The belief that technology is destined to evolve and expand, therefore, requires individuals to remain "flexible," always open to go wherever technology might lead. It is important to also note the implied assumption that students who are not given opportunities to "use and learn" the latest technologies will be disadvantaged, forever handicapped by a reliance on "old technology." The theme of preparing students for a technological future was a dominant feature of the discourse and will be discussed in more detail in the next section.

The assumption that technological change is inherently progressive, while reflecting a more general cultural orientation towards a technocratic view of progress, represents yet another dimension of the conceptual framework that influenced the way participants in this study understood the issue of technology in education. One might argue that it is not surprising that this faith in "progress-through-technology" would be particularly strong among teachers in Silicon Valley communities. After all, the growth and success of high-technology industries has determined the economic well-being of many families and, indirectly, school districts located in the area. Bowers (1988, 1993a) and others, however, have noted that this assumption is based on an ideology that equates technology with progress and privileges technical interests above other areas of human and ecological concern. As a result of this uncritical stance towards technological change, acknowledgment of the problematic aspects of a technology-intensive education are virtually absent in the discourse.

Technology is culturally and ideologically neutral

In addition to the assumptions that technological development is inevitable and that technological change is inherently progressive, the discourse reflected yet another cultural myth regarding the nature of technology: technology is a culturally and ideologically neutral "tool" whose purposes and effects are determined solely by its designers and users. Linda's comments were typical: "I view [technology] as another one of the teaching tools that I have at my disposal that um . . . allows me to connect with different types of students in the classroom." This statement reveals a tendency to view technology as objects that are simply at one's "disposal" and therefore, by implication, devoid of inherent amplification-reduction characteristics (Bowers, 1988).

During the course of conversations with the participants, they often reminded me that technology is "just a tool" that can be used to make things better, faster, more efficient. For example, Anne commented that:

> Technology is just another tool. I mean, I don't think a car is great for a car's sake. It's something that let's you get somewhere. Yes, it's great to have the bells and whistles, but if it doesn't work, we're in a lot of trouble.

Many teachers articulated a similar point of view, which seemed to limit the criteria for evaluating a new technology to whether or not it "works." This focus on the instrumental value of technology to the exclusion of how technology, even if it works, might bring about unforeseen ecological, cultural, or ideological changes was a dominant feature of the discourse. This perspective reflects a general orientation within the discourse towards the technical interest, as defined by Habermas (1972), that emphasizes technical performance over critical understandings of the political and moral implications of technological development (see p. 64 - 65).

Technology was also referred to as a "value-free" tool that can be used for good or bad purposes. Dan put it this way: "Technology is amoral. It has no moral anything, it's not good, it's not bad, it's not dark, it's not light, it's just technology, it's a tool." Bowers (1988), Mander (1991), Postman (1992), Winner (1986) and others have noted that disconnecting technology from its built-in biases results in the flawed assumption that the design and application of new technological systems has no moral or ethical implications. This line of thinking encourages the view that all innovations, from the microprocessor to nerve gas to the Human Genome Project, can be regarded as neutral, amoral, value-free products of science capable of being put to good or bad uses. As a result, a dangerous form of moral relativism is promoted under the guise of the presumed neutrality of science and technology.

Participant discourse on technology, framed in language that reinforces the notion of technology as a neutral object, often downplayed or ignored the significance of technology in the cultural-mediation process. For many, the sophisticated technologies they use in their teaching had become "second-nature" or a "natural" part of the learning environment. As Anne explained:

> I mean, for me, it is completely transparent. I don't even think about it. I mean, people say "Are you using technology?" [And I reply], "No. What do you mean?" You know, [they say] "Well you've got all this stuff." [And I say] "Well, that's not technology, that's just stuff."

This comment discloses the degree to which technology in general is understood in simplistic terms that fails to take into account the powerful cultural and ideological dimensions of technological development. As a result, technology becomes a taken-for-granted, "transparent" element in the learning environment, "just stuff" that is considered to be of no consequence beyond the narrow concerns of teaching course content.

When teachers talked more specifically about technology as an instructional tool, their belief in the essentially neutral nature of technology was reflected in an apparent lack of awareness of the cultural-transmission characteristics of classroom technology. New technologies, like the computer, are seen as ideal tools for instruction because they are perceived as being culturally neutral. This idea is evident in Michael's comment that "[Technology is] just a tool . . . [that is] there to help [students] . . . produce, create, and access information that otherwise isn't available to them." Echoing a similar perspective, Carol added:

> Technology is not going to replace teachers, it's not going to replace anything. You know, you can use a blackboard, you can use graph paper.

> It's just . . . with technology, it's a tool that you can do things better, faster, the kids are more active on it. So, it's a tool, just like a blackboard is a tool, chalk is a tool, graph paper is a tool.

What is significant about this discourse is what is *not* being said or reflected upon. For instance, Michael implied that the learning process is dependent upon the students' ability to access and manipulate context-free "information." Not only is this idea based on a narrow view of learning and knowledge, his statement exposes a failure to understand how computers amplify a false sense of objectivity. Bowers (1988) has argued that the notion of "objective," computer-generated data veils the fact that information gathered and stored on a computer is an interpretation itself, influenced by the conceptual framework of the individual who collected the data and further limited (distorted) by the design of the technology. Carol suggested that all instructional technologies, even the most rudimentary, are "just" tools to help students "do things better." Her statement, however, appears to lack a recognition of the non-neutral nature of instructional tools and, in particular, how computer technology has contributed to automation in the workplace and the overall deskilling and standardization of educational practice (Apple, 1986; Giroux, 1988). The language used by Michael and Carol reinforces both a simplistic information-transfer model of instruction and a mistaken view of technology as culturally and ideologically neutral.

In general, the discourse on educational computing that occurred at the two Model Technology Schools strongly mirrored the generally uncritical view of technology found in the broader culture, where a modernist vision of progress-through-technology is embraced. Participants not only articulated little awareness of the culture-technology dynamic, they did not appear to have an understanding of the non-neutrality of technology, that is, how technology mediates experience and alters patterns of thought and language. These conclusions are hardly surprising given the cultural and professional context in which these educators work. As argued in Chapter Two, the administrative philosophies and instructional practices currently dominating the field of education have been heavily influenced over the years by a technocratic ideology seeking to "scientifically manage" the learning process, in part through the use of technologies like radio and television that were perceived as being "neutral" transmitters of knowledge.

Dominant assumptions about the role and value of technology in schools

Conversations with teachers at Oakmont and Glenview revealed an underlying conceptual framework regarding the nature of technology and technological change that I believe informs their perceptions about the educational uses of technology. This framework includes a set of assumptions that scholars have linked with the modern, technocratic worldview that became dominant in the mid-nineteenth century (Bowers, 1988, 1993a; Postman, 1992; Roszak, 1986). Those assumptions (i.e., technological change is inevitable and progressive; technology is inherently neutral), in turn, serve as a foundation upon which teachers construct their personal perspectives about the educational uses of technology.

As I talked with teachers about the issue of technology in education in general, and in particular about their personal experiences as educators in Model Technology Schools, other dominant assumptions emerged in the discourse. This second set of beliefs, about the role and value of technology in education, can be characterized in the following way: (a) Technology prepares students to live and work in a high-technology society, (b) technology enhances classroom instruction, (c) technology assists teachers in accommodating student diversity, and (d) technology helps teachers manage the classroom. As we shall see, these core beliefs in turn point to other commonly held assumptions about the nature of learning, teaching, and the purposes of public education.

Technology Prepares Students to Live and Work in a High-Technology Society

It became clear that the participants believed the most compelling rationale for integrating technology into the school experience is *not*, as one would expect, the instructional benefits of technology, but a perceived need to promote a general "technological literacy." Technological literacy was presumed to be a requirement for living a productive, meaningful life in a high-technology economy and society. Because participants tended to subscribe to the belief that technological development is inevitable and virtually beyond limit (a fast approaching "tidal wave," as Dan put it), they reasoned that they had a professional obligation to prepare their students to live in the "Information Age." Their dialogue revealed a belief in the need to expose students to the new technologies, to help them feel comfortable with computers, and to help them cope with rapid technological advances. Janet explained that "There are a lot of positives . . . [about] feeling comfortable with the computers, getting kids used to using computers. That's one powerful thing, that they become acclimated to the computer environment." Maria, summarizing the rationale for encouraging teacher use of technology at her school, stated:

> We have to move into the twenty-first century and . . . we [need] to be able to deal with the technology that [is] available out in the market because our students will need to cope with it. So we need to be able to cope with it also.

Emerging from this shared belief about the role and value of a technology-saturated curriculum was the idea that a certain amount of technical skills and general "technological awareness" was required to live in an increasingly high-technology society, as evidenced by Donna's comment:

> If we don't prepare our students with a background in technology, we are not preparing them for the world that they are going into. I think we need to be preparing students for the world that they are going to be living in, which is the present and beyond. And that has to include technology, just with the way things are going.

Maria added:

> [T]he students [need to] be prepared to deal with the new technologies when they are adults and have to earn a living . . . and just to live, to live realistically and be able to cope with what's around them . . . I think they will be less well-prepared for the life they will have to live and the gadgets and the equipment they will have to deal with [if they are not exposed to technology in school].

Again, Donna reasoned:

> [As] these kinds of functions just become more and more commonplace, then, it's a societal thing, it's not just a job thing. It would be like someone who doesn't own a microwave and they insist on heating all of their food in the oven or on the stove . . . eventually you get to the point where everyone is using microwaves.

An analysis of the language contained in these comments reveals a common assumption of the need to "prepare for," "deal with," and "cope with" the "gadgets" that will inevitably be a part of life in the future. What is significant about this point-of-view is a general lack of critical questioning of the cultural or ecological implications of an increasingly technology-dependent society or educational system (Apple, 1986; Bowers, 1988; Roszak, 1986), as well as the absence of any alternative to the dominant cultural vision of social, economic, and political "progress" through technology (Mander, 1991; Postman, 1992; Winner, 1991). Instead, it is assumed that the only "realistic" response is to socialize students into an increasingly technical culture.

A corollary to this position assumes that an emerging high-technology economy will demand greater technical skills of the workforce in the future. Conversations revealed an across-the-board acceptance of the argument, often put forth by educational reformers and business leaders, that sophisticated technical skills will be needed in all sectors of the labor force and that it is the responsibility of public K-12 education to train the workers of the future (Pogrow, 1983). As a result, teachers often spoke of the value of teaching generic computer skills like wordprocessing and database functions. Teachers in the humanities as well as mathematics and science expressed a need to teach these new "basic skills." For example, Janet, a history teacher, commented "Just about any job that there is today is using computers for inventory control or whatever. I think having the technology here and the computer labs, and getting [students] into keyboarding is an invaluable thing." Donna, echoing the thoughts of nearly all the teachers, said matter-of-factly "I think . . . not having the [computer] skills will affect them in the job market, the workplace."

The general acceptance of the idea that computer-based skills are part of the survival skills necessary to function in a high-technology economy and society led many teachers to conclude that virtually *any* contact with new information technologies constituted a worthwhile educational experience. Note, for example, Sarah's comments:

> [It is important] that [students] have the experience of using some technology because that is part of teaching a student to be ready for what they are going to have ahead. The fact that a student has the experience of standing and working on an overhead camera and they go to apply for a job at Apple [Computer, Inc.] down the street, you know, that is something that they have done. And you don't put it on the resume but it just . . . you know, you look like you've got some background experience . . . *I think that just about everything we do, technology-wise, contributes to student success in the future* because that is what's out there. [italics added]

Michael concurred:

> I think the students gain in that they will be better prepared . . . [for] *everything they are going to encounter in the workplace and in their home.* I think their minds are being opened to some of the things that are out there as far as what you can do on the computer, what you can access on the computer, what it can do for you. [italics added]

Here again, one can detect not only an assumption that *all* students need to develop a "background" in technology, but that this background experience serves as preparation for *"everything they are going to encounter"* in the world. This line of thinking reflects a tendency on the part of some participants to elevate technical interests and knowledge to a privileged status, as well as hold a disturbingly limited view of human experience. One gets the impression that some teachers have unwittingly come to regard their students as little more than future high-technology workers. Again, the assumptions and rationales found in the participant discourse might be considered a manifestation of a more general cultural climate that influences the working conditions of teachers. That is, the beliefs and practices of the participants in this study can be viewed as "rational" responses to working in a school system that has a long tradition of viewing the workplace training of students as its most important mission (Apple, 1990).

Apple (1986), Mander (1985), Roszak (1986) and others have suggested that the recent demand for more technological literacy among students is based on a flawed set of assumptions about the nature of the labor market as well as a dangerously narrow view of the purpose of public education in a culturally-diverse, democratic society. Nevertheless, the belief in the need to prepare students to take their place as citizens and workers in the Information Age was the dominant feature of the discourse on the role and value of technology in education.

Technology enhances classroom instruction

Another assumption to emerge in the discourse regarding the role and value of technology in schools is the belief that new information technologies are especially suited to enhance classroom instruction. All participants expressed that they felt "lucky" or "fortunate" to be teaching in a school where they had so many instructional tools available to them. Dan explained:

> I don't know what it is like to work in a non-technology school, but I would be afraid to go to one . . . To go to a district that was very poor in technology and have to teach in some more standard ways, I would be afraid that my kids . . . you know, the discipline problems would multiply, because the kids wouldn't be as excited about the material. I would have to keep them reading and all of that.

Classroom teaching has long been conceptualized as a kind of "science" of applying proven techniques and tools to bring about learning (Bowers & Flinders, 1990; Doll, 1993; Giroux, 1988). The participants appeared to reflect this mindset in their valuing of new technologies as instructional resources. As Dan stated, "A lot of the equipment that I use in here, like the laserdisc, even the video . . . all of that stuff allows me to have instructional flexibility in what I throw at my kids." Michael's comments also amplified this perspective:

> [The] main purpose [of technology] is in giving many teachers another strategy to help get ideas across to the students or to help them get their curriculum covered . . . [Technology helps in] getting to all the students what you need to get across. And I think the technology here helps many [teachers] with that.

These assumptions support Giroux's (1988) argument that many teachers have been trained to view themselves as "technicians" in search of newer, better strategies and tools "to help them get their curriculum covered." That is, educators have been socialized to a belief that the key to increased student learning lies in applying "proven" techniques in systematic ways. This perspective suggests, not only a natural reliance on technology, but also another set of taken-for-granted assumptions about the nature of learning and knowledge. For example, Linda's comment that technology is "another tool to use . . . to make it easier for [me] to impart the information" unveils a belief in technology as a neutral transmitter of information and teaching as a process of transferring information (equated with knowledge) to students.

The value teachers placed on technologies as instructional aids was expressed in three main points: (a) Technology enhances access to and communication of content-related information, (b) technology provides quick feedback and a fast-paced learning environment, and (c) technology allows greater opportunities for students to engage in "higher-order" thinking.

Technology enhances access to and communication of content-related information. A belief that technology enhances both the teacher's ability to communicate information to students and the student's ability to access and manipulate information generated by the technology was prevalent in the discourse. The benefits of having "good material" available for students, of having access to "resources" and "experts," and of using technology to "present" the curriculum were repeatedly voiced. Donna explained, "I think that [technology] is very powerful because it is just a doorway to . . . reach so many other things. Like accessing resources on-line, I mean, that is just incredible."

Some teachers were enthusiastic about technologies like computers, CD-ROMs, and laserdiscs because of the sheer volume of information that can be stored and easily accessed for classroom use. Steven stated:

> If you have a laserdisc that has 50,000 pictures on it . . . and you could bring up a discussion in the class and use the laserdisc to follow the question at random . . . A thing that can show essentially any of the 50,000 slides at any time, that just blew me away.

Others emphasized the unique ability of telecommunications technology to connect the classroom to a "world of information" via the internet. For example, Carol commented that:

> The internet is just unbelievable. It's just another new door that has opened for me . . . because on there you have listservs that help both teachers and students. You have some college students who as part of their grade have to answer questions from [other] students, so you have [services] like "Ask Dr. Math" or "Ask a Scientist" [or] "Ask a Geologist." [Students can] ask about homework problems [and] within 24 hours, these students get back to my students with e-mail to answer their questions.

Reflecting a similar viewpoint, Barbara explained:

> I think things like the internet and the InfoTrac that we have . . . I think the kids are retrieving a lot of information . . . bits and pieces of things . . . that they probably wouldn't retrieve from books. [The] internet and information access to things tends to give the kids information in small bits rather than a 200 page book. In that respect, they are getting information.

As these quotes suggest, a distinctive feature of the discourse is an emphasis on the role of "information" in the learning process, as students use technology to retrieve "bits" of information and "answers" from on-line experts. This exposes a common belief that students learn as they come in contact with, analyze, and manipulate information. "[Technology is] . . . there to help [students] . . . produce, create, and access information that otherwise isn't available," explained Michael. This tendency to view learning as primarily contingent upon access to information (either through teachers, textbooks, or "experts" on the internet) and to view knowledge as incremental "bits" of information seems to reflect the same mindset that promoted the educational uses of earlier technological innovations like film, radio, and television (Bowers, 1988; Roszak, 1986). Now computers, the ultimate information-processing machines, are regarded as ideal tools for learning.

Related to this idea is the belief that technology assists teachers in communicating the course content to the students. As one teacher explained, "[Technology was provided] as . . . aids to teachers to help [us] disseminate the information that [we] wanted to for [our] curriculum." When participants described using technology as an instructional tool, they often spoke of employing combinations of hardware and software to "present material" to students. Anne's comments were typical of the discourse on the instructional value of technology:

> We look at handing out declarative knowledge, and [we are] looking at ways [we] can do that more efficiently, or allowing kids to really extend with it . . . It's so much better to have it on the computer where if they provide input or suggest changes, you can show it to them right there.

Later in the conversation, Anne added:

> If I've got a computer or laserdisc or something else that can deliver something better than I can, I mean, I want them to do that. So, I see my job as helping to direct students to different ways to acquire this knowledge, and then challenging them to find other ways to expand and refine it. And if the computer is a tool that allows them to do that, then I will push them in that direction.

Janet commented:

> I use the laserdisc a lot to bring illustrations [in]to the lesson . . . So students, for example, will read a lesson in the textbook, and then we'll be correcting the study guide the next day, but while we're correcting it, we'll go through the pictures that sort of illustrate the concepts of the person or object that is being discussed. And so that has been really great . . . having access to that.

It is significant to note the use of certain metaphors within the discourse reflect assumptions about learning and teaching that guide teacher's beliefs about the role and value of technology in education. The excerpts above express the view that technology helps teachers "deliver" material and "hand-out" knowledge to students; technology-accessed pictures are used to illustrate the "object" being discussed. Once again we see a didactic, teacher-centered, information-transfer model of instruction being the dominant framework within which teacher's construct their beliefs about the educational uses of technology. This framework can also be characterized as a form of the "banking-model" of pedagogy, critiqued by Freire (1970), that regards education as an act of depositing "knowledge" into students, who are in turn viewed as "containers" or "receptacles" to be filled.

Technology provides quick feedback and a fast-paced learning environment. A second common theme was the idea that technology can increase learning by providing students with quicker, more precise "feedback." Many teachers discussed the educational advantages of the virtually instantaneous response of the computer over the slower, more tentative, and often ambiguous process of human discernment. For example, Carol observed:

> [The students] get instant feedback [from the computer]. They type something in and it's instant. If they do it on graph paper, I would have to go around, or their neighbor would have to go and take a look at and say, "Well, I think that's right. I'm not quite sure, maybe that's it" . . . But if they are doing it on the computer, and if I'm on an overhead, [with an] LCD panel, [then] I can say "Does your graph look like mine?" Instant feedback, that's unbelievable . . . So it's instant feedback, it's instant gratification if you want to think about it that way. The students immediately know if it's right. If they don't, they immediately fix it and then they understand it and then they go on.

In this excerpt, technology is seen as providing a kind of instant-learning environment, where students can discover immediately from the computer "if it's right" rather than talking with their teacher or peers about their understandings. Michael explained the advantages of immediate feedback in this way:

> If you know you have the right answer or the wrong answer, [the computer] will tell you . . . [Students] will be able to do more problems because maybe the first few [they] make mistakes but then [they] catch on,

> and then [they] know [they] got it right. And then the more [they] get right after possibly getting a few wrong and being given hints, then [they] start to get them right because [they] get the pattern down. [Students are] getting the immediate feedback of whether [they] were right or wrong, which can help build [their] confidence . . . which will increase their productivity.

According to Carol, technology can provide an instantaneous, exact response to student queries that teachers might not be able to provide as quickly:

> [Students] can start playing "what if" questions . . . and the [computer] gives them instant feedback . . . I can't tell them exactly what is going to happen if they change this number from 4 to -55, but they do it on a computer and they know right away what is going to happen.

Overall, it appeared that the *immediacy* of technology (in providing feedback, answering questions, calculating numbers, etc.) was very appealing to the participants. Two different teachers referred to this aspect of technology-saturated learning as "instant gratification" in the classroom. This kind of fast-paced environment is valued on the grounds that it makes instruction more effective, more efficient, and also because it makes school more like "the world" that the students encounter daily through television, video games, and other electronic media. "It seems to me," commented Dan, "that kids are so much into an MTV-type of mentality, that they need to have a certain amount of stimulation before they start to really get an interest in [the subject] and get into it."

In general, the teacher discourse lacked critical reflection on possible negative side-effects of making school curriculum more attuned to the "MTV-type of mentality." Many participants seemed to rely on the fast-paced, dynamic images of new technology to gain and hold the attention of their students, and few questioned the implications of reconstituting the classroom environment to mirror the culture of the electronic media students are saturated in already. Mander (1985) and other scholars have raised questions about the educational consequences of a rapid acceleration of experience and interaction brought on by electronic technology. Shor (1992) has suggested that students exposed to mass culture and electronic media develop *accelerated perception*: "speeded-up habits of thinking, looking, and speaking . . . . [that] weakens [their] ability to examine ideas, texts, and events" (p. 131). One wonders if technology-saturated classrooms at Oakmont and Glenview are amplifying this orientation, as technology is used to speed-up the instructional process and captivate students.

Technology provides students with greater opportunities for "higher-order" thinking. The participants also felt that new technologies allowed students more opportunities for in-depth analysis, problem solving, and "critical thinking." "I think it's making time for people to do a lot more thinking," observed Anne. Technology was viewed as a means to by-pass time-consuming, mechanical processes and skills that, for some students, might be barriers to more sophisticated problem-solving and analysis. For example, Donna, a math teacher, explained that "We are not just plugging-and-chugging the numbers [anymore], but the computer plugs-and-chugs the numbers for us, and now we can look [for] patterns in the data." Michael commented that the "main point of technology" in his classroom is to get his students to a higher level of application of concepts, "where [they] have to think." He added:

> Once [the students] have that general understanding of what they are dealing with, [I can] use that technology to then quickly advance them to . . . where they are doing higher order thinking . . . Rather than taking all of the time teaching them small things and how to find this and that, [the students] can quickly use the technology [to] get a quick picture of what it looks like, [to] see instantaneously whether there is a solution . . . Rather than having to set it all up and having to do all tedious work by hand.

Using technology to ease the burden of the "tedious," skill-based chores in order to more quickly "advance" students to higher levels of thinking (often equated with problem-solving) was most prevalent within the discourse of mathematics and science teachers. However, social science and language arts teachers also mentioned the enhancement of student critical thinking skills as a major advantage of having a technology-rich learning environment.

This belief that classroom technology can propel students to more "advanced" thinking (i.e., problems-solving, analysis) reflects a dominant cultural bias towards hierarchical models of cognition and intelligence. Doll (1993), Kincheloe and Steinberg (1993), and Bowers (1993a) have examined these modernist conceptions of intelligence (evident in cognitive models such as Bloom's Taxonomy) and have argued that they represent socio-cultural constructions that privilege formal-operational-instrumental forms of knowledge and thinking. In addition, many scholars have characterized computer technology as embodying the rationalities and epistemology of the Cartesian-Newtonian tradition, which also favors formal-operational-instrumental forms of thought and knowledge (Bowers, 1988; Dreyfus & Dreyfus, 1985; Roszak, 1986; Weizenbaum, 1976; Winograd & Flores, 1986). From this perspective, it can be argued that participants may view technology as an important symbol of the kind of thinking that they wish to foster in their students.

As the above analysis shows, the participants valued technology as an instructional resource because it enhances access to and communication of content-related information, provides quick feedback on student performance, and allows students more opportunities for higher-order thinking. These beliefs about the instructional value of technology point to some underlying assumptions about the nature of knowledge and the learning process that influence the thinking and practices of these teachers. Most notably, the discourse revealed a technicist view of the educational process, where knowledge (objectified, culturally-neutral, decontextualized) is "delivered" to students, who are in turn are construed as "vessels" to be filled and sent to the next stage in the process. Emphasis, therefore, was placed on the role of "information" (produced, accessed, and manipulated with the help of technology) in the learning process. In addition, a preoccupation with "feedback" reflected the strong and persistent influence of behaviorism; the educational process was thus framed in the reductionist language of "stimulus-response" patterns. Furthermore, the valuing of the "instant," fast-paced world of technology underscored a belief that it offers a way to capture and hold the short attention-spans of the MTV-generation students. Lastly, I was struck by the common adherence to a hierarchical view of cognition and intelligence that privileges logical-analytical reasoning over other forms of understanding.

<u>Technology assists teachers in accommodating student diversity</u>

A third feature of the discourse was the belief that technology is a valuable tool for accommodating the needs and interests of a diverse student population. Participants often spoke of how technology enabled them to "reach" or "connect with" students in a way that perhaps they were unable to do under more traditional (less technology-intensive) instructional modes. Technology seemed to represent variety and options for students and teachers in the educational process: teachers now had more ways to teach, students had more ways to learn. Linda explained it this way:

> I view [technology] as another one of the teaching tools that I have at my disposal that um . . . allows me to connect with different types of students in the classroom. Not every student can relate to an old transparency on the overhead, or writing on the chalkboard, or seeing it on the LCD . . . It's one more way . . .

Stories of how a particularly "difficult" or "low-achieving" student would suddenly blossom with creativity and enthusiasm when given the opportunity to learn with technology were frequently conveyed. Janet shared:

> I think the main thing, and it's true for a lot of the things that we do as teachers, is to try and find more ways to reach more kids. For some kids the technology [is] going to be the way to reach them. [For] example . . . I think it was my first year teaching here, I had a student that I inherited [in] the fourth quarter . . . and this young man just did nothing. But when he had to do a Presidents report, he did a Hypercard stack, and you know, [the principal] was just blown away that here was this mushroom who [used to do] nothing . . . So . . . it [is] a way to reach more kids.

Stories like this give one the impression that certain technologies had an almost magical ability to capture the attention and imagination of students. Another teacher observed:

> There are kids that I would believe were, you know, two I.Q. points above a plant, in terms of the way they interact with others and in terms of how excited they get about what I present. But because of technology, we are giving students a lot more options . . . Kids who don't have a lot of social skills really channel their energy and their talents. I've gotten some stuff back from kids that was just phenomenal.

For teachers facing a growing number of students who have become alienated from school and the formal learning experience, the ability of technology to "reach" and engage resistant students is especially powerful.

Teachers comments in this area tended to center on two key themes. First, various technologies were seen as a way to enable students to overcome what can be loosely described as "learning disabilities." Students previously encumbered by either limited academic skills (i.e., poor reading skills) or more severe physical and cognitive disabilities were now able, through the use of technology, to transcend those obstacles and achieve the academic standards set for them. Janet explained:

> There are a lot of kids who can't read it or won't read it, but when they see it, they can get it . . . For our special kids, you know, they say a picture is worth a thousand words. And [for]the kids that can't write . . . a lot of my

> special ed[ucation] kids this year have terrible penmanship. [But now] they are able to write on the computer.

Alan added:

> I have a student . . . who when he writes you can't understand anything, but when he puts it on the computer, its a whole different thing. And you can tell that over the years he's had his hand slapped about his handwriting and this is what makes him so nervous about writing. [But] the computer is taking that obstacle away. It has also taken away the obstacle of kids who won't write because of spelling, because now with spellcheck, they can catch a lot of their errors.

Anne concurred:

> [Technology] can help [students] overcome some of their own disabilities . . . And for kids who have special disabilities, I think it is excellent. I taught special ed[ucation] for years, and the most difficult thing for those kids was that they couldn't express what was in their head. And so technology is allowing them to do that.

In these examples, technology was clearly seen as a way for teachers to empower students who they believe are hampered by learning disabilities. It is interesting to note that participants tended to focus on the computer as a tool to assist students in expressing their thoughts in written form. This pattern appears to support Bowers' (1988) and Ong's (1977) arguments that computers, as a text-based technology, are reinforcing a long-standing cultural orientation (bias) that favors literacy over orality.

A second theme was the commonly held belief that technology helps teachers address the different learning styles in their students. For example, technology was referred to as a "visual medium" that naturally appealed to "visual learners" in the classroom. Obviously influenced by Gardner's theory of multiple intelligences, teachers expressed the conviction that it was their job to try to accommodate as many student learning styles as possible. Alan suggested:

> I think that the thing that computer and video help with is that they give a visual image to help those who are visual and auditory learners. Those

> who are linguistic [learners], they can read Prince and The Pauper, and understand it and . . . enjoy it that way. But [for] those six people like me, who have to have visual images . . . they'll really not know what you're talking about until maybe they see it . . . So I think [technology] helps make the lessons appeal to all the different learners.

Reflecting the same line of thinking, Sarah explained:

> [Technology] allows for varied learning styles. That is one thing that it absolutely does. It helps with the multiple-learning styles that you have in a classroom. I tend to be a certain learning style. I talk and I talk and I talk . . . and then I remember, "Oh, wait a minute, there's a couple of students that really need to see it". . . I have to remember to help them with the way they will understand it. To have the TV in the classroom, videotapes and laserdiscs, helps to reinforce the concepts. And I do see some of the kids going "Ohhhh. That's what you meant." And these are not stupid kids. These are kids who just didn't get it from my style.

Implied in these reflections is the assumption that effective teaching practice involves a crucial matching of teaching styles with learning styles, and that unsuccessful instruction (when students "just didn't get it") can be traced to what is in effect a "compatibility" problem between the sender (the teacher) and the receiver (the student). Technology is seen as a valuable instructional tool because it allows teachers to translate the message into a different form that the student is able to decode. Thus, some participants appear to have interpreted Gardener's theory of multiple intelligences to fit the metaphorical framework of "information-transfer" models of instruction, where technology acts as a neutral conduit through which knowledge is transmitted.

This emphasis on the use of technology to instruct students of all learning styles can thus be viewed as yet another expression of a technicist mindset found to be prevalent throughout the discourse. Other teacher comments about the value of technology in instruction appeared to reinforce this conclusion. For example, Anne explained that:

> Different student talents are recognized because *the delivery system for the information* is different. So, students may find that they do understand something that they can see visually that they didn't understand if it was only presented in an auditory fashion. [italics added]

She added:

> [Technology] allows [me] to *present material* from a variety of sensory perceptions . . . [Students] don't just listen to somebody talk. I have a lot better ability to have visuals if I've got a laserdisc player or video tape or whatever. So [I am] going to use a lot more senses *to get out the information*. . . .Technology gives [me] an opportunity to *tap in to different senses* for doing it and it *allows [students] to make more connections*. [italics added]

Again, it is significant to note that words and phrases like "connect," "delivery system," and "tap into" used so often by participants are fundamentally technical metaphors. These metaphors for teaching are a significant linguistic feature of the discourse and offer yet more clues about how technology may be influencing the cultural and symbolic ecology of classrooms in MTS schools.

<u>Technology helps teachers manage the classroom</u>

Lastly, the teacher discourse occurring at MTS schools reveals a strong belief that new technologies are valuable "management tools" to help teachers organize and bring order to the classroom. Participants enthusiastically described how computers greatly assisted in the "mundane" chores associated with being a secondary school teacher, such as record keeping, grading, and creating and organizing classroom materials. As Anne explained, "I think that if it hadn't been for technology, I wouldn't be able to handle the kind of class-load that I have and the kind of curriculum that I deliver."

While visiting the research cites, I was often reminded by teachers and administrators that one of the goals of the Vista Model Technology School program was to increase "teacher productivity," and that "management use" was encouraged along with "instructional use" of computer-based technology. With respect to the goal of achieving more effective classroom management through technology, the MTS program appeared to be a smashing success. Numerous examples were observed of teachers using computerized-grading systems, preparing materials on the computer, and communicating information to students, faculty, even parents via computers. For many teachers, management use of technology took precedence over instructional use, and, in general, participants found it much easier to talk about *how technology helped them run the classroom* than *how technology helped their students learn*.

Most teachers concurred with my assessment that faculty at both Oakmont and Glenview were much more likely, on any given day, to be using technology for management tasks (i.e., grading, record keeping) than as an integral part of instruction. As Steven observed:

> I think . . . that personal productivity has for the most part exceeded the instructional implementation [of technology] . . . if you go to the teachers [workroom], you will see that [the computer] is on and used all the time. That is the personal productivity side [of it].

As conversations tended to drift naturally towards the use of technology for "personal productivity," it became clear that many participants greatly valued the time-saving features of using technology. They often referred to how technology helped to make things "more efficient," "quicker," and "easier." As Linda shared:

> I would say about 40% of the time it is a critical thinking tool that the kids use and 60% of the time it is a management tool . . . [B]y management I mean, [for example], I have a short quiz I want to give the class, O.K. . . . and boom [snaps fingers], it's up there [pointing to the overhead screen]. [The students] write out their answers, they pass back their scratch papers. I don't have to worry about passing out little quizzes, [and] I don't have to worry about having to run them off. And next period comes in [and] they have a different version of that quiz because they tell each other the

> answers and the questions . . . and so I just change them real quick . . . I do the same with tests, when we go over them . . . I show them the correct answers on the screen there, so I don't risk losing tests that I may want to use again on a future day.

The language and tone of this excerpt clearly illustrates the degree to which Linda values technology as a way to make the student evaluation process more efficient and manageable. The emphasis on speed and control evident in the discourse further reveals the dominant ideology influencing teacher perspectives and practices in these contexts.

It is in the area of student evaluation where new technologies appear to have generated the greatest enthusiasm among participants. As a high-school history teacher, I am especially sympathetic to the amount of work involved in assessing the progress of large numbers of students. Nearly all participants were using some type of computer-based grading systems, and were quick to praise such systems. Alan shared:

> To have 160 kids and have a 160 papers, [I would not like to] go back to the calculation of the grades [by hand], because that would eat up a lot of [my] time. And I remember staying up until 12:30 at night trying to get the kids grades together. And now I don't have to do that unless I get behind with punching in the grades.

Besides their ability to quickly "calculate" students grades, these programs were also valued as a diagnostic tool that enabling teachers to identify, in a more precise manner, the cause of a student's poor academic performance. Teachers also shared a common appreciation for being able to generate computerized grade-reports, as Janet's comments suggested:

> [The computer print-out] is showing [the students and parents] in black and white . . . [I] can show this to the parent so that they can see where [I am] coming from . . . It really helps to pinpoint what is going on. And the way [the program] breaks it down into different categories, [the parents] can see what is going on.

The language used here points to some interesting aspects of the computerized-grading phenomenon. One is left with the impression that technology offers "pinpoint" precision and a "black and white" analysis of student performance. The grading process, therefore, has been further removed from human (subjective) judgment, and thus rendered more "objective." Regarding this, Maria observed that:

> [I] have fewer conflicts with the kids about their grades because what they see is in black and white . . . [The computer print-out] is a tremendous psychological tool because when the kids have it in front of them, unless I have made a typo[graphical error], they simply don't debate the grades . . . [The computer] doesn't lie.

Even when the participants shared their experiences with instructional uses of computers and other new technologies, they often emphasized the time-saving aspects of high-technology teaching. For example, Steven stated "[When I] explain the process of photosynthesis . . . [I can use] a simulation where [the students] can see diagrams of molecules joining frame by frame . . . It's just quicker." Later in the conversation, he added:

> If it's a good application, it is much less intensive of my time . . . it demands less of me . . . The days that we do the Science Sleuths are a blast because I can just sit back and watch every class absorb the stuff and investigate it and figure it out.

When I asked Linda about the advantages of using technology in instruction, she explained:

> [Technology] is fast. I'm not wasting time . . . I mean, I have the notes [on the computer] and I go "Boom". . . I'm not writing on the board, I'm not wasting time . . . I don't have to re-write it every period when the kids come in. I think that the time that is saved . . . really is [in the] numbers of hours. If you look throughout the 180 hours of instruction that I have per year, I would venture to guess that I actually save a good 20 to 30 hours of instruction time . . . [The students] are able to cover more. In my classroom, we are able to read one extra novel each year, compared to

> what we did before. So there is a lot more ground covered in the class itself.

Clearly evident here is a belief that technology is a valuable tool to make the learning process itself more efficient. Technology, in this view, maximizes the "ground covered" per instructional hour, thereby allowing the teacher to include more in the course curriculum. What is significant to note here are not only assumptions about the value of technology in the educational setting, but also underlying theoretical biases about the nature of teaching and learning on which those assumptions are based (i.e., teaching as a "covering" of pre-determined course content). One also cannot help but notice how these features of the discourse reflect the rationalities of the efficiency-movement in education, when reformers adopted industrial models of management in order to better control and standardize the educational experience (Callahan, 1962; Kliebard, 1986).

Lastly, teachers at Oakmont and Glenview spoke of how technology assisted them in the preparation and dissemination of curricular materials. Nearly all participants spoke at length with satisfaction and pride about the "professional-looking" notes, overheads, and presentations generated with the help of computers. Alan's comments were typical:

> And the designing of [my] documents . . . um . . . it helps there. The visual way that [I] present material to the kids has changed . . . because remember when we were in the "purple plague?" I mean with the dittos (laughing) . . . and you know, the kids never read those purple things. They weren't attractive, you know, they were blurred, you couldn't read [them] . . . So it has changed the clarity and precise nature . . . and also the attractive quality to the document that the teachers make in order to instruct the kids.

Anne added:

> In the olden days, when I was going to present something to my class, it would be handwritten, run on a ditto. I might write things out on an

> overhead if I went along. I wouldn't even consider doing that now. Everything I do for my class [now] is on the computer . . . [I can] immediately go back and fix things that are invalid or nebulous or misleading . . . I [can] slip the disk into the computer, put it on the LCD panel, select it an make it bigger, and the whole class [can] see the problem and [can] discuss it.

An analysis of the language used by the participants reveals additional insights into the assumptions that influence how teachers value technology as an educational tool. Because participants' work involves "designing documents," "presenting material," and "presenting something to class," they value the way computers can help make those things "bigger," more readable, "clear," "precise," and "attractive." Anne summed up her feelings about the instructional value of technology in this way:

> [If] I'm going to be delivering something to my students, I expect it to look good. It's going to be formatted, and it's going to be computer-generated. I'm not going to just stand there and talk or read them a piece of paper. I'm going to have a persuasion-slide thing or some sort of video or laserdisc or computer animation for something else to help get across my ideas. And I can't believe that somebody would stand there with a pointer and a chalkboard in this day-and-age when we have so many better ways to do it. And if you want to be treated as a hermit from the Dark Ages, well, that's fine. But if you want to be considered somebody who is a professional, [then] you [need to] present your material in the most varied, dynamic, and exciting way possible.

As the discussion above has suggested, a significant feature of the discourse on the role and value of technology in the classroom is a belief that technology is an indispensable management tool for teachers. Participants valued technology because it helped make their teaching more time-efficient, organized, and systematized. It helped make classroom materials and presentations more attractive and clear. It also helped remove some of the ambiguity and uncertainty that comes with assessing student learning, making the grading process appear more "objective" (i.e., technology-based, statistical).

These ideas reinforce (amplify) a highly technicist, product-oriented, management-centered view of the educational process, where teachers strive to rationalize and standardize as many dimensions of practice as possible (Apple, 1986; Bowers & Flinders, 1990; Giroux, 1988).

I summary, I have identified several guiding assumptions within the discourse that influence how teachers at MTS schools construct their meanings and perspectives on the issue of technology in education. Regarding the general nature of technology and technological development in society, participants tended to subscribe to the dominant cultural myths that technological development is both inevitable and progressive, and that technology is essentially a "neutral" tool that contains no inherent tendencies to reshape culture and redirect human thought. In addition, several commonly held beliefs about the role and value of technology in education were identified: (a) Technology prepares students to live and work in a high-technology economy and society, (b) technology enhances classroom instruction, (c) technology assists teachers in accommodating student diversity, and (d) technology helps teachers better manage the classroom.

Furthermore, these beliefs in turn reveal another layer of assumptions and theoretical biases about the nature of learning, teaching and knowledge that guide the discourse and meaning-making of teachers in these technology-saturated schools. These biases include a tendency to conceive of (a) knowledge as external, objective, and culturally-neutral; (b) teaching as the "delivery" of pre-determined curricular content; and (c) learning as information processing and instrumental problem solving. These assumptions, currently influencing the thinking and practice of MTS teachers, are primarily rooted in the same modernist, technocratic worldview that became the conceptual guidance-system of earlier generations of educational reformers in this century.

In addition, the discourse revealed very little awareness of the possible negative implications of either a technology-managed classroom or technology-intensive instruction. Participants generally spoke of technology in unproblematic terms; as an instrument of educational "progress," as an "advantage" enjoyed by the faculty and students, as "just another tool" to aid in learning. This uncritical posture was evident when teachers were asked if they could think of examples of how technology could be used *inappropriately* in the classroom. Participants were often taken aback by this question and struggled to offer an answer. Some responded with examples of "showing videos too much" or "using drill-and-practice software all of the time." A few side-stepped the question or expressed feelings of being uncomfortable discussing "negatives." One participant, for example, said "Oh, I hate to emphasize the negative [about technology]. I always like to emphasize the positive." Still others admitted they had never thought about the question and couldn't think of any examples of how technology might be inappropriately applied to the classroom setting. Another participant said bluntly, "any usage [of technology] I would have to call good usage."

Lastly, the nature of this discourse on this technology and education seems to support arguments made by Apple (1986), Bowers (1988, 1993a, 1993b), Roszak (1986) and others that, in general, educators are not aware of the cultural, ideological, and epistemological dimensions of the technology-mediated learning experience. This was evidenced in participants' references to computer technology being ideal instructional "tools," "delivery systems," or "resources," metaphors that frame technology as a "neutral" conduit through which knowledge is transmitted to students.

In the next section, I will present a series of brief narratives that serve to illuminate how the dominant assumptions and rationalities identified above may be manifesting themselves in the cultural-transmission process occurring in technology-saturated learning environments at Oakmont and Glenview. These accounts represent an attempt to capture the complexity of the current technology-in-education movement by bringing to focus what Bowers (1988) has called the "cultural dimensions" of educational computing.

Part II: Encountering the Transmission of Culture in a Technology-Saturated Learning Environment

At the outset of this investigation I knew that I wanted to focus on the experiences and perspectives of teachers in Model Technology Schools. This decision was guided by my desire to hear what these teachers had to say about technology-in-education, to understand what it meant for them. This approach to the research was informed by Bowers and Flinders' (1990) notion that teachers serve an important role in the primary socialization process that occurs in the classroom. Teachers act, consciously or unconsciously, as "gatekeepers" of ideas (ideologies) that get passed along to students through the cultural-transmission process. In this sense, I was interested in how teachers influenced the student's socialization into the world of ideas, particularly ideas about the nature of technology and the learning process.

Just as I have experienced differences in my colleagues' views on the purposes and potential of computers in the social studies classroom, I reasoned I would encounter multiple, unique "stories" about technology and teaching as I talked with participants and explored the MTS culture at Oakmont and

Glenview. I did observe and record a variety of perspectives, beliefs, and practices suggesting that individuals filter their experiences with "the new" through their own unique prism of personal biases and convictions.

I did, however, identify some interesting patterns and recurring themes embedded in the teacher discourse and amplified in the broader learning environment that have become a focal point of this analysis. These patterns of thought play a significant role in the ecology of ideas and culture at Oakmont and Glenview, and undoubtedly influence the way teachers, students, and administrators come to understand the role and purpose of technology in the classroom setting.

What follows is a presentation and analysis of several common themes of experience that occupied a prominent place in the mental landscape of the culture I encountered at Model Technology Schools. These themes, explored in four narratives, are presented in relation to artifacts (computer print-outs) found at the research sites. The purpose of this elaboration of themes is to illuminate how assumptions found in the teacher discourse are manifested in the broader ecology of language, thought, and cultural patterns at Oakmont and Glenview. My intention is to offer an admittedly incomplete exploration into the cultural dimensions of educational computing and, in so doing, perhaps uncover more questions than answers.

Figure 1: Computer print-out of Micrograde™ grading program

Class Grades for PERIOD 1 TRI.2, 3/9/95, 1:39 P.M.

Student ID	Grade	
LS 149	A	(97.0%) #
N3	A	(95.8%)
N35	A-	(92.0%) #
R69	A	(95.3%)
ST 282	A	(94.7%)
G005	B-	(80.4%)
ST 512	A	(96.9%)
LS 301	A-	(93.5%)
	B	(84.3%)
ST 299	A	(100.1%)
ST 505	B	(85.9%)
ST 513	A	(99.2%)
ST 227	A	(99.2%)
LS 150	B	(86.2%)
LS 147	A	(97.1%)
N 6	B	(86.6%)
ST 733	A	(94.0%)
ST 223	A	(95.9%)
N 31	A	(98.7%)
2447	A	(96.3%)
LS 317	A	(97.5%)
R171	B	(85.3%)
N20	C+	(79.7%)
ST 261	A	(95.4%)
ST 291	A	(96.8%)
N30	A	(98.0%)
LS 311	C-	(71.8%)
N2	A	(97.9%)

= projected grade

credit: Micrograde © 1994 Chariot Software Group - reprinted with permission

Davy (1985) has written that "tools create a culture of tool-users who have to operate them on the tool's terms" (p. 11). I wondered about the culture of tool-users being created in technology-saturated schools as I sat in the teacher workroom at Glenview Junior High waiting for fifth-period to begin. At a nearby table, one of the faculty was working on a Macintosh computer, frantically inputting student scores on a computerized grading program and printing out individual reports for her next class. "The students expect these now, so do their parents" she complained, but then grudgingly admitted "It does make things better, though." Before I could ask "why," the bell rang and she rushed out of the room, a whirlwind of jangling keys, juggled books, and sighs of exasperation.

At Glenview, the faculty shared a common workspace adjacent to the library that included a photocopier, ditto machines, and two Macintosh computers connected to a laserprinter. The computers in particular were in nearly constant use, as teachers used wordprocessing and graphics programs to prepare classroom materials. I observed that the computer was in especially high demand at the end of the grading period, when faculty were required to report student grades to the administration. Even on a "regular" day, I invariably encountered one or two teachers working on student grades at the computer, updating student information or inputting recent scores. I also noted that in many classrooms, teachers had adopted a policy of providing weekly "grade updates" in the form of computerized print-outs detailing student scores on tests and other assignments.

In conversations with the participants at both schools, it became clear that most, if not all, utilized some form of computerized-grading program. Often, the very first thing cited by teachers when asked about the impact of technology on their daily routine was their use of grading software. For some, their first experience with a computer in a school setting was learning how to use a grading program. Sarah reflected back on her first days working at Glenview and learning about technology for classroom use:

> Actually, the first thing was Micrograde. I had never had grades on a computer before . . . I'm still learning things about that program because, you know, . . . you just have to use it, I think . . . You see, I really never had a good system on my own anyway, so Micrograde really did help me out.

In another conversation Janet recalled:

> There was a lot of pressure to have everybody use, if not Micrograde, some computer-type grading system . . . although, it's nicer for the parents if all the printouts worked the same way. I think there was pressure for. . . not overt pressure, but you know, during prep period, everyone else was in [the workroom] doing their stuff on the computer.

It became clear early in the investigation that the use of computers to calculate and manage student evaluation and assessment was a significant aspect of teachers' experiences with technology at these sites.

Because so many teachers appeared to be using the Micrograde™ program at both sites, I reasoned that the instruction manual for this software was perhaps one of the most widely-read documents among the staff at Oakmont and Glenview. Therefore, it provided additional insights into how computer technology may be influencing the cultural ecology of MTS classrooms, and in particular, faculty beliefs and practice regarding student assessment. The instruction manual stated that Micrograde™ is designed to "simplify tasks" related to the "calculation" of student grades, and emphasized a number of features of the program, including its ability to "track up to 120 assignments per class," print-out "customized progress reports," perform "statistical analysis of class performance," and assist the teacher in "logically planning [their] course structures" (Chariot Software Group, p. 1). In addition, the manual claimed that teachers "can use much more sophisticated grading schemes for [their] classes because Micrograde™ takes care of all the tedious calculations," but cautioned that "the computer requires very specific information in order to process grades"

(p. 1). An analysis of the statements contained in the manual suggests a number of underlying assumptions about the nature of learning, knowledge, and student assessment that faculty and students are encountering in the learning culture. For instance, it is assumed that student evaluation must be "calculated" numerically, "statistically analyzed," and based upon student performance on multiple "assignments."

I began to address the issue more directly in interviews and engage teachers in conversations about, not only *how* and *why* they used grading programs, but also what those programs might mean within the broader context of the school culture. It has already been noted in the previous section that technology was perceived by the faculty as a valuable "management tool" that could be employed to assist in time-intensive and detail-oriented tasks associated with teaching in a classroom (see page 128 - 133). Most teachers felt "management use" of technology was more prevalent on a daily basis than "instructional use." With respect to student evaluation, the appeal of computerized grading systems did not stem solely from their utility as organizational aids. In fact, some teachers admitted that the use of grading programs "created more work." It appeared that these systems were valued as important *symbols* within a culture that regarded technology as a powerful legitimizer of the rationalities and ideologies of that culture.

For example, several participants referred to the way grading programs made student evaluation more systematized and precise, and therefore less ambiguous. When I asked Janet about her use of grading programs, she explained:

> [The computer print-out] is showing [the students and parents] in black and white . . . [I] can show this to the parent so that they can see where [I am] coming from . . . It really helps to pinpoint what is going on. And the

> way [the program] breaks it down into different categories, [the parents] can see what is going on . . . [The printout] is in black and white and it is official-looking . . . [I] tell the kids "The computer can't make a mistake."

These comments reveal much about both the philosophy of education and the status of technology in this particular environment. Students learning is "broken down" into different "categories" so that it can be processed by the computer. Since technology "can't make mistakes," the process of student assessment is assured of "pinpoint" accuracy. Implied in the discourse is the assumption that curriculum and instruction must be configured to match the requirements of the grading program. Also, the view that technology-based evaluation "can't make mistakes" masks the fact that the numerical scores processed by the computer are based on subjective decisions by the teacher regarding the kinds of tests, assignments, and grading policies used.

Some teachers valued computerized grading because it *created the impression* that student evaluation was objective and rational. Several participants explained that showing parents and students a computer print-out of a grade report had a powerful "psychological" effect. One participant commented, "It's wonderful! [I] have fewer conflicts with the kids about their grades because what they see is in black and white." She added:

> [The computer print-out] is a tremendous psychological tool because when the kids have it in front of them, unless I have made a typo[graphical error], they simply don't debate the grades . . . [The computer] doesn't lie.

Another participant concurred:

> [Technology] has probably [helped teachers avoid] a lot of parent-teacher conferences, because each six weeks the parent receives, at least from me, a printout that the parent has to sign so I know that the parent saw it. And it's spelled-out right there, the kid did his homework, didn't do his homework, how he did on his tests, how he did on his orals, how he did on whatever it was . . . So I don't have parents calling me and asking me

"What is wrong with little Johnny?" And when I do have a parent-teacher conference, and I take out the printout, I say "As you see, this is what happened and that is what happened." Parents are usually at a loss for words.

Here, technology was valued because it was regarded as a means to make student assessment more "black and white," more objective, and therefore less debatable. Grading programs, because they are technology-based, were seen as a way to convince parents and students that the evaluation process and policies were rational and systematic, beyond scrutiny or critical questioning. The intention, at least for some participants, was to use technology to eliminate the dialogue that might otherwise occur between parents, students, teachers, and administrators about the educational needs of individual students. As one participant explained:

> The [computer-grading] thing has really changed [classroom management] . . . parents expect the print-outs . . . When a child is not doing well, they can see it . . . and you know, many parents can be very defensive, [but then] they see the printout and see what's going on . . . in testing, homework, and classwork . . . [The principal] has mentioned. . . that his phone calls went down about 90% once the teachers came on board with [the grading programs].

Intrigued by the idea that computerized grade reports were being used to legitimize teacher grading practice and reinforce the notion that student assessment was objective, I explored this theme further in my conversations. I found most teachers accepted this feature of computerized-grading as a positive outcome, and had not given much thought to the broader implications of silencing student and parent voice in the grading process. Also, there seemed to be little critical reflection about the consequences of using technology to make student assessment more "black-and-white," as the exchange below suggests:

> researcher: Do you think that if you had your assignments and grades in a traditional gradebook . . . and it was every bit as elaborate as a computer

print-out, do you think that would have the same effect on students and parents?

participant: No. I think because one is handwritten and the other one is printed . . . it looks much more official.

researcher: Other participants have mentioned this to me. I'm wondering if somehow the computer makes the grading system more legitimate.

participant: Do you think that kids think that if [the teacher] is competent enough to do this kind of thing, then [the teacher] is competent enough to do the grades?

researcher: Possibly. Or perhaps there is something about the "mystique" of the machine. I think we tend to look at computers and technology as if they must be correct because they are machines.

participant: Yeah, that could very well be true. But I know we have two veteran teachers who were transferred to our school . . . and they have not done the grades with the computer. And they have had a lot of hassles . . . I know the students [have] complained.

With few exceptions, participants evidenced little awareness of how using computerized-grading systems might reinforce a cultural orientation towards a dehumanized, mechanical mode of schooling. In general, teachers I talked with were very enthusiastic about using technology to better "manage" their classrooms. Some however, when asked to reflect on this phenomenon in more depth, recognized problematic aspects of filtering complex processes such as student assessment through a computer program. For example, during my second conversation with Steven, I asked him to clarify an earlier thought on the value of technology:

researcher: You mentioned "anonymity" amongst the kids as a problem that technology helps to solve. What did you mean?

participant: I'm not sure (long pause) . . . It brings up a different thought now.

researcher: Tell me that one then.

> <u>participant</u>: That it's [now] easier for teachers to *consider kids as computer print-outs*. Where we used to have to go through individual parent conferences and talk about kids as individuals, um . . . because the report cards were written. Now I think *things are a little more standardized*. When you give a print-out to a kid, *it's more depersonalized*. [The program] prints out everyone's status by points and you hand it to the kid and you say "Here's how you are doing". . . But on the other side then, it makes kids take much more responsibility for where they are at, because *they know it's objective*. [italics added]

Here, Steven grappled with the tendency, amplified through the use of grading programs, to objectify students (students are "computer print-outs") and dehumanize the learning process. His sensitivity to this issue, however, is in contradiction to his own belief that computerized grading systems provide an "objective" assessment of student learning. Once again, we can see how a set of taken-for-granted assumptions about the process of learning and evaluation (i.e., student learning must be quantified and measured objectively) frame how teachers come to understand the role and value of technology in education.

Reflecting on the popularity of computerized-grading systems at Oakmont and Glenview, I became more aware of how the assumptions and rationalities discussed above manifested themselves in other areas of the classroom ecology. As noted in part one of this chapter, I was struck by the prevalence of technical and industrial metaphors in the participant's discourse. Teachers were concerned about their own and their student's "productivity." They saw technology as a way to boost "efficiency" and enhance the "delivery" of course content to students. They gave examples of how computers enabled students to "create a better product" and "connect" more directly to expert-generated information.

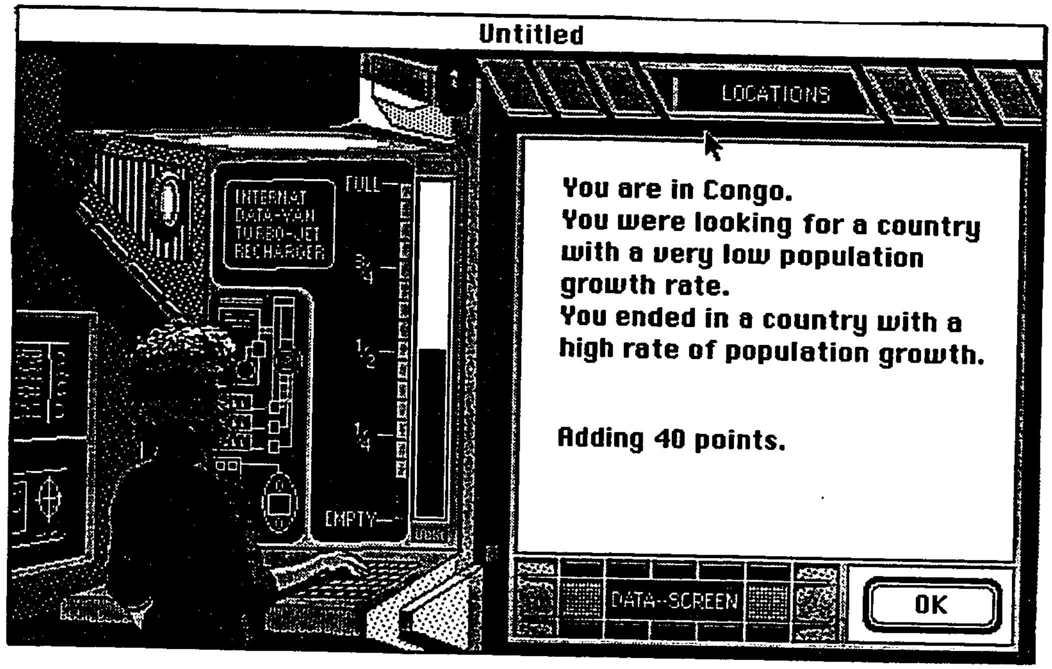
Conversations about computerized grading, along with observations of MTS classrooms, created an overall impression of technology reinforcing (amplifying) what Apple (1986), Bowers and Flinders (1990), Doll (1993), and Giroux (1988) have defined as educational practice based on a technicist-modernist ideology. This vision is guided by the desire to systematize, rationalize, and standardize the educational process as much as possible for the sake of efficiency, control, and manipulation. Within this paradigm, students are objectified (as numbers, print-outs, kids) and regarded as "products" to be evaluated at each stage of the process. Teachers serve as technicians employing "quality control" strategies based on objective, quantitative measurements generated by technology. The technologies (i.e., grading programs) in turn give teachers an enhanced sense of legitimacy since their own "human" judgment is increasingly regarded as irrelevant.

The cultural amplification identified here supports the arguments of Bullough, Goldstein and Holt (1984) and Giroux (1988) that instrumental ideologies and technocratic values dominate teacher training and professional practice. In particular, Giroux spoke of the development of "management pedagogies" conceived by educational administrators and promoted in teacher education programs, where "knowledge is broken down into discreet parts, standardized for easier management and consumption, and measured through predefined forms of assessment" (p. 124). The adoption of management pedagogies is characterized by teachers increasingly abdicating their professional and intellectual judgment to curriculum experts and educational software designers. In this sense, one can view the wide-spread use of computerized grading programs as furthering the trend towards the deskilling of teacher work and the devaluing of teacher judgment.

If tools do indeed create a culture of tool users that must operate the tools on their terms, it seems that an important question educators must ask is how does the increased use of computerized grading systems in classrooms mediate teachers and students' experience of the symbolic dimensions of culture? Or, put another way, how might the cultural-transmission characteristics of grading systems be amplifying a particular set of assumptions about the nature of technology, teaching, and learning? Another set of questions is raised about the implications of the increasing standardization and routinization of teacher practice, exemplified in the use of generic grading programs and pre-packaged curriculum. For example, how might administrators' promotion of the use of grading programs further serve to deskill teachers' work and reinforce management pedagogies in the classroom?

Data-Based Learning

Figure 2: Computer print-out of International Inspirer™ geography game



credit: International Inspirer © 1993 Tom Snyder Productions - reprinted with permission

On a cold Monday morning in February I entered room six, the newest computer lab at Oakmont High School. I noticed the previous week that Ms. Smith had made arrangements for her tenth-grade world studies classes to work in the lab. As I opened the door slowly and peered in I found that the room, which often sat empty, was filled with students staring intently at the glowing monitors. As I stepped inside I could see that most students worked in pairs, seated in front of computers arranged on circular tables. Ms. Smith, a young and energetic teacher, was finishing role call and attending to the required paperwork that demands attention at the start of each new class. She explained that students were working with a geography-based program called International Inspirer™, "a fun way to reinforce basic geography skills," as Ms. Smith described it.

I found an empty chair and sat close to a pair of students working with the program. I discovered that International Inspirer™ is a very popular game among students and social studies faculty at Oakmont, and in subsequent days I observed its use in numerous classes. In the game, students earn points according to how well they navigate a world-wide trip to nations that meet the criteria of questions posed by the computer. For example, a student team may find themselves in Romania and be asked to end their trip in a country with "a very low population density." To effectively plan their journey, students consult booklets containing maps and a wide-range of statistical data (i.e., beer consumption per capita). According to the software's teachers guide, the main goal of International Inspirer™ is "to familiarize students with the basic geographic location of the nations of the world" through an "exciting game format" (Tom Snyder Productions, p. 7). It adds that students can:

> . . . uncover interesting facts (there is one doctor for every 78,000 people in Ethiopia), discover surprising data (China and Russia are the world's leading moviegoers), and raise some valuable questions (why is AIDS such a big problem in Central Africa?). (p. 7)

A casual glance around room six revealed an impressive sight for any history teacher who has struggled to ignite a spark of interest in geography among their students. All of the students appeared to be actively engaged in the game, studying their maps and checking their "data" booklets. The room was calm, orderly, and "hi-tech," yet students were focused and seemed to be enjoying themselves. I asked a student sitting nearby how many times they had played the game this semester. "Five or six times," she replied. Was it still fun? "Yes." "Why?," I pressed. She and her partner paused for a moment. They were not sure. "Maybe it's because it's just a game . . . you know, we get points and we're competing with other teams," she explained. Her friend added, "We find out about different countries . . . That's kind of cool."

They resumed their game and I watched Ms. Smith circulate around the room, recording team scores and engaging in friendly banter with a group of girls dressed in bell-bottoms. I closed my eyes for a moment and listened to the strange mix of "beeps," "buzzes," "boings," and "wrrrrrrrs" that signaled various events in the game. I was struck by the cleverness of the software designers who incorporated computer-generated pin-ball sounds into the program, presumably to make it more Nintendo™-like for mass appeal.

I noted in my observations of computer labs at both schools that the instructional use of computer technology was limited to a few dominant applications: wordprocessing, computer programming, and pre-programmed drill-and-practice and simulations. I was surprised by this rather unimaginative use of some very sophisticated technology. In addition to the International Inspirer™ game described above, I encountered students using grammar drill programs for a German class, a vocabulary exercise based on a computerized worm dissection, an economics simulation entitled "Running the U.S. Economy," and an assortment of other low-level games and "drill-and-kill" software. The extensive use of pre-programmed, skill-based software by teachers at Oakmont and Glenview appeared to support research suggesting that educators tend to use new technologies to reinforce traditional models of curriculum and instruction (Becker, 1991; Cuban, 1986; Scott, Cole, & Engel, 1992).

As noted in the earlier analysis of teacher conversations about technology and education, I encountered a set of underlying theoretical biases regarding the nature of technology, teaching, and learning that framed the participants beliefs and practices. These assumptions were remarkably similar to the patterns of thinking embedded in official policy statements on the use of technology in California schools (see discussion of the pilot study presented in Chapter Two). Those assumptions (guiding metaphors) include the view that teaching is primarily an act of information transfer and that learning requires access to and manipulation of data, which in turn is presumed to be culturally-neutral and "objective." For example, Michael explained that "While [the students] are using technology . . . [my] focus is now not on teaching the material as much as how to take the information and give it to [my students], and [they] learn how to use it." Later in our conversation, he summarized technology as "something else up [my] sleeve that helps [me] get across information." Steven, commenting on the instructional value of the internet explained, "[Students] are going to have to know how to communicate by e-mail and do research, how to manage information [and] data."

Roszak (1986) has offered an extensive critique of the promotion of "information-processing" models of learning and cognition that occurs in the literature on computer-based instruction. Bowers (1988, 1993a) has discussed the cultural amplification characteristics of popular educational software and revealed some of the hidden ideological and epistemological "lessons" that they encode into the classroom ecology. (These perspectives have been discussed in detail in Chapter Two.)

I reflected on these ideas as I sat and watched students interacting with the International Inspirer™ program. The students *appeared* to be learning and very engaged in the tasks presented to them. Students *looked* like they were learning the locations of places like Madagascar and Mali. However, a more critical analysis of the game revealed another layer of "content" that carried far greater implications for the learning culture than the various learning objectives described by the software publisher.

For instance, I was struck by the character of the graphic images presented to the students (see figure 2 on p. 148). The illustration depicts a woman in a high-technology command-center, hands ready at the keyboard to control the "Internat Data-Van Turbo-Jet Recharger." Nearby, a "Data-Screen" communicates essential information and questions to students. The overall tone of this graphic seems to celebrate military-style technical control, amplify an ideology of progress-through-technology, and elevate the importance of "information" and "data" in the educational process. The text is presented as disconnected, decontexualized "factoids," further reinforcing the idea that students are interacting with objective, culturally-neutral, knowledge.

The teacher-guide that accompanies the International Inspirer™ software touted the game as an "information intensive strategy activity" that "will hone students' general problem solving and critical thinking skills" (Tom Snyder Productions, p. 8). It cited a number of "valuable social studies skills" that promise to be developed through interaction with the game, including: (a) deciphering *information* on a graph, (b) interpreting number and geographic *data*, (c) researching *information* in a variety of sources, and (d) comparing and evaluating related *information* (p. 8; italics added). The underlying message evident here concurs with Roszak's (1986) analysis that computer-mediated learning encourages a view of students as "information-processors" and raises "information" (communicated as "neutral" data) to a privileged status in the creation of knowledge. It also appears to reinforce a Cartesian view of knowledge (incremental, objective, abstracted) and a technocratic mode of thinking that regards "general problem solving" as dependent solely upon information (data) provided by technical and scientific experts (Bowers, 1988).

The bell rang and students rushed to finish the game and report their scores to Ms. Smith who hurriedly wrote them on the board to be saved for tomorrow's session. Team eight was in the lead with 2,050 points. "Make sure you save your game and return the floppy disks to me before you leave," she shouted as her students walked briskly out of the room, bulging backpacks slung over their shoulders. It occurred to me, as I watched the students filing out of room six, that this period must have been a nice break for Ms. Smith, a relaxing respite from the daily grind of keeping five classes of thirty-plus students engaged and attentive. Today, computers will do that for her. "I love the computer-lab days," she sighed, "and I really think the kids get a lot out of it. The technology gives them a chance to get more actively involved."

Many participants spoke of the "interactive" nature of computer technology as a rationale for the move towards a high-technology curriculum. For example, Carol explained that:

> [The students] become active. They can't sit back and do nothing . . . They have to punch the buttons. The computer is waiting for them to answer a question so they can't keep daydreaming . . . If they have to get so much done, they have to get it done.

Linda spoke of the benefits of taking her students to the computer lab:

> Each kid has his own station and can work at their own pace and the computer tells them when they have done things correctly, praises them, um . . . corrects them if they [get the answer wrong] . . . It's very good practice.

These comments reflect a dominant feature found in the literature on educational computing that describes computers as interactive machines, infinitely patient and programmed to respond to the individual learning needs of students (Bork, 1979; Kleiman, 1984; Taylor, 1980). A closer examination of the actual implementation of computer-aided instruction at Oakmont and Glenview, however, reveals a different story. As mentioned earlier, teachers praised computers for their ability to "individualize" instruction. I found this concept of individualization to be most curious, since typical drill or simulation software provides no more individualized instruction than a standard textbook. True, educational programs can be designed to speed-up, slow-down, or lead students through different sets of problems. But no matter how elaborately programmed, educational software remains fundamentally a pre-packaged, generic set of activities created by somebody completely disconnected from and unaware of an individual child's needs or circumstances. The problem of thinking that computers are especially equipped to make learning more individualized was poignantly illustrated in a story, told by one participant, of a mathematics class using a drill-and-practice program:

> [The programs that the school] suggested that I use down at the computer lab are mainly drill-and-kill types of programs . . . Basically, [the program] just keeps hurtling problems at [the students] until [they] stop. And it was really funny because the first time that I used it I told them, "O.K., do 20 of this type." But the only way you can end it is that you have to click on the little close box in the corner, and the [program] doesn't stop after 10 or 20, it just keeps going. And I had a lot of students in my class who are second-language learners, [who] have trouble understanding verbal directions, and um . . . It wasn't until I walked around and saw this kid on number 108, and he had done like 108 of these addition problems! And I was like, "Oh my gosh, you can stop! You can stop!"

The argument that technology provides interactive, individualized instruction is often cited by those defending the computerized curriculum. As the story above reveals, however, the ability of computers to create a responsive, individualized learning environment have been vastly overstated. As the comments and observations presented here suggest, many students' experiences with technology at Oakmont and Glenview consists of "punching the button" and going on to the next question. I found many examples of this kind of active-learning with technology in MTS classrooms, and little critical reflection among teachers on the assumptions and rationalities embedded in these programs. Furthermore, my analysis of technology-based learning activities like International Inspirer™ revealed a "hidden-curriculum," an underlying set of guiding assumptions and values, being transmitted to students and teachers. These included an information-processing model of thought, an ideology of progress-through-technology, and instrumental mode of problem-solving. This tacit cultural-amplification process that occurs as students increasingly engage in technology-mediated learning raises a number of important questions for educators that will be summarized in the final chapter of this study. Among them: (a) How might the increased use of instructional software like International Inspirer™ alter the cultural ecology of the classroom and, in particular, reframe the epistemological assumptions that guide educational practice?, (b) what are the implications of an increasingly technological approach towards instruction that is based on an information-processing models of learning and cognition?, and (c) what role should teachers play in making explicit the cognitive, cultural, and ideological assumptions programmed into educational software?

Figure 3: Computer print-out of student programming assignment

```
procedure compare (side1, side2, side3: integer; var length, girth: integer);
{length and girth is changed in this procedure, and the sides are not}
begin

  if side1 >= side2 then {first compare side1 and side2, and separate two possibilitie
    if side1 >= side3 then    {comapre side1 and side3 if side1 entered is larger than
      begin {calculations, in this case, side1 is the length}
        length := side1;
        girth := side2 * 2 + side3 * 2;
      end
    else{In this case, side3 is larger than side1, which is larger than side2}
      begin
        length := side3;
        girth := side1 * 2 + side2 * 2;
      end
  else if side2 >= side3 then{This catagory is under the condition that side2 is larger
    begin  {This subcatagory is for the condition that side2 is greater than side3}
      length := side2;
      girth := side1 * 2 + side3 * 2;
    end
  else{This subcatagory is for condition that side3 is larger than side 2}
    begin
      length := side3;
      girth := side1 * 2 + side2 * 2;
    end;
  writeln('The length is ', length : 1);
end;

{**************************************************************
  procedure booleanexp (var large, heavy: boolean; length, girth: integer; weight: re
{This procedure is designed to create the boolean variables, so they are formal paramet
{in this process, the rest of the variables are used in order to achieve this, and they are
  begin
    heavy := weight > maxweight;            {assign the boolean var heavy}
    large := girth + length > maxlength;    {assign the boolean var large}
```

The door to room 7a of building five at Oakmont High School was locked and the blinds were pulled. When I stepped inside, I felt I had been somehow transported in a split-second to a research and development facility at one of the nearby high-technology firms. As I glanced around the cluttered "Network Operations Center" (NOC), as it is officially known, I found it difficult to believe that I was still on a high-school campus. An incredible assortment of CPUs, monitors, printers, and other less recognizable advanced-technology gear overwhelmed the small room. Various powerful-looking computers, obviously not of the "home-computing" variety, occupied every available inch of desk-top space. The dimly-lit room possessed a bluish glow emanating from a dozen monitors, their screens full of strange and arcane symbols that I, a techno-buff in my own right, could not decipher. Non-descript black boxes laced with green and red lights flickered a bizarre Morse code to no one in particular. On workbenches and tables lining the NOC lay a jumbled collection of discarded relics only recently considered "state-of-the-art." Three-year old computers, slightly-worn hard-drives, and dusty monitors served as an informal monument to the frenzied pace of the hi-tech industry, where the product-life of newly-designed equipment is now measured in months.

After a few moments of gazing at all the technology and wondering how many kilowatts per second were being consumed by the NOC, I noticed Mr. McGwire, Oakmont's technology coordinator, sitting at one of the more "user-friendly" computers. He described the NOC as the "nerve center of the campus computing activity" and the "hub of our internet domain."

In the course of the few weeks that I spent at Oakmont, I visited the NOC quite often and used it as a "home-base," a place to sit and prepare for an interview or record some notes. I also found this location interesting, from a cultural perspective, in terms of its symbolic value as the "nerve center" and focal point of the school's technological agenda. As I sat in the NOC and observed the daily routines and rituals, the comings and goings of people and equipment, and the conversations and situations, I was able to gain additional insights into what technology had come to mean for teachers and students at Oakmont.

The NOC was strategically located in the middle of building five, surrounded by Oakmont's four computer labs, three of which are immediately accessible through doorways. As a result, by spending time in the NOC, I was able to readily assess the types of computer-based learning activities being conducted during the different periods of the day. As described earlier, one of these labs, room 7b, was used almost exclusively for computer programming classes.

The computer programming curriculum at Oakmont has grown tremendously since the inception of the MTS project, to the extent that this past semester saw four introductory classes and one Advanced Placement Computer Science class offered to students. Since the majority of computer-mediated learning occurring at Oakmont consists of programming instruction, I had ample opportunity to observe these classes and talk with teachers about their experiences in those contexts. I also felt that because of the administrative emphasis on expanding computer programming courses, it would be appropriate to investigate this aspect of the school culture in more depth.

I noted that the computer science teachers felt very strongly that students gained a lot from learning computer programming. Carol remarked:

> Well, [the programming classes are] really beneficial. Now a lot of colleges, in order to major in math or computer science or business [students] have to take a computer programming course . . . It teaches the students organization, it teaches them algorithms. They have to write the algorithm, they have to know all about it, then convert it to a program. And the computer will only do what you say to do, it doesn't understand what you want it to do (laughing), so it just follows directions. It really teaches students a good top-down, modular, programming design.

Michael expressed the educational value of programming this way:

> I think the best benefit is teaching [the students] to think exhaustively and logically through solving a problem . . . One of the hardest things even in math or any subject is to take a problem that . . . you can't even conceive of how to solve it initially, and learning strategies by which you just get used to breaking down problems into smaller and smaller tasks that seem doable and manageable. And then once you can do that, then putting the pieces all back together into a working solution to a problem . . . And the ability to just start thinking systematically and logically . . . I think it applies . . . [to] all areas of thinking. The main thing it [does] is it teaches you how to think . . . thoroughly through problems and be able to come up with solutions.

These comments not only illuminate how these participants value the computer science curriculum and the general role of technology in secondary schools, but also point to some underlying assumptions about the nature of knowledge and thinking that inform these beliefs. For instance, both of these teachers talked of programming as a means to teach general problem solving "strategies" such as "organization," "exhaustive" thinking, and a "top-down," "modular" approach to complex situations. These metaphors reflect a Cartesian-technicist orientation that emphasizes procedural thinking and a linear-mechanical framework for understanding phenomenon (Bowers, 1988, 1993a; Doll, 1993).

The second quote, in particular, emphasizes the universal application of "thinking systematically and logically" to "come up with solutions" in all areas of thought. As I talked with Michael, I was struck by the similarity of his point of view to arguments made by Papert (1980) and other advocates of educational computing that programming a computer teaches students how to "think." Michael's comment that solving complex problems involves breaking them down "into smaller and smaller tasks" seemed reminiscent of Papert's claim that the "microworld" of LOGO is educationally valuable because it breaks down knowledge into "mind-sized bites." As discussed in some detail in Chapter Two, the notion that in programming a computer students acquire basic cognitive strategies, and that the computer can be used as a tool for teaching "thinking," has been a dominant feature of the mainstream discussion on educational computing (Papert, 1980; Taylor, 1980). As the discourse above suggests, I found this line of thinking to be prevalent among the computer science teachers at Oakmont.

An interesting exchange with another participant also serves to highlight the tendency to equate instrumental problem solving (taught in computer programming courses) with the general concept of "thinking." After visiting Donna's fourth-period programming class, I talked with her about her experiences:

> researcher: What about the programming class? Do you like teaching computer programming?
>
> participant: Yes, very much.
>
> researcher: What do you like about it.
>
> participant: Well . . . the content . . . [but] it's not the Pascal that I think is important that they are learning, but it is the thinking that goes with it.
>
> researcher: What kind of thinking is that?
>
> participant: Being able to take a large problem and break it down into its component parts . . . We talk about procedures . . . It feels very solid to me.
>
> researcher: What do you mean "solid?"
>
> participant: Um (long pause) . . . I guess I just really feel like it has meaning. And I think it is important.

Again, it is significant to note the general use of the term "thinking" by Donna to describe what students are learning as they interact with the Pascal programming environment. I was also intrigued by Donna's comment that the kind of thinking encouraged in her classes felt "solid" and "important" to her.

Later, I had an opportunity to ask Donna to elaborate on her feelings about teaching programming:

> researcher: Why did you use the word "solid" to describe how you felt about the "thinking" being taught in the programming classes?
>
> participant: (Laughing) . . . It's embarrassing . . . This is going to sound funny, [but] there is something beautiful about the way that the computer's memory [works]. If there is a four in the memory right there, then there is a four in the memory right there! If that's what you pass to this procedure, then that's what the procedure will see . . . [It is] very cause and effect . . . It's something that is not interpretive, it is very . . . hard . . . I can't find the words to say it, but I think that is a neat discovery for [the students].

I found Donna's comments to be important in relation to the issue of the cultural-transmission process that is occurring in the computer-programming classrooms at Oakmont and other high schools. Her remarks appear to reflect a form of technological consciousness, amplified in the learning culture, that favors linear, analytical, "hard" thinking and de-emphasizes more "interpretive," holistic, and metaphorical forms of thought and knowledge. Admittedly, only a relatively small percentage of students at Oakmont enroll in computer programming courses. However, it is reasonable to conclude that this general epistemological and ideological orientation significantly influences the ecology of ideas and values at Oakmont, particularly when one takes into account other examples of the technocratic mindset being promoted through the use of grading programs and educational software like International Inspirer™.

Bowers (1988), Davy (1985), and Roszak (1986) have argued that implementing a programming-based curriculum merely teaches an instrumental, procedural form of reasoning and furthers the amplification of technicist conceptions of knowledge. On a broader scale, critical scholars have pointed to the growth of the computer literacy movement as another manifestation of an increasingly technocratic culture that privileges certain groups, interests, and modes of consciousness over others (Apple, 1986; Ellul, 1990; Giroux, 1988). For instance, Apple (1986) suggested that "given the expense of microcomputers and software in schools, the pressure to introduce such technology may increase the already wide social imbalances that now exist . . . . Thus, the computer and literacy over it will 'naturally' generate further inequalities" (p. 166). Observations of MTS sites suggested that even within schools, computer technology tends to be distributed and accessed unevenly, therefore creating a new layer of barriers, divisions, status, and privilege that define the school culture. In particular, my visits to the computer labs and the NOC at Oakmont seemed to point to what Stoll (1995) has described as the "culture of exclusion" that comes with technology.

It became apparent during my time at Oakmont that the computer facilities were generally "off-limits" to the majority of the student body. Doors to the NOC and the computer rocms were generally kept locked, and some were affixed with signs reminding students of who was permitted entry. The NOC in particular, as a kind of "inner sanctum" that housed a lot of the networking equipment, was especially sealed to student access. Occasionally a student, perhaps lost or looking for someone, would wander in and earn a sharp rebuke and scornful gaze from Mr. McGwire or other staff. However, I did observe that a small cadre of six to ten male students seemed to be able to enter and leave the NOC at their leisure and in general have "the run of the place." I also learned, to my surprise, that the labs were closed during lunch and shortly after the final class was dismissed in the afternoon. I came to the conclusion that student access to the computer labs was reserved, in a sense, for the privileged few. This was not the result of any explicit policy, but an expression of a more subtle, de-facto form of discrimination that favored certain students: individuals enrolled in the programming, internet, journalism or keyboarding-wordprocessing classes which tended to monopolize the labs. With the exception of the keyboarding and wordprocessing courses, which were elective classes open to all freshmen, these classes are attended mainly by the what could be considered the technological elite of the school.

At Oakmont, it appeared that there were "insiders" that "belonged" in the computer rooms and "outsiders" that are made to feel unwelcome. In my field notes I recorded an event observed during the morning break that reinforced this impression:

> Apparently a couple of younger kids [had] wandered in [to the lab in room 6] and were trying to do something on one of the new computers. Anyway, there were several "techie-guys" who were older, and they began teasing these guys, who seemed to be "out of their element" and not belonging to the scene. One of the techie-guys said, "John, this guy wants to know where he can find the internet! HA HA!"-- something like that. The older teaser and his buddies milked this for all it was worth with little comments like "We have a class that you can take to learn that" and "It would take me three months to teach you!" Eventually the two younger boys, looking rather discouraged and apparently unable to get help with their question, shuffled out of the room.

Of course, one could argue that adolescent teasing is a common fact of life and that there is nothing particularly significant about older, "in" students humiliating younger, "out" students. However, as I reflected on this incident later, I began to wonder more about the question of whether technology in this context was amplifying a social stratification based on technical skills and savvy. Occasionally, my conversations with the participants gravitated towards this aspect of culture in a technology-saturated school. One participant remarked:

> What I find interesting is this breech between the technological "haves" and the "have-nots"... Some people feel like they are "in" with technology, and they know what's going on. And then there is this

> problem I think with sort of a "technological elitism" that is often shown. And the message gets sent to people who aren't familiar with technology . . . um . . . I think that makes them feel very out of it.

The idea that technological development in the field of education involves issues of power, equity, and status has been explored by many scholars (Apple, 1986; Giroux, 1988). As discussed briefly in Chapter Two, critical research has been done on the issue of instructional computing and gender bias, unequal access, and varying use patterns among socio-economic groups (Cole & Griffin, 1987; De Remer, 1989). A detailed presentation of these studies will not be undertaken in this investigation. However, I wish to briefly note that the question of technology privileging some groups over others was a noticeable feature of the discourse that occurred among the participants of this study. For example, some teachers observed that technology has reallocated status and altered social patterns within the school culture. Anne commented,

> [Technology] changes the social status. I've had kids that are just unbelievable nerds, and nobody wants them around, but they know the computer. So all of a sudden people don't mind having them in their group . . . Kids who are completely without any kind of social status all of a sudden go way up there because they are real good at manipulating that stuff.

Donna remarked:

> I think that sometimes when [teachers] are using technology in the class, and [they] are dealing with lots of students and lots of problems, [they] kind of really appreciate and rely on those students who can help others [with the technology] . . . [Students are] kind of get elevated as an authority if they have those skills.

A few participants wondered if technology in the classroom was reinforcing broader social inequities. For example, Steven pondered "You know, [technology] might recreate the schisms and the classes . . . where the curious and the go-getters achieve, and the ones that aren't self-motivated don't. I don't know." Alan expressed a concern that expensive technology is unevenly distributed and, therefore, is widening the educational and social gap between the well-off and the poor.

> There is a class division. [Technology is] beginning to divide the class with who has the resources at home to do the research because they have [something] on CD-ROM . . . and [then] there is the person who still has to jog down to the library, you know. So there is purely an economic division, the "haves" and "have-nots". . . And I think I also see a broader thing . . . I spend about six or seven weeks in Washington DC [with my sister], and she is a sixth grade teacher . . . and the things that I talk about to her just blows her mind. And she's there sitting in the nation's capital. But then she is teaching kids who are from a very low poverty base-line, and they are going through devastation as far as drugs, family life and the whole thing . . . And I see the tremendous advantages that technology affords one group of people. And [the people] in the nation's capital, they have absolutely nothing.

Alan's comments about the division between the technological "haves" and "have nots" seen in his own classroom and in the broader culture prompted further reflection on the question, which has been posed by Apple (1986) and other critical scholars, of *who wins* and *who loses* in the "technologized" school:

> I think [technology] represents anxiety to those kids who feel that they are behind and don't have the resources at home. I have a kid now, he's from Nevada . . . clearly he is grossly behind everybody else. And I think it is because . . . he was held up economically. He's grossly behind with technology. And I think there is a fear there, and an anxiety, because he feels that everybody else is just whizzing by . . . So I think to that student [technology represents] anxiety and fear.

I found Alan's sensitivity to these issues to be uncommon among the other participants in this study. Nevertheless, his concerns touch on issues that are important yet often ignored in the mainstream discourse on educational computing. Alan's observations also reveal other dimensions of the cultural and ideological amplification occurring in technology-saturated learning environments. That is, computers not only bring an increased emphasis on a certain "style" of thinking to the learning culture, they also carry, like all forms of technology, particular social and political biases that rearrange the power relationships within the culture (Postman, 1992; Winner, 1991). As the remarks above imply, students who have access to technology and who have knowledge of computers are empowered, "elevated as an authority," and enjoy a privileged status in the community. Students who do not have the access or the skills are marginalized and considered to be outsiders.

I sat in the back of room 7b observing Donna's fourth-period programming class. Thirty-one serious looking students sat silently behind evenly-spaced rows of Macintosh computers, staring intently at their monitors and occasionally glancing up to check the clock. Donna sat at an unoccupied terminal correcting some assignments. It dawned on me that after thirty minutes or so, I had yet to observe any significant conversation or interaction taking place, either between students or between teacher and student. There was an uncanny stillness and sterility to the scene. The only noticeably audible feature of the classroom was the hum of computers and a chorus of "clicking," the ubiquitous sound of the "information age," as fingers struck plastic keyboards. Despite Donna's cheerful presence and Barry Bonds posters on the wall, the room more closely resembled a "hi-tech sweatshop" than a class full of high school students.

These students, I presumed, were the future engineers, programmers, and systems managers of the country, on the fast-track to lucrative careers in high-technology companies. At Oakmont, these kids represent the "elite," the "insiders," who have access to and are mastering the world of technology. As I watched them work out the "bugs" in their programs, I reflected back on an earlier conversation I had with Donna about how technology is influencing the field of education and how it might be reconstituting the learning culture at her school:

> participant: I'm wondering about our tendency to separate things into . . . "techy" and "fuzzy". . . like techy is engineering or science and fuzzy is the humanities . . . and so I wonder if we are going to be strengthening that division or if the technology is really going to be able to encompass the fuzzy things, so that we all see technology as more of an umbrella [for] all . . . For example, we'll see English classes using technology in ways that are just as rich as math and science.
>
> researcher: [But] would the English [class] get more techy and less fuzzy?
>
> participant: Yeah . . . I don't know . . . If technology does become more [of] an integral part of schools, how is that distinction going to be different? Or . . . ?
>
> researcher: Or would the techy be amplified at the expense of the fuzzy?
>
> participant: Exactly . . . I don't know.

I found Donna's comments to be quite interesting in light of the themes that emerged in my observations and conversations with teachers. It is significant to note her awareness of a "division" between "techy" and "fuzzy" areas of thought and inquiry. I perceived her intuitive labeling of these two areas of human experience as an expression of the more general differences between a positivist-Cartesian-technicist orientation and an interpretive-metaphorical-humanistic orientation to knowledge and understanding. While I am wary of using such sweeping categories in my attempt to analyze Donna's comments, I found her distinctions between "techy" and "fuzzy" to be useful metaphors for grappling with the deep cultural, ideological, and epistemological frameworks being selected, amplified, and reduced in the mental ecology of the MTS school.

I was particularly struck by Donna's hope that technology can become an "umbrella" for all areas of thought and experience, that it can bridge the gap between the "techy" and the "fuzzy" and "encompass the fuzzy things." Once again, it appears that her choice of metaphors reveals a tendency, noted throughout the teacher discourse, to assume that the application of technology to all areas of the school curriculum is inherently positive and a sign of educational progress. It also implies a belief that the *modes of thought* represented by technology are superior and thus should serve as a unifying cognitive and epistemological framework around which all learning experiences are organized. Donna's response to my wondering if the spread of "techy" might come at the expense of other forms knowledge and thought also reflects a general lack of critical reflection (found among other participants) on the implications of an increasingly technology-intensive educational experience.

A host of scholars, philosophers, and social critics have noted the "imperialistic" nature of technology and the technological consciousness. For example, Weizenbaum (1976) decried the "imperialism of instrumental reason" that has been fueled by the recent development and spread of computer technology (p. 255). Postman argued that "there is an imperialistic thrust to technology, a strong tendency to get everyone to conform to the requirements of what is new" (1994, p. 26), and warned of the "technopolization" of society, where "the only questions worth asking are the questions technology can answer" (1989, p. 9). Apple (1986) and Bowers (1988) noted the tendency among educational technologists to expand the use of computers to all areas of the school curriculum. It is argued here that the amplification of the interests and rationalities of technology can be seen both in the teacher discourse and in the broader ecology of language, thought, and social interactions at Oakmont and Glenview. As documented in part one of this chapter, participants regard new technologies as important instructional tools that can be applied across the curriculum. It was also observed that most teachers utilize computer-based grading systems that demand a certain approach to student evaluation and curricular organization. Furthermore, conversations with computer science instructors has revealed that general "thinking" is often equated with the narrow form of reasoning required to program a computer (i.e., logical, analytical, procedural thinking), and computers are viewed as tools to teach "problem solving." In addition, the amplification of this technical mindset appears to contribute to the favoring of the technological elite; certain students are granted access to and mastery over technology, and those that possess technical skills are "appreciated" more by the faculty. This creation of a culture of exclusion, particularly strong at Oakmont High School, deepens the stratification among the student body along socio-economic lines (i.e., well-off students with computer equipment at home thrive in a Model Technology School.).

These broader dimensions of cultural amplification occurring in technology-saturated learning environments raise important questions for educators. For instance, what might be the long-term consequences of the amplification of mechanical, procedural ("techy") forms of problem-solving and knowledge-creation, as well as a de-emphasizing of intuitive, metaphorical ("fuzzy") forms of knowledge in the learning culture? How can the human interests of equity and diversity be preserved as the field of education increasingly appropriates the means and modes of technology, and as society continues to allocate them unevenly within schools and across neighborhoods?

Chatting With Computers

Figure 4: Computer print-out of on-line conversation

```
<Daisy> Overfelt is in San Jose, California
<snoopy> I am not a guy!!!!!!!@!@@#$^^%%^^$&&%^$**
<Diamond> Hey well thats cool
<Daisy> We believe you, Snoopy!
> DO YOU know where cupertino is?
<snoopy> you better!!!!!!!!
<Daisy> Yes
<snoopy> good
> how old are you?
<GINA> she is not dum
<GINA> who
<Daisy> I'm 14
<snoopy> that's for sure!
> so am I!
<Diamond> Ladybug thanks man!
<EN][GMA> daisy: i am here. .=)
<Diamond> Who's that?
<Daisy> Any of you have a boyfriend
<snoopy> HEY! TALK TO ME
<GINA> Hello Bugar is here
<Diamond> How about you?
> not at the momento
```

My visit to Glenview on a rainy Thursday during the lunch-break found an interesting, if not highly unusual, occurrence: a large number of junior high students (actually a good portion of the entire student body) *voluntarily* spending their free-time in a school library. "It's always like this on rainy days, especially now that we have the computers," explained Barbara above the excited chatter of a group of boys seated at Macintosh terminals. Behind them, other students appeared to be waiting impatiently for the next available machine. "Everybody wants to use the computers," said one of the girls waiting her turn. "If you don't get here fast enough, you kind of have to wait until somebody leaves or Mrs. Ross kicks somebody off the computer."

Over the course of several weeks visiting Glenview I learned that the school library has become a popular "hang-out" for students with spare time before, during, or after school. (This relatively easy access to technology for all students at Glenview stood in sharp contrast to the more limited student access to technology at Oakmont.) Even on sunny days, the library was frequently crowded with students, most of whom had staked-out their territory at one of the thirty Macintosh computers. I observed that students utilized their free-time on the computer to type assignments, play computer games, and occasionally create illustrations and graphics to decorate class reports. But by far the most common use of computers by students at Glenview consisted of "logging-on" to the "Chat-line," a feature of the Knowledge Network Gateway™ internet service provided to the school by a local communications company. The Chat-line enables users to "talk" with other users logged-on to the service, both at Glenview and at other sites (schools) in the state. In other words, students can converse in "real-time," through the computer, to a friend sitting ten feet away or with a student three-hundred miles away (and quite possibly both at the same time!). Mrs. Ross explained that all students are required to go through an networking "etiquette" course before they are issued their "I.D. codes" that are needed to log-on to the internet. Because the Chat-line has become something of a popular fad at Glenview, and because students at both schools have so enthusiastically taken to "cyberspace" when given a chance to explore it, I decided to investigate this phenomenon in more depth.

As presented in the previous sections, the participants all expressed an enthusiasm for and wonderment of the internet, and in general regarded telecommunications as the "cutting-edge" tool that will revolutionize education. For example, Steven remarked that he would like to have "five internet nodes" in his classroom and explained that "the internet [enables] kids [to be] connected to the world through a medium that's not just the teacher." Carol emphasized the way that the internet allows her students to access "experts" and get quick answers. Several other participants commented on the way the internet can be used to increase communication between parents, students, and teachers. For instance, Dan noted:

> I've got kids who talk to me on my e-mail . . . they found me on the CityNet . . . they tracked me down. "Mr. [Stevenson], we're here! Come chat with [us]!" . . . [The internet] is such a wonderful toy for [students], such a wonderful tool that they can use . . . And I don't even think they realize how much they are learning from it . . . They can log on at home. . . They can talk to their parents, they can talk to me. I even had a student ask me about the Christmas homework assignment . . . They didn't know what the heck I was talking about [in class], so they knew that I was on CityNet so they sent me a little e-mail.

I found Dan to be particularly interested in the internet phenomenon, and often our conversation drifted towards how it was altering the school culture. For example, when I commented on the popularity of the Chat-line, Dan responded:

> I can see the dynamics of the [school] already changing from when [we] let [students] get [access to the Chat-line]. Because now all of a sudden instead of hanging out at lunch and talking, just hanging out with each other, they go into the library and they chat with each other . . . through the computer.

Intrigued by the idea that students seem to be favoring computer-mediated interactions over face-to-face interactions, I asked Dan to share his thoughts on why this was occurring. He explained:

> What [the students] are really doing when they are chatting through the computer is they are putting themselves into a world with thousands of people in it. You know? . . . I mean, they don't even realize that they are doing it, but that's why they like it so much. [I] ask [a student] . . . "Why are you on this computer?" And he says "Because I am talking to this guy." [Then I ask], "Well, who is this guy?" [And the student answers]

> "Oh, he's a guy on the other [side of the library]." "Well, why do you have to use a computer to talk to him?" And the kid will [say], "I don't know. I just do."

Then Dan added:

> If it was just a one-on-one conversation between them and the other person, I don't think they would [use the computer] as much. If it was [just] point to point e-mail, I don't think they'd do it. But instead, they are going . . . into a "chat room" with dozens or hundreds of other people . . . throwing their comments out into that room, and then it finally gets to the other person . . . It's just a dynamic that . . . with the 900 students at school that we have now, that's 900 possibilities for students to interact. And all of a sudden, by putting that computer between two people in the same room at the same school, you've made millions of possibilities off of that. Because now [students] are going through this Chat center that could have people from all over the country, or all over the world, and then get it to the guy on the other side. And they are just addicted to it.

Dan's comments were significant in a number of areas. First, it appears that students at Glenview are not only being exposed to greater amounts of computer-mediated instruction (in the form of drill-and-practice software and simulations), but their interactions with teachers and other students are increasingly mediated through various forms of technology. Furthermore, Dan's exchange with a student using a computer to talk to a friend sitting a few feet away suggests not only a new form of mindless "addiction" to technology, but also a missed opportunity for a more critical dialogue with the student about the implications of favoring more artificial and filtered forms of communication over face-to-face dialogue. In addition, I was struck by Dan's explanation of the appeal of the chat-line, which seemed to emphasize the positive aspects of translating one personal message into "millions of possibilities" of interactions. His enthusiasm for the sheer *quantity* of sender-receiver connections over the *quality* of discourse also appeared to reflect a technicist mindset of "more is better."

On one level, the appeal of the Chat-line among students is an expression of a fascination with novel communication gadgets that caused me to spend hours as a kid talking to my friend on a walkie-talkie. On the other hand, I sensed that the popularity of the Chat-line, and the internet in general, suggested influential cultural-amplification processes at work in these particular contexts. After my conversation with Dan, I began to listen more closely to what the participants had to say about the internet and began to pay more attention to how communication and social patterns within the school culture were being mediated by computer technology.

One of the noticeable themes in participant discourse related to idea that some students are increasingly choosing to spend their time in the "virtual" realities of computers and cyberspace rather than dealing with real people and real situations. Many teachers wondered whether or not technology presented another form of "escape" that distracted students from their assignments and school responsibilities. As Alan remarked, "I have this sense that [technology] is also a growing excuse for not doing homework. There are some kids who will spend hours on a computer and they know that they have a paper to do." Actually, I experienced this idea first-hand one afternoon at Oakmont when I wasted two hours "surfing" the World Wide Web and discovered that the internet is valuable tool for obtaining all the latest speculation and lurid details of the O.J. Simpson Case. I also observed numerous occasions where students, in the middle of a class project or guided computer-based lesson, could not resist the temptation to quickly "log-on" and check the latest gossip on Nirvana or send an e-mail note to a friend. In light of these observations, I found it easy to understand why Postman (1994) recently entitled an article on the role of computers in schools "Technology as Dazzling Distraction."

Some participants pondered the thought that technology like the Chat-line might be preempting basic social interactions. For example, Steven confided:

> I [have been] noticing less connectivity between the kids. Kids [are] not really telling stories to each other. I mean, I think kids used to talk to each other more . . . make elaborate descriptions of things . . . If you interact with a computer or a keyboard, you are not interacting with people anymore. Even though [the Chat-line] is communication between people, a lot of times kids will sit their and play solitaire on the computer, versus talking with each other. Or [they will] play Tetris for hour upon hour, versus sitting and talking about something. I just see it diminishing connectivity between kids in some ways.

Carol wondered if perhaps "some of the interpersonal skills are being lost," and explained:

> It's . . . like the students have the relationship with the computer. Sometimes kids will come in [to the labs] and sit at a computer . . . [Then they] go home. Do they call up their friends, do they go out and play basketball? Have you ever seen anybody play stickball anymore in the street? No! They're all home playing Nintendo . . . So their relationship is with the computer rather than with their friends out in the street just hanging out . . . I think some of them are losing interpersonal skills.

Exploring a related theme, Alan expressed a sense of feeling that technology is making it more difficult for him to know his students in subtle ways:

> Technology has affected our relationships . . . I don't have to spend that much time reading their writing because 90% of them pass their work in on the computer . . . The sad thing is that I don't even know what their handwriting is like anymore, and I used to be able to identify a student just by his handwriting . . . . [Now] you can't identify the personalities. But what you identify with now, I think, is [the] sentence style and structure.

These comments suggest that computer technology in these contexts may be weakening personal ties, dialogue, and sense of community. According to Carol and Steve, students are not "telling stories" to each other, not "sitting and talking," not playing or interacting as much, perhaps not building relationships to the extent that they used to. Instead, as Carol suggests, students now have "the relationship with the computer" and other technological companions, and thus are not developing "interpersonal skills." Previously only found at home, these new electronic diversions are increasingly part of the culture in schools like Oakmont and Glenview.

While some teachers expressed a general feeling that technology might be creating more opportunities for students to avoid personal interactions and participation in community, a few conveyed the belief that the new technology was contributing to more extreme forms of anti-social behavior in some students. Participants told of encountering a new, less benign type of "computer-nerd" that spends hours at home and school playing video- and computer-based games. For instance, Janet remarked:

> We have a few kids this year who don't have any social skills because that is all they do is sit at the computer . . . you know, computer nerds . . . And [I had] one little boy [who was] hitting kids, making people cry, and I called his mom and she said, "Well, he's a computer nerd . . ." He interacts with the computer rather than with other kids.

Alan expressed a similar concern for students that appear to be consuming a steady diet of technology-generated violence and gore:

> Boys use [computers] for fun and games . . . I've noticed the type of kid that [those games] seem to appeal to. They are a different breed that has been brought about [because of the games], and unfortunately it spills over into their thinking and [their school work]. Their paper will sound like Dungeons and Dragons, and it's blood and guts, and it's violent. And it's strategies on how to "get" you. They are nice little twelve year old kids, but when I listen to their humor sometimes it's scary. And [I] don't ask [them] to write an adventure story, because then it really gets . . . blood and guts. And I think that is amplified by some of those [computer] games that the boys play.

It is interesting to note Alan's perception that the values and culture that the students are exposed to through technology-based games "spills over into their thinking." His awareness of the cultural dimensions of technology was encouraging, yet rare among his colleagues. Alan's use of the word "amplified" in explaining how technology mediates the student's encounter with culture is particularly appropriate in light of the arguments put forth by Bowers (1988, 1993a, 1993b) on the non-neutrality of computers and other forms of technology.

In spite of my significant experience with technology and a general awareness of the latest developments in computing, I was surprised by what I found on my own excursions on the internet. Largely unregulated at both sites, the on-line services available to students do provide an eclectic mix of "information" at a simple click of the mouse. In a few minutes one day at Glenview, I was able to peruse the Magna Carta and FAQ's (Frequently Asked Questions) about Paganism. One day I strolled into the computer lab in room three at Oakmont and found three boys, apparently dismissed early from class, playing a "cybergame" called something like "Imperial DikuMud." Not familiar with these new internet-based games, I asked the boys to explain to me what they were doing. One student told me that it was a "Dungeons and Dragons-sort of game" where players assume roles and interact not only with the game but with other "real people" in cyberspace who are logged-on to the same mainframe computer. The objective of the game, as I understood it, was to gain status in the "cyberworld" by solving riddles and eliminating enemies. Another young man enthusiastically explained to me that there were different "levels" of violence that one could inflict on the "virtual" foes: based on one's status in the game, one could tickle, hit hard, maim, kill, massacre, or vaporize people. Very successful players who achieve the highest level of status in the game can "request immortality." One student, who appeared to be very adept at the game, told me that he had been playing this particular scenario for a total of three days and 14 hours.

As the discussion above reveals, one aspect of the cultural transmission process occurring through the use of technology in schools involves the amplification of computer-mediated experience (i.e., communication, play) and the reduction of more natural human interactions. That is, students are being socialized into a culture that values (emphasizes) technology-mediated experience over non-mediated experience. Examples of this amplification process were found in many areas of the school life: classroom use of telecommunications, computer-based activities, video-taped lessons and student projects, and video-journalism classes. I even encountered new forms of technology-mediated "tutoring," where teachers produced and distributed videotapes of themselves correcting students' assignments. Remarkably, this "electronic cloning" of teachers was seen as a strategy to make school more "personal" and "meaningful" for students.

According to Bowers (1988, 1993a), Postman (1992) and others, as technology increasingly becomes the filter through which young people encounter the world (at school and at home), it is redefining what "communication," "learning," and "play" are for these students. For instance, as students increasingly use the Chat-line as the favored mode of interaction, they learn that "communicating" involves sending decontextualized, text-based messages through a computer. Furthermore, students who spend more and more of their leisure time playing technology-based games learn that "playing" is done in isolation, an activity that occurs between individuals and their computers. The fact that the content of these games largely revolves around themes of violence, domination, and manipulation also serves to underscore the point that the values and belief systems programmed into technology, often overlooked by advocates of educational computing, form an integral part of the cultural-transmission process occurring in the school environment. This being so, educators would do well to spend more time evaluating the educational value and appropriateness of the various technologies made available to students.

My reflections on these "lessons" encountered in a technology-saturated school relate in a number of ways to the ideas about the cultural, ideological, and epistemological dimensions of technology presented in Chapter Three (Bowers, 1988; Postman, 1992; Roszak, 1986). Technologies like the Chat-line and the internet are not neutral educational tools but powerful mediators of experience. Like all tools, their very design determines how students interact with and use them. In this respect, students' perceptions of "what is" are reconstituted to fit the logic of the technology. Postman explained it more eloquently when he wrote:

> New technologies change what we mean by "knowing" and "truth;" they alter those deeply embedded habits of thought which give to a culture its sense of what the world is like--a sense of what is the natural order of things, of what is reasonable, of what is necessary, of what is inevitable, of what is real. (1992, p. 12)

One afternoon at Glenview I encountered four girls and one boy seated at the computers. As usual, I discovered they were all using the Chat-line, except for the boy, who had been recently banned from on-line privileges by Mrs. Ross. Apparently, she caught him using inappropriate language on the Chat-line, so now he sat rather glumly playing an "artillery" game instead. It became clear to me after a few minutes of observation that the girls were "talking" with each other through the computer. A computer printout of a typical Chat-line conversation reveals the kind of communication that occurs as students interact through the computer (see figure 4 on p. 170). The text presented on the computer screen lags several seconds behind what is actually being typed by the users, and it often represents several conversations occurring at once between individuals at different terminals. As a result, the dialogue appears disjointed, fragmented, random, and incoherent. It takes practice just to be able to follow who is saying what to whom. Students usually adopted pseudonyms and therefore were able to hide their true identity. Emboldened by the shield of anonymity provided by the computer, some students sent rude, profane, sometimes threatening messages. A coincidence served to reinforce this observation as one day during my research a news story broke concerning a high school student who posted a death-threat for President Clinton on the internet.

In general, I observed the character of the conversations occurring on the Chat-line to be on the level of what one would find on a bathroom wall at a gas-station. In fact, it occurred to me that, at least for some students, the appeal of the Chat-line was precisely that: it serves as a kind of "electronic bathroom wall" where one can leave random "messages" for whoever happens to notice them. Perhaps some students at Glenview have engaged in a meaningful dialogue on the Chat-line, and it should also be noted that the Chat-line is monitored for "abuses." However, as figure 4 suggests, at its best, the Chat-line offers a kind of computer-mediated interaction that radically distorts the communication process, reducing it to anonymous exchanges of short, disconnected, and often random messages. The significance of the "Chat-line-style" of communication is further amplified by the fact that, according to many of the participants in this study, students are spending more time "talking" through computers and therefore less time engaging in natural conversations and social interactions.

Observations of students communicating, learning, and playing with computer technology in the school environment left me with a number of impressions about how technology may be reconstituting the ecology of language, thought, and social patterns that comprise the learning culture at

Oakmont and Glenview. To summarize, computers and telecommunications systems have become influential mediators of the learning experiences, communication processes, and social interactions engaged in by teachers and students at Oakmont and Glenview. As individuals at these sites have increasingly chosen to interact with and communicate to others through computers, they have experienced a form of communication limited and distorted by the requirements of the technology. That is, students and teachers have experienced communication not as a face-to-face process that includes tacit, contextual, give-and-take dimensions of meaning, but as a fragmented, decontextualized, random series of sender-receiver signals. Furthermore, teacher's concerns about the abandonment of natural communication and interaction among their students is further evidence of a form of cultural amplification through technology that emphasizes a technical culture (where human-machine relationships dominate) rather than a culture sustained by human contact, dialogue, and a shared sense of community and moral vision.

My analysis of how the increased use of computer-based communications systems is mediating the cultural ecology of the MTS school is admittedly impressionistic and incomplete. There were a number of other aspects of this phenomenon that emerged in the teacher discourse and site observations that unfortunately cannot be reported in any depth here. For instance, classroom use of the internet and Chat-line raised concerns among many of the participants related to issues of regulation of on-line services, loss of teacher influence, and effects of these new technologies on public perceptions about the nature of schooling and education. My intention here was not provide a comprehensive analysis of these particular issues, but rather, to offer a limited discussion of how technology might be influencing the broader ecology of thought and social patterns in educational settings. This discussion is presented as a starting point for raising questions that might guide future investigations, such as: What assumptions and cultural orientations towards communication processes are being amplified and reduced through the increased use of computers and telecommunications systems in educational settings? What are the implications of socializing children into a culture that favors computer-mediated communication and experiences over natural forms dialogue, interaction, and community participation? What role should teachers play in engaging their students in a discussion about the limitations and problematic aspects of technology-mediated learning and interaction?

As the four essays above have attempted to show, computer technology is an influential element of the classroom ecology that, in spite of a commonly held view that regards it as a "neutral" educational tool, is selecting and amplifying various patterns of thought within the learning culture. Specifically, in these narratives I have observed that technology is amplifying a set of ideological-epistemological assumptions based on a technocratic worldview, including: (a) The amplification of a technicist-modernist conception of education that is expressed in the impulse to rationalize and standardize educational practice, the objectification of students, and the reification of industrial metaphors for education; (b) The amplification of "information-processing" models of learning and cognition that are guided by misconceptions about the nature of knowledge and thought, as well as an adherence to an ideology that emphasizes "data" over "ideas;" (c) The amplification of a technical mode of thinking (instrumental, analytical, procedural) and the consequent privileging of those with access to technology and technical skills; and (d) The amplification of a cultural bias towards computer-mediated forms of experience and interaction, resulting in superficial, distorted patterns of communication and a weakening of social bonds and interpersonal skills.

As Bowers (1988) and Ihde (1979) have explained, the ability of technology to select and amplify a particular experience or aspect of culture is necessarily accompanied by a concurrent reduction (de-amplification) of other experiences or patterns of thought. From this perspective we can see how the four areas of amplification mentioned above suggest dimensions of the mental ecology of the classroom being put "out-of-focus" through the increased use of technology. For instance, increased reliance on computer-based educational games like International Inspirer™ diminishes an understanding of knowledge as a social construction built upon particular belief-systems, and puts out-of-focus culturally-based forms of knowledge that cannot be programmed into the computer. Similarly, teaching "thinking" through a computer programming curriculum de-emphasizes non-procedural, intuitive, holistic forms of understanding and thought that might be considered irrelevant or non-functional within the programming environment, as well as reduces an awareness of how thinking involves more than the mere processing of data. Furthermore, the wide-spread use of telecommunications and computer systems within the educational context might diminish an understanding of communication as a complex, culturally-embedded process involving metaphorical dimensions of language and tacit, nonverbal-paralinguistic cues (Bowers, 1988; Bowers & Flinders, 1990).

In the next chapter, the reporting of this investigation will be concluded with a summary of the findings and a final discussion on the implications of these findings, including some important questions that educators need to consider regarding the role and use of technology in education.

CHAPTER SIX:
CONCLUSIONS AND IMPLICATIONS OF THE RESEARCH

This investigation has been guided by a general desire to better understand the phenomenon of computer-based technology in the public school setting. The methodology employed in this study reflects the view that technological development in education is a social and cultural experience that, therefore, cannot be adequately understood apart from the historical context from which it emerges. In addition, the methodological approach has been guided by a theoretical orientation that regards educational technology as a mediator of culture within a broader ecology of language, thought processes, and social patterns that interact in the classroom and school.

The role of language has been emphasized throughout this study as a focal point for understanding how technology reshapes culture and alters collective understandings about the nature of experience, thought, communication, knowledge, and learning. The questions guiding this inquiry, therefore, have centered on how teachers at two Model Technology Schools bring to language their experiences and perspectives on the value and role of technology in their classrooms. The examination of teacher discourse and identification of the underlying assumptions about technology, teaching, and learning contained therein served as a starting point for an analysis of the broader cultural transmission process at work at these technology-saturated schools.

In the following sections, the conclusions of this investigation will be briefly summarized and a discussion of the implications of this research will be presented as a means for suggesting further lines of inquiry. Lastly, this paper will conclude with some final personal reflections on the research process and the idea of technology in education.

Dominant Assumptions About the Nature and Value of Technology in Education

Conversations with the participants of this investigation revealed a set of dominant assumptions and theoretical biases regarding the nature and educational use of technology that influence the broader ecology of ideas transmitted within the learning cultures at Oakmont and Glenview. The research identified a commonly-held constellation of beliefs about technology and technological development that reflect a modernist-technicist worldview now dominant in Western, industrialized societies. These beliefs regard (a) technological development as inevitable, (b) technological change as inherently progressive, and (c) technology as a culturally and ideologically "neutral" tool. As documented in Part One of Chapter Five, participants generally situated their discussion of educational computing within this conceptual frame, where technology is viewed unproblematically as an instrument of social, economic, and educational "progress." To summarize the dominant perspective found in the discourse, technology was assumed to advance on its own terms, bringing new possibilities and opportunities, and forcing individuals and institutions to adapt to the changing social and economic order. Furthermore, the collective perception that technology is "neutral," having no cultural or ideological dimensions, reinforced the generally uncritical stance towards technology and technological development.

In addition to this core set of beliefs about technology, the research also revealed a number of underlying assumptions regarding the role and value of technology in education that further guided the discourse of the participants. These include the beliefs that: (a) Technology-equipped schools prepare students to live in a high-technology economy and society, (b) technology enhances classroom instruction, (c) technology assists teachers in accommodating student diversity, and (d) technology helps teachers manage the classroom. That is, the participants, in general, value technology as a means to promote technical skills and a "technological awareness" among their students to ready them for life in an increasingly technological culture. They also value technology as an instructional resource or "tool" that can be employed to communicate content-related information to students, provide quick feedback, and advance students to "higher-order thinking" activities. Also, technology is valued by the participants as a means to engage the interests and accommodate the learning styles of a diverse student population. Lastly, technology is highly valued as a "management tool" that can assist teachers in lesson preparation, recordkeeping, and student evaluation.

The dominant assumptions summarized above, as well as the metaphorical language used by the participants throughout the discourse, also suggested another layer of beliefs about the nature of knowledge, learning, and teaching that influence the ecology of ideas at work in the cultural transmission process in MTS classrooms. For instance, it was noted that when teachers spoke of the use of technology in their daily practice, their comments tended to frame (a) knowledge as external, objective, and culturally-neutral; (b) teaching as the "delivery" of pre-determined curricular content; and (c) learning as information processing and instrumental problem-solving. These theoretical biases form another dimension of the underlying conceptual "guidance-system" directing the constitution of culture in these contexts, particularly with regard to the collective understandings of the nature and educational role of technology.

Cultural Amplification in Technology-Saturated Schools

The assumption and theoretical biases identified in the discourse provided a necessary entry point for examining how technology may be influencing the broader cultural ecology of language, values, ideologies, and social relationships at Oakmont and Glenview. That is, participants' beliefs about the nature and value of technology in education served as a conceptual backdrop for understanding the cultural-transmission processes occurring in the technology-saturated learning environments at both sites. The observational phase of this investigation revealed numerous examples of technology mediating the transmission of culture through the selection-amplification-reduction process described in Chapter Three. These examples represent some common patterns of thought and experience, identified in the participant discourse and amplified in the broader ecology, that characterized the cultural development of the schools. The observations below are offered not so much as final "conclusions," but as starting points for future discussions and investigations into the nature of the cultural dimensions of the technology-saturated learning environment. They are summarized as follows:

1. There is an amplification of a cultural orientation towards a technicist-modernist conception of education that is expressed in the impulse to rationalize and standardize educational practice. This ideological bent is enhanced by the increased use of pre-programmed, computer-based instructional activities and grading systems, which in turn contribute to the objectification of students and the deskilling of teacher practice. Also, the amplification of a technicist disposition towards education is manifested in the reification of industrial

metaphors for teaching and learning, prevalent within the participant discourse and therefore transmitted to the broader cultural ecology at Oakmont and Glenview.

2. There is an amplification of a cultural orientation towards "information-processing" models of learning and cognition. This is evident within the discourse and wider ecology in the valuing of computer technology to generate, transmit, and manipulate "data" and "information," which, in turn, is regarded to be the primary basis for gaining knowledge in nearly all fields of inquiry. This suggests an epistemological orientation that equates information with knowledge and the amplification of an ideology that values "data" (accessed through technology) over "ideas" (arrived at through moral discourse and personal reflection). Furthermore, the emphasis on computer-mediated learning, in general, amplifies a cultural bias for forms of knowledge that can be formalized and represented in a digital format; that is, knowledge that can be programmed into computers.

3. There is an amplification of a cultural orientation towards a technical mode of thinking (instrumental-analytical-procedural) and the consequent privileging of those with access to and mastery of technology, particularly computer technology. This is expressed within the broader school ecology in a tendency to regard computers as general "thinking" tools, equate learning with instrumental problem-solving, and elevate the intellectual skills required to program a computer to a status above other forms of thought and knowledge. Also, the amplification of a technocratic culture was observed in the rewarding of students

and teachers with technical skills and the marginalization of groups who are not as technologically literate.

4. There is an amplification of a cultural orientation towards technology-mediated forms of experience and interaction as computers and telecommunications systems are increasingly used in learning activities and interpersonal communication. This orientation involves the promotion of a conduit view of communication and language, where dialogue is misrepresented as the sending and receiving of decontextualized, print-based messages. In addition, participants' concerns about the weakening of interpersonal connections and social skills among students who spend significant amounts of time learning and playing on computers suggests another dimension of the amplification of a technical culture, where human-machine relationships preempt other forms of experience.

Implications of the Findings

The analysis of the underlying assumptions about technology contained in the teacher discourse and the cultural amplification-reduction processes influencing the ecologies at Oakmont and Glenview suggest a number of important implications for educators who find themselves working in high-technology-intensive schools. These concerns focus on teachers and their role as mediators ("gatekeepers") of the cultural-transmission processes occurring in their classrooms as students encounter an ecology of ideas, language, social patterns, and technologies.

In general, the findings of this study suggest, as Bowers (1988) and other scholars have argued, that computer-based technology is not a "neutral" educational tool but an influential element of the classroom and school culture.

The implications of this idea, not adequately addressed in the mainstream conversation on technology in education, reframe the issue of teacher-knowledge about the educational uses of technology. That is, the traditional approach to "training" prospective teachers in the use of technical systems for classroom instruction, which has focused almost exclusively on the technical, "how-to" questions, must be reconsidered if teachers are to begin to understand the cultural, ideological, and epistemological dimensions of technology-mediated learning. Additionally, experienced teachers must be encouraged to re-think their assumptions and taken-for-granted beliefs about technology, teaching, and learning that guide their practice, particularly the cultural myth of the "neutrality" of technology.

Bowers and Flinders (1990) have called attention to the central role that teachers play in the transmission of culture within their classrooms, as students come in contact with the underlying assumptions and guiding cultural metaphors (i.e., technological innovation as progress) that influence the direction of discourse and community life. Within this framework, it becomes clear that the findings of this investigation reveal a socialization process at work in technology-saturated schools and classrooms related to fundamental ideas about the nature of technology, culture, education, knowledge, learning, and communication. For example, the prevalence of teachers' remarks about computers being "just another educational tool" that they have at their disposal reinforces the notion, amplified throughout the wider ecology, that educational technology is culturally and ideologically neutral. Within the context of a classroom lesson, this assumption, and the underlying ideology upon which it is based, is transmitted to students without a critical examination of its social, economic, and political implications. Similarly, a participant's tendency to refer to computer technology as an effective "delivery system" of the course curriculum contributes to a cultural orientation towards technicist conceptions of education, and socializes students to the idea that learning is a passive receiving of pre-packaged, objective, "culturally-neutral" knowledge. From this perspective, the teacher's role in framing students' encounters with the instructional uses of technology and the "master ideas" upon which those encounters are based becomes a crucial dimension of teachers' professional knowledge.

The findings of this research, therefore, suggest a re-examination of the assumptions upon which researchers, reformers, and policymakers have traditionally considered the issue of technology in the classroom. Bowers (1988) has argued that educators must develop a more sophisticated understanding of the language-technology-culture relationship and, in general, adopt a critical posture towards current efforts to restructure the education system with advanced technology. In particular, he focuses on the role of teachers in the cultural transmission process and their responsibility in making important professional judgments about whether or not computer technology *should* be employed for various purposes in the classroom, as well as how the use of technology in instruction selects and amplifies taken-for-granted cultural patterns. For example, teachers must make critical decisions about the use of computerized-grading systems in light of a broader understanding of the tendencies of those systems to communicate (transmit) a particular cultural orientation towards the nature of learning and teaching. Furthermore, Bowers has recommended that teachers *make explicit* the tacit assumptions and rationalities that are embedded within the technological systems so that students can gain the conceptual building-blocks necessary to critically evaluate the elements of culture encountered through technology. For instance, students learning about the economy through a computer-based simulation must be made aware of the cultural assumptions encoded into the software and the extent to which the program reinforces, as well as weakens, a particular ideological or epistemological orientation. Bowers summarized his view on the role of the teacher in this process by stating:

> When microcomputers are utilized in the classroom, the teacher has the same professional responsibilities as when other technologies are used; namely, to control the dynamics of the socialization process in a manner that contributes to students' ability to put their own cultural experiences into perspective and to address in a meaningful way the adequacy of the conceptual and moral foundations of the modern world. (p. 106)

In reframing the issue of technology in education to include an awareness of how technology mediates the cultural-transmission process in the classroom and school, and in reasserting the role of the teacher in the language-thought socialization of students, Bowers offers an important alternative to the uncritical use of technology in education.

Suggestions for Future Inquiry

Throughout the analysis of the participant discourse and site observations presented in Chapter Five, several questions were posed in an attempt to bring into focus the cultural, ideological, and epistemological dimensions of educational computing. For example, how might the use of computerized-grading systems by teachers at Oakmont and Glenview be amplifying a particular set of assumptions within the school culture about the nature of technology, teaching, and learning? How might the increased use of instructional software like International Inspirer™ alter the cultural ecology of the classroom and, in particular, reframe the epistemological assumptions that guide educational practice? What might be the long-term consequences of an educational emphasis on instrumental forms of problem-solving and technical skills, as well as the general amplification of technical interests in technology-saturated schools?

These questions are exceedingly complex and present enormous difficulties for educational researchers intent on answering them. Nevertheless, they are vitally important questions given what we know about the technology-language-thought connection and how it influences the symbolic underpinnings of culture. These questions also suggest a re-orienting of the research agenda away from experimental, quantitative, technical approaches to more naturalistic, interpretive, qualitative investigations into the phenomenon of technology in education. This new research agenda would be guided by a desire to reveal the powerful yet subtle ways that technology and culture interact in educational settings, and to better understand the nature of the cultural-transmission processes at work in technology-saturated learning environments.

Concluding Comments

This investigation has utilized document analysis, interviewing, and ethnographic observations in an attempt to capture the complexity of the cultural dynamics occurring at two Model Technology Schools. In this respect, this study represents a form of inquiry that is interpretive, context-bound, and impressionistic. The findings are presented, therefore, not as final "answers" to the questions posed in Chapter One, but as tentative descriptions, valuable to the extent that they raise additional questions and point to issues and experiences that have not been adequately addressed in the research on educational computing. In that sense, this research represents another "story" told about technology in education, in the same way that Bryson and De Castell (1994) have discussed the various "true stories" that make up the *multiple discourses* on classroom computing.

It should be noted that the context of this investigation, the Vista Model Technology Schools Program, is guided by a particular philosophy that undoubtedly is influencing the way participants frame their understandings of the role of technology in the classroom. The Vista MTS program is a "teacher-centered model" of technology integration that is based on the belief that "Teachers - when provided direct and appropriate access to the tools and resources of technology - develop, evaluate and disseminate an instructional delivery model that uses technology across all curriculum areas and grade levels" (Lamson & Barnett, 1994). Furthermore, a Vista MTS brochure states that the goal of the Vista MTS project is to "empower teachers by providing them appropriate access to technology, to increase their productivity and to enhance their methods of classroom delivery through the use of technology-assisted strategies" (in-house Vista MTS brochure). The language used in these goal statements clearly reinforces a highly technicist view of education. Teachers are given access to "tools" to implement "instructional delivery." Teachers "increase their productivity" through using "technology-assisted strategies." Given this educational vision promoted at the administrative level, it is hardly surprising that the cultural orientations found in the participant discourse and amplified in the broader ecology are of the kind reported here. It may be reasonable to conclude, therefore, that the findings of a similar study conducted in a different context, one where technology integration is guided by a different set of assumptions about technology, teaching and learning, would yield different results.

The methodologies used in this investigation, being interpretive in nature, called for a continual assessing of the influence of researcher bias and critical reflection on the validity of the inferences made from the participant conversations and site observations. I have endeavored to be "true" to the data and careful not to impose pre-determined conceptual categories, even as I recognized the necessary role the researcher plays in the interpretation of events and meanings.

Like other qualitative researchers who strive to tell as much of the tale as possible, I was frustrated by the realization that several aspects of the phenomenon I encountered at Oakmont and Glenview could not be included in this report. In general, I was confounded by the complexity of the ecology of relationships between teachers' beliefs and practices, the nature of the technological systems utilized in the classrooms, students' interactions with and perspectives on technology, and wider institutional conditions and biases that influenced the patterns of thinking encountered during the investigation. Unfortunately, the paradoxical aspects of technology in the educational setting that I became aware of during the course of the study could not be adequately represented here. For example, in some instances I found classroom technology contributing to more personal, humane interactions between teachers and students; in others, a reinforcing of social barriers and the dehumanization of the educational process.

In summary, the research presented here offers a portrait of technology in education that highlights the problematic aspects of regarding technology, particularly computers, as "neutral" educational tools ideally suited for classroom use. The analysis of teacher discourse and wider school culture reveals technology as a powerful mediator of the cultural transmission occurring at Oakmont and Glenview. The underlying assumptions informing participant's beliefs and practices, and the manifestation of those assumptions within the ecologies observed in technology-saturated classrooms, suggest that the integration of new technologies into schools is often strengthening dominant cultural patterns. These dominant patterns of thought tend to frame the educational process within a technicist paradigm, where technology is seen as the chief source of educational progress.

Scholars and social critics are now examining the question of whether the recent push to infuse schools with the latest computer technology will further reinforce the modernist, technocratic ideology that has so powerfully shaped the evolution of the American educational system in this century. For example, Grundy (1987) has speculated as to "whether the introduction of computers into classrooms will continue to promote the ascendancy of the technical interest in the curriculum" (p. 33). Echoing a similar thought, Bowers (1988, 1993a, 1993b) has wondered "whether the current state of computer technology used in the classroom strengthens those cultural orientations contributing to a technicist social order" (1988, p. 6), and raised concerns about the educational uses of new technology being grafted onto a traditional (modernist) set of assumptions about the individual, learning, and teaching. Apple (1986) has cautioned against a situation where "the technology transforms the classroom in its own image, [where] a technical logic will replace critical political and ethical understanding" (p. 171). These perspectives all reflect a concern for maintaining the fundamentally human interests of diversity, discourse, equity, community, moral deliberation, and cultural renewal as the preeminent guides for educational policy, rather than the ideals of technical control and technological advance. "The central question is not whether one is for or against computers in education," concluded Sloan (1985), "but to define the human and educational criteria and priorities that can make a truly human use of the computer possible" (p. 4). Bowers' reflections on the essential issue facing the technology-in-education movement are offered below as a final thought to conclude this study:

> In effect, a twentieth-century view of knowledge involves using the microcomputer as a powerful and legitimate tool of the teacher and students. But it means subordinating the machine to the complexity of the human/cultural experience rather than amplifying only those aspects of experience that fit the logic of the machine. (1993a, p. 75)

EPILOGUE

> What we too easily call "progress" is always problematic - technology is always a Faustian bargain. It giveth and it taketh away. And we would all be clearer about what we are getting into if there were less cheerleading about the use of computers and more sober analysis of what may be its costs intellectually and socially.
>
> -N. Postman (1994, p. 26)

This research is the result of a gut feeling, an intuition, a perturbation about the interplay between technology, education, and culture that I experienced in my teaching. The process of becoming aware of the problematic aspects of a technology-intensive curriculum, shared briefly in the introduction, led me to take a more critical look at the phenomenon of classroom computing. This project has given me an opportunity to ask some questions that have not been asked and seek a greater understanding of an issue that is of tremendous significance.

During the last few months I have often talked with relatives and friends about my graduate work. The conversations usually went something like this:

her/him: So I hear you are getting your Masters this year. That's terrific! What topic will you be studying?

me: Well, I'm going to be doing research on the issue of technology in education, which has been a big interest of mine.

her/him: Great! It's incredible what is happening now with computers, the internet, all that stuff in the classroom. It seems like that is the direction that we need to go, you know, to use technology to help teach kids.

me: Well, actually, one of the ideas I'm exploring is that when we "use technology to help teach kids," we need to be careful about what we are doing. It seems that everybody is jumping on the bandwagon for computers in classrooms, yet few are pausing to consider how they might be used inappropriately or be simply an expensive diversion away from more important things.

her/him: (looking puzzled) Oh. (long pause). Well, anyway, good luck with your studies. Like I said, I think that technology-in-education stuff is really exciting. [end of conversation].

It became clear to me over these past months that the perspectives about technology-in-education that I was exploring (i.e., that educational technology is not "neutral," that classroom computing involves the transmission of culture) were "against-the-grain," counter-culture ideas. They just do not register with most people. A critical examination of technology of any sort, especially educational technology, is viewed as a result of some confused thinking, or worse, a deliberate assault on "progress." Even an education professor who I was working with wondered if I have taken a "Luddite" position in my thesis.

I do not believe I have. I am not "anti-technology," nor would I side with anyone advocating a total ban on educational computing. I am an educator who has used technology extensively, believe it has helped me to reconsider my professional practice, and still feel that new technology can play an important role in classroom instruction.

How, then, has my thinking changed? How has this project influenced my views on the role and value of technology as an instructional tool? My feelings are now characterized by a general sense of ambivalence towards new educational technologies, rather than the enthusiasm I felt when I unpacked that first shipment of computers several years ago. I am more ambivalent now because I believe that the application of new technologies to education does involve, as Bowers (1988), Postman (1994) and others have suggested, a "Faustian bargain," where some experiences are amplified and others, many of them important and valuable, are diminished or lost. I am ambivalent because for every "success story" that is told of students accomplishing great things with technology, there are still students whose love of learning and ideas is being pummeled out of them by mindless, drill-and-practice, computerized "learning systems."

Weizenbaum (1976) has described the computer as a "solution looking for a problem." His comment caused me to wonder: What are the educational problems that classroom computers are helping to solve? This seems to be an obviously fundamental question, so I decided to ask it of the participants in my study. The question, apparently too obvious to have warranted much thought, caught many teachers off-guard. Their answers were not only interesting, but provided insight into the unique perspectives of the participants and how they frame their understandings of both technology and the educational process. Many, like Michael, focused on the ability of technology to solve the problem of communicating course content to students: "The main thing that it solves is in giving many teachers another strategy to help get ideas across to the students or to help them get their curriculum covered." Others, like Carol, pointed to the problem of motivating students to learn: "Attendance has increased . . . students want to come to class . . . . There was 100% attendance every time they knew that I was going to the computer lab." A few had a difficult time identifying educational problems that technology is especially equipped to solve. Linda commented, "I kind of think that we're right now in the process of creating more problems in education with technology than we are solving."

Postman (1994) has pointed out that the dominant answer to this question in the mainstream discourse appears to be that computers "will give students greater access to more information faster, more conveniently, and in more various forms than has ever been possible" (p. 26). The findings of this investigation tend to support Postman's assertions. Nevertheless, I believe most teachers, if they pause to think about it, will agree that there is more to education than transmitting information, facts, or content to students. All would surely agree that no machine can match the power of a flesh-and-blood teacher to motivate, inspire, challenge, or instill pride in a student. Even among my conversations with Model Technology School teachers, a few expressed the idea that computers and other fancy new technologies have precious little, if anything, to do with good teaching and meaningful learning.

Could it be true, as Postman and others have suggested, that technology in schools is nothing more than a "dazzling distraction," another reason to avoid the real issues and problems facing society? I have become more aware of the ways in which technology can distract students away from more important activities, social as well as intellectual. I also have a greater understanding of how technology has distracted school districts and communities into committing vast resources of time, money, and energy towards slick, mass-marketed visions of high-technology schools. Some have argued that technology is an attractive solution for social and educational problems because it *appears* so neat, clean, powerful, scientific, and, most importantly, apolitical. Restructuring the school system with technology seems to be one educational issue that everyone agrees on, from the Religious Right to the American Federation of Teachers to inner-city school boards. The "neutrality" of technology, however, is an illusion.

I will return to my teaching position in the social science department at San Benito High School soon. I anticipate that I will continue to use computers and other new technologies occasionally, in ways that I believe are appropriate and meaningful for my students. I hope I do not lose sight of the fact that classroom use of high-technology always involves a subtle, yet powerful, "hidden curriculum" that may exert a more profound influence over a student's consciousness than the explicit "content" of the computer program or technology-based activity. I understand now that teaching in a technology-intensive environment requires taking extra steps to reveal the logic of the machines, to make explicit the cultural assumptions being amplified through technology in the classroom ecology. As an educator working in a culture prone to seeking technical solutions to human and social problems, perhaps I must take on the perspective of Postman's (1992) "technological resistance fighter," someone who

> . . . understands that technology must never be accepted as part of the natural order of things, that every technology - from an IQ test to an automobile to a television set to a computer - is a product of a particular economic and political context and carries with it a program, an agenda, and a philosophy that may or may not be life-enhancing and that therefore require scrutiny, criticism, and control. In short, a technological resistance fighter maintains an epistemological and psychic distance from any technology, so that it always appears somewhat strange, never inevitable, never natural. (Postman, 1992, p. 184-185)

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A campus of The California State University

APPENDIX A

College of Education • *Division of Teacher Education*
Bilingual Education • Child Development • Elementary Education • Secondary Education
One Washington Square • San José, California 95192-0074

Agreement to Participate in Research

Responsible Investigator: Ken Shears

Title of Protocol: Teacher Discourse on Learning and Teaching in Model Technology School Classrooms

1. I have been asked (or, my child or ward has been asked) to participate in a research study investigating the influence of computer technology on classroom discourse about teaching and learning.

2. I will be asked to (or, my child or ward will be asked to) participate in classroom observations and formal interviews at the school site from January 23, 1995 through March 15, 1995. Notes of the classroom observations will be recorded daily by the investigator. Interviews will be tape-recorded.

3. I understand that no risks to the participants are anticipated in this study.

4. I understand that the participants are not guaranteed any specific benefits as a result of being involved in this investigation.

5. I understand that the results of this study will be submitted to the School of Education at San Jose State University as part of the investigator's Master's Thesis. The results of the study may be published but no information that could identify the subject will be released.

6. I understand that the participants will receive no compensation for participation in the study.

7. I understand that any questions about the research may be addressed to Ken Shears at (408) 323-1017. Complaints about the research may be presented to Dr. Victoria Harper, academic advisor, at (408) 924-3789; or Dr. Karen Reynolds, Program Coordinator, at (408) 924-3711. Questions or complaints about research, subjects' rights, or research-related injury may be presented to Dr. Serena Stanford, Associate Academic Vice President for Graduate Studies and Research, at (408) 924-2480.

8. I understand that no service of any kind, to which a subject is otherwise entitled, will be lost or jeopardized if a person chooses to not participate in the study.

9. I understand that my consent to be a part of this study is given voluntarily. I understand that I am free to withdraw from the study at any time without prejudice to my relations with San Jose State University or any other participating institutions.

10. I have received a signed and dated copy of the consent form.

***The signature of a subject on this document indicates agreement to participate in the study.**

***The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.**

_______________________________ ____________
Subject's Signature Date

_______________________________ ____________
Investigator's Signature Date

APPENDIX B

Sample of Interview Questions:

1. Tell me about what happened to you when this school became a Model Technology School. How did you feel about the change at that time?

2. What was your understanding of the purpose of the MTS program?

3. What does being a teacher in an MTS school mean to you?

4. How has technology helped you teach? How has it helped your students learn?

5. What are some of the attitudes and opinions about technology that you hear among your colleagues?

6. In your opinion, what is the "best" way you are currently using technology in your classroom?

7. Can you think of any examples of how new technologies might be used inappropriately in the classroom?

8. Besides the content of the lesson, what else do you think students are learning when technology is used in the classroom?

9. Can you think of an example of how technology has changed relationships and/or interactions between you and your students?

10. How do you think technology might be influencing other aspects of the school culture?

11. How would you sum-up the overall value of technology in education?

12. In your opinion, what is the strongest rationale for integrating new technologies into the classroom?

13. If technology is a "solution," what is the "problem" that it addresses?

CHARIOT SOFTWARE GROUP

123 CAMINO DE LA REINA, SAN DIEGO, CA 92108

May 10, 1995

TO: Mr. Ken Shears
19110 Almaden Road
San Jose, CA 95120

FROM: Nancy Furlong
Marketing Manager
Chariot Software Group

RE: Permission to use MicroGrade product /graphics included in Thesis

Per our conversation earlier this week, I grant you permission, on behalf of Chariot Software Group, to include our MicroGrade product and/or its graphics as part of your Master's Thesis. Please include the product's name, MicroGrade and our company name, Chariot Software Group, as the source of any graphics or for any related copy.

Please let me know if you have any questions or need any additional information.

Sincerely,

(619) 298-0202, FAX (619) 491-0021

Tom Snyder Productions

EDUCATIONAL TECHNOLOGY

May 23, 1995

Mr. Ken Shears
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