

EDUCATION FOR AN INFORMATION AGE
Teaching In The Computerized Classroom, 6th edition

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Chapter 13: Computers, Education, and Society

Chapter Thirteen
Computers, Education, and Society

It is useless to bemoan the departure of the good old days of children's modesty, reverence, and implicit obedience, if we expect merely by bemoaning and by exhortation to bring them back. It is radical conditions which have changed, and only an equally radical change in education suffices.

John Dewey (1859-1952)

Science cannot stop while ethics catches up.

Elvin Stackman

Some are born good, some make good, some are caught with the goods.

Thomas Jefferson (1743-1826)

For every man there exists a bait which he cannot resist swallowing.

Friedrich Wilhelm Nietzsche (1844-1900)

A teacher who can arouse a feeling for one single good action, ... accomplishes more than he who fills our memory with row on row of natural objects, classified with name and form.

Johann Wolfgang von Goethe (1749-1832)

LEARNING OUTCOMES

The children in our classrooms have been raised in a world where computers and computer-based technologies have changed the landscape of their daily lives. We even have a special name for these young people who've grown up since, say, the late 1980s; we call them "digital natives." The rest of us, who've had to get used to this new digital world later in life, are called "digital immigrants!"

What does this digital reality mean for our students? What is their mindset? How does it affect their day-to-day lives? That is what this chapter is all about.

Our examination of the sociological impact of computers begins with a broad sweep across the canvas of our world. We will consider the computer as a tool that supports research, enables discovery, stimulates invention, fosters environmental and organizational control, and facilitates communication between individuals and groups, which in turn fosters understanding, cooperation, and accord. We will next concentrate on the increasingly central importance of education as the key to the survival of the individual in a modern, computer-controlled, information-based society when what you know is at least as important as what you can do.

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Lest we have too rosy-eyed a view of the computer's impact on our world, we also will examine the dark side of the rapid proliferation of computer-based technologies. Privacy is threatened—some would say it is dead and gone. Inequities—the so-called Digital Divide—are becoming more, rather than less, pronounced. New kinds of crime have emerged, along with new risks to children—some of which we already discussed in chapter 8. Teachers and students need to be aware of these negative aspects of computerization so that they will be less likely to become victims of the negative outcomes of a computerized society. The knowledge that comes with this awareness empowers the individual, and that is what learning is all about.

Here then are the topics that will be discussed in chapter 13.

- Computers are transforming our world
 - Extending the capabilities of the mind
 - Extending the capabilities of the body
- Education and the Information Society
 - Information overload
 - Information and wealth
- The place of computer-based learning in schools
- Ethical and legal issues and computers
 - Privacy invasion
 - Computing inequities: The Digital Divide
- Security: Hacking and Cracking
 - Computer viruses
 - Worms and Trojan Horses
 - Spyware and Spam
 - Trespass of Computer Systems
 - Money theft (Embezzlement)
- Steps Schools Should Take to Secure Computer Networks

COMPUTERS ARE TRANSFORMING OUR WORLD

Not all computerization is for the better. Weizenbaum (1976) reminds us of the words of John Dewey, who wrote: "Every thinker puts some portion of an apparently stable world in peril and no one can predict what will emerge in its place." The invention of the computer has indeed changed the world. According to Weizenbaum, the very existence of the computer makes it possible to manage more data than ever before. This has resulted in our *collecting* more data than ever before.

While this is a boon to researchers, it also affects the way we solve problems. As Weizenbaum points out, "the computer did arrive 'just in time.' But in time for what? In time to save—and save very nearly intact, indeed to entrench and stabilize—social and political structures that

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otherwise might have been radically renovated or allowed to totter under the demands that were sure to be made on them." The computer has "buttressed" and "immunized" social and political structures "against enormous pressures for change." Weizenbaum goes on to question the use of the term *Computer Revolution*, arguing that computers have done more to *prevent* change than bring it about.

On the other hand, Beniger (1986) makes it clear that increased levels of control promote progress in any field of endeavor. The computer, by giving us greater control over systems such as transportation, communications, banking, science, and industry, directly affects the rate of discovery, invention, and progress. Artists and artisans from all walks of life—including teaching—recognize the potential of the computer to extend human capabilities in the realms of creativity and problem-solving. The computer thus seems likely to have a beneficial impact on our world. Let us begin then by briefly examining some of these beneficial social impacts.

Extending the Capabilities of the Mind

Alan Turing, an English philosopher and mathematician, published a paper in 1937 which anticipated the invention of the modern electronic digital computing machine. Turing described a theoretical, logical machine (Turing, 1937), now known as the Turing machine, which would be capable of processing any *computable* function.

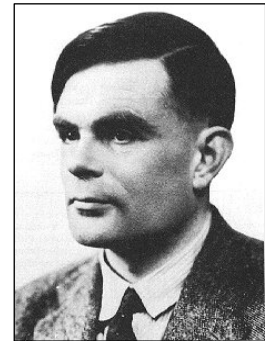


Fig. 13.1 Alan Turing, Mathematician and Cryptographer, 1912-1954



Kurt Gödel (1931) had already shown that there was a class of problems in mathematics that were simply unprovable. But what Turing established for the record was that, given time, we could build a machine that could come up with the solution to any *computable* problem we set our minds to! So he called his theoretical machine "The Universal Machine."

Fig. 13.2 Kurt Gödel, Mathematician and Logician, 1906-1978

Turing might be called the Father of Artificial Intelligence (AI) because of his early recognition of the electronic computer's extraordinary potential as a 'thinking machine.' He liked to compare the computer to the human brain. As Hodges (1982) notes, Turing had always been interested in physiology. Certainly, he showed a thoroughly modern understanding of neurophysiology when, in 1930, he observed: "We have a will which is able to determine the actions of the atoms probably in a small portion of the brain... The rest of the body acts so as to amplify this."

The brain proposes, the body disposes. By analogy the computer, like the brain, can be programmed to control an endless series of machines and environments which would otherwise

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need the presence of a thinking human being. These would include social or community environments such as transportation, all areas of science (including health and welfare), communications (including entertainment), agriculture, accounting and other processes in business and industry, and so forth.

More and more tasks previously carried out by intelligent human beings are now being given over to suitably programmed computers. The computer is just a dumb machine which, once programmed, is able to work tirelessly, processing data of all kinds at high speed and at little cost. It is also much less error-prone than the human data processor. This is why folks such as Gottfried Wilhelm von Leibnitz and Charles Babbage racked their brains to devise automatic calculators: human computers just make too many mistakes!



Figs. 13.3 and 13.4 Leibnitz and Babbage

Ironically, the electronic digital computer mindlessly performs operations that enhance our ability to think. Human thought is predicated on knowledge, which is the outcome of acquired and assimilated information, which itself is made possible by symbol systems (data expressed in the lexicon of a language). We think using the tools of the language(s) we have learned. Where computers today come in handy is by allowing us fast, easy access to the information that we need to think about things—anything!

Teachers thus have a golden opportunity today to improve the educational experience for their students by creating an environment in which children can take advantage of computer-based technology to extend their ability to think and learn.

Research has shown that writing is a pre-eminent learning tool. The very act of writing—of organizing thoughts into a coherent form—is an important step towards understanding, which is itself as fundamental building block of learning.

Research also has shown that children's writing skills are considerably enhanced when they use the computer as a writing tool. This is partly because they are liberated from the constraint of having to form letters by hand, but it is also because they are able to capture their thoughts and, above all, revise their thoughts much more easily using a word processor than with pen and paper.

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Thus the computer promotes learning by promoting writing. It also promotes learning by taking much of the drudgery out of processing data.

Put the computer in the hands of trained (educated) individuals and those individuals can “think” with their fingertips, processing and analyzing huge databases of information on the way to drawing conclusions about our world—in science, technology, business, government, philosophy, the arts—which advance our understanding and increase our ability to control our environment.

As we shall see later in this chapter, this increasing level of control is not necessarily a good thing. The computer helps us think; unfortunately, it can’t help us act morally or ethically. That is something we still have to do on our own.

Extending the Capabilities of the Body

Even animals use tools to help them accomplish physical tasks. Computers are no different from other tools in this respect, except that they have a lot more flexibility and versatility as Universal Machines, plus—and this is a big plus—they can be programmed to operate autonomously, without human intervention.

Robotics Scientists routinely are able to pick up and examine rocks on the surface of distant planets. Back on earth they slip their hands into “gloves” that are connected by radio signals to the “hands” or, more accurately, claws of robots that have been sent to those planets to do the scientists’ exploring for them. The robots have cameras fore and aft to transmit pictures of the objects they sample, and the scientists manipulate them remotely as if they were there on the planet inside the shell of the robot. The robot responds precisely and delicately, controlled from hundreds of thousands, maybe even millions, of miles away.



Fig. 13.5 The Lunar Rover

The picking and placing of rocks is analog; the data processing, including the control of the robot and the imaging, is entirely digital—just as Alan Turing in 1937 figured it could be done.

Other remotely operated vehicles (ROVs) are used to study the ocean depths, or to investigate unexploded bombs, or to check out areas that may have been contaminated as a result of toxic

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emissions. In general, ROVs allow us to go where it would be either very difficult or very dangerous for us to go in person.

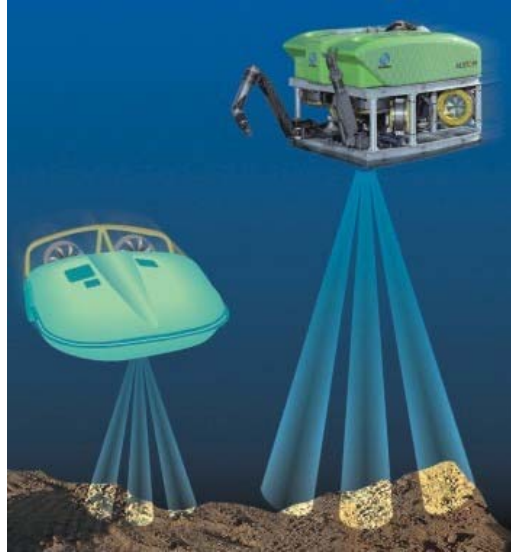


Fig. 13.6 Submersible ROV

However, robots, in the form of robotized cameras, also can manage the places where we live. They can rule the road—in the United Kingdom, for example. If you go to the UK for a visit, watch out if you decide that you'd prefer to rent a car. Wherever you drive, cameras will be watching you! This is very convenient for the UK government, since the cameras control computers that automatically take pictures of the license plates of speeding drivers, locate them in the database of licensed drivers, and automatically send a speeding fine notification through the mail—without a single policeman in the loop!

Cameras rule! George Orwell, of Big Brother fame, would not be in the least bit surprised to see what is happening in so-called free societies such as the UK. But then, maybe we have to give up freedoms in order to guarantee freedoms. Now there's a conundrum!

Help for the disabled Today we can say that if a person can control the movement of any part of his or her body—the raising of an eyebrow, the blink of an eye, the flick of a finger, the twitch of a toe—a computerized device can be designed to use that movement to allow a person with a disability to function independently in the mainstream of society.

As stated in chapter 14, in the United States there are over 50 million people with some kind of physical disability—that's 1 in 6 of the population. The growing industry for computerized devices to assist this segment of the population has already produced inventions that give one reason to hope that the term *handicapped* will eventually all but disappear from our vocabulary.

Consider what has already been achieved.

Consider a quadriplegic, paralyzed from the neck down, who has a voice-controlled robot programmed to be his companion, preparing his meals, feeding him, fetching and carrying for him, and so forth (NOVA, 1985). Consider the paraplegic, paralyzed from the waist down, and

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now able to walk because of mind-directed, computer-controlled functional electrical stimulation of the leg muscles (NOVA, 1985). This is now old news.

Consider a blind person who is able to see faint images for the first time in his life because of a computer-based system that literally plugs into the visual cortex at the back of his brain and transmits to the visual cortex pictures captured by a video camera, bypassing the eyes altogether.

Computers also produce some surprising and moving "high tech, high touch" outcomes. Dr. Rena Uptis at the Hennigan school in Boston, Massachusetts relates the story of "one little girl—classified as non-verbal because she had never spoken in school—[who] spoke for the first time at the computer, asking her teacher to come and see her work" (Spence, 1987). In another example, an autistic child was able to be mainstreamed because of the computer's capability as a voice synthesizer. "In time," the child said with the computer's help, "I will utter the truth of my plight. I will remember the people who helped me. I cannot do this without help."¹ Without the computer the child would probably have been trapped forever inside his disability.

"The blind see and the lame walk..." The more aware we become of the many extraordinary computer-based applications that are being designed by inventors and researchers across the globe, the more we can appreciate the relevance of the term *computer revolution* as an apt description of the transformation that is taking place in every corner of our world.

In schools, computers are making possible the elusive dream of individualized education even as they facilitate collaborative learning and inter-cultural communication. As Melmed (1988) observed: "The application of science and technology, which has had such a powerful effect in other social and economic sectors, can be the basis of a new instructional model with much improved learner productivity."

EDUCATION AND THE INFORMATION SOCIETY

Information Overload

Revolutions create chaos as readily as they bring about change. A significant accompaniment of the computer revolution has been an information explosion that threatens to overwhelm the decision maker at every turn. While too little data, like too little knowledge, is a dangerous thing, so too is too MUCH data, otherwise known as information overload.

This problem is not new. Francis Bacon (1561-1626), the English essayist, philosopher and statesman, was perhaps one of the last people who could honestly say: "I have taken all knowledge to be my province." A century later, Voltaire (1694-1778), the French writer and philosopher, was forced to admit that "the multitude of books is making us ignorant."

Information overload was definitely a problem in the 17th and 18th centuries, and it is getting worse rather than better, even *with* the data-processing capabilities of the computer.

¹ From a TV documentary on autism.

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This is because the computer can only process data—the raw material of information; you need the human brain to process information. Fig. 13.7 illustrates the Knowledge Spectrum (Debons, 1988), which we discussed in some detail in Chapter 8. Notice the two segments of the spectrum—the Data Driven and the Cognitive Driven segments. The computer helps us more efficiently handle data processing in the Data Driven segment. Beyond that, it's up to us to use our mind to make sense of what the computer presents to us. Only then does it have the potential to become information.

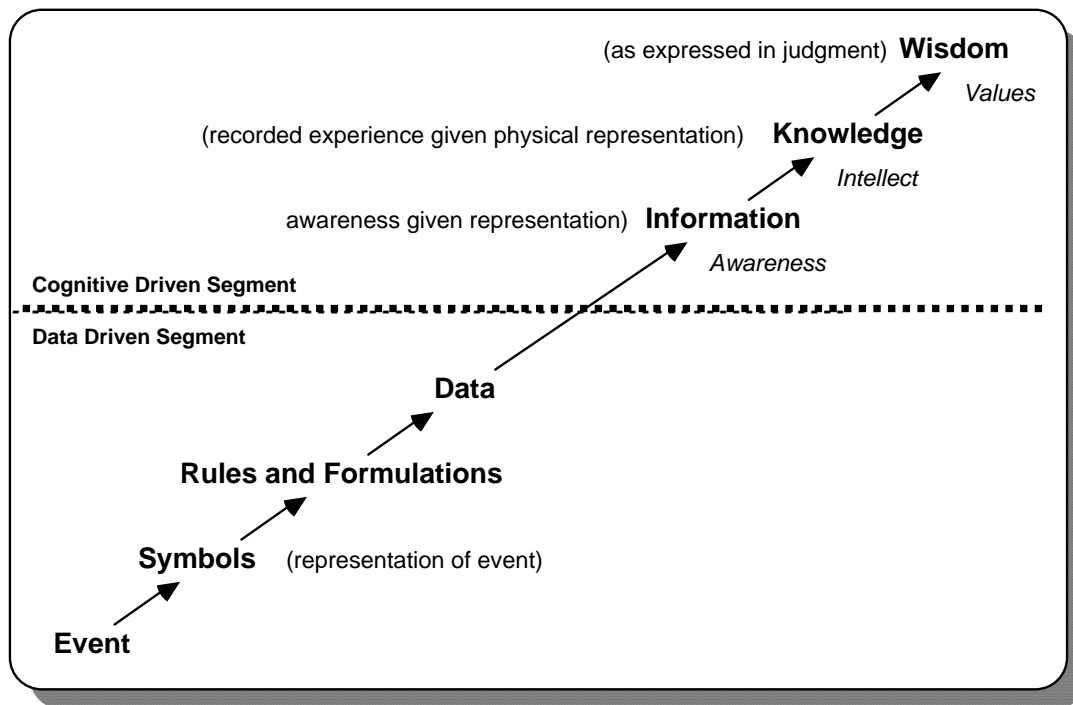


Fig. 13.7 The Knowledge Spectrum (Debons, 1988)

Information overload is brought about by advances in technology. In this sense, technology is driven by its own success, like a dog chasing its own tail. Computer hardware and software engineers are increasingly challenged to develop and refine the highly complex systems of control that will allow us to maintain political, economic, and social equilibrium in these technologically turbulent times.

Information and Wealth

In a pre-industrial society, the source of wealth was land. Then, in the 18th century the Industrial Revolution caused a shift to capital as a primary source of wealth. Today, information is a major source of wealth. Data is the raw material of information, and processing it effectively is what makes one company more competitive than another.

An increasingly large percentage of the workforce in an increasing percentage of countries earns a living from transmitting, receiving, and processing information. Since 1890, the numbers of those employed in agriculture in the United States, for example, has fallen from 95% of the population to no more than 1% today. Since 1950, the number of those employed in blue collar

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labor (construction, production, transportation, and so forth) has fallen from 62% to what is projected to be less than 23% by 2012. By 2012, it also is projected that close to 80% of the workforce will be processing data in information-intensive or service-oriented jobs (US Bureau of Labor Statistics, 2004).

This has significant implications for education. As Ogilvy (1993) observes, "What the farm was to the agricultural era, and the factory to the industrial era, educational institutions will be to the information era."

The Place of Computer-Based Learning in Schools

In light of this new reality, education is essential for *all* citizens so that they can contribute effectively and benefit from the wealth that the society produces. Two questions arise:

- To what extent can computers be used to improve the process whereby an individual acquires an education?
- What role will teachers play in "schools" where much of the learning is computer-based?

The myriad computer-based learning applications developed for K-12 education can help release teachers from the primary burden of responsibility for knowledge transfer. Learning, after all, is ultimately the responsibility of the individual student. The teacher, through the thoughtful integration of student-centered methodologies and computer-based technology, can become the facilitator of knowledge acquisition—a knowledge broker, if you will. The teacher's role is to create and sustain an environment in which children can seek, find, and assimilate data, thus becoming informed through the acquisition of knowledge.

The teachers of the future will need intellectual skills of a different kind from teachers of the past. Teachers will still need to know math, history, geography, chemistry, and so forth—they will still need to be educated—but this kind of knowledge will be less important than:

- knowing how to manage a learning environment;
- knowing how to select and set up appropriate individualized learning experiences for children based on their age, propensities, capabilities, and interests;
- knowing how to motivate children;
- knowing how to recognize and work with the subtlest of learning disabilities;
- knowing how to create positive and productive interaction between the child, the school, and the home.

Researchers (Van Dam, 1991), monitoring a classroom where computer-based technology was integrated intensively into the curriculum, noticed that the teacher seemed to have very little to do. The children were working alone or in groups; some with and some without computers. There was a quiet hum of activity; everyone was involved in the learning process. The teacher was attentive to everything that was going on, moving easily from one group to another, sometimes in response to a verbal or non-verbal call for help, other times to more precisely feel the pulse of the learning process as it occurred.

One of the researchers asked one of the 9 year olds: "What does the teacher do?"

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"He's very important...", one of the youngsters replied.

The researcher was not satisfied with the response. What did the youngster mean? So the question was put again. "Yes, but what does the teacher *do*?"

"Well, he's there in case we need him," said the boy, after a moment's pause.

"He's very important... He's there in case we need him..." What a beautiful description of the role of the teacher in the student-centered, student-directed learning environment. The teacher does not direct the entire learning experience. Rather, the teacher sets up and maintains an environment that fosters learning for the student participants. The teacher does not pass on all the knowledge. Rather, the teacher ensures optimal conditions for knowledge acquisition. The teacher is not an officer in a regimented educational system. Rather, the teacher is a "knowledge broker," acting as an intermediary between students and the data that they seek to fulfill their *individual* information needs.

Children need teachers more than ever in a world where information overload creates confusion in immature minds. But they need teachers less and less as imparters of knowledge, and more and more as imparters of wisdom.

"He's very important... He's there in case we need him..." There is an increasing number of classrooms worldwide where this concept of the teacher as facilitator of learning is a reality, and in many of those classrooms the computer is becoming an invaluable, if not essential, learning tool.

ETHICAL AND LEGAL ISSUES AND COMPUTERS

Many societies today are faced with serious problems regarding the upbringing of their children. This is especially true in the so called developed world where half of all marriages fail and where, even when the marriages last, both parents feel constrained to work to make enough money to have a decent standard of living¹.

With the best will in the world, parents in such families have difficulty giving their children the care they have every right to expect from the dependable and attentive presence of a nurturing adult. Many children are "latch key kids," coming home to an empty house and left to fend for themselves for several hours until a parent comes home. Other children come home to a house where the parents have little energy left to respond to their need for attention.

Too often, the children *are* finding at home all the wrong kinds of role models pacifying them hour after hour over largely unsupervised, dubiously educational, TV channels and, much more dangerous, largely unsupervised internet access. As Postman (1986) observed, "We are now a culture whose information, ideas, and epistemology are given form by television, not by the printed word." Shanker (1992) further reminds us that "Studies and statistics—and our own observations—tell us that American families are increasingly fragile and unstable, and we fear that, as a result, many children are being seriously damaged." In a culture where the immediate

¹ The percentage of households where both spouses work full time is increasing year by year to where it is now nearly triple what it was in 1969 (Source: Bureau of Labor Statistics, *Currently Population Survey*, 1999).

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family appears to have less and less control over a child's upbringing, children need all the help they can get.

In some countries, such as in the kibbutzim (collective farms) in Israel, children are put in the almost total care of specially appointed nurses and educators from a very early age. Today, however, this responsibility is more important than ever. Societies such as those described above are relying more and more on professionally-managed institutions such as schools to act *in loco parentis*. Acting *in loco parentis*—*in the place of parents*—is nothing new for teachers because children have always spent a large proportion of their waking day in school. What, then, are some of the contemporary legal and ethics issues that teachers should discuss with students?

Privacy Invasion

"Privacy," observes Rothfeder (1992), "is an issue charged with emotion. Nothing makes Americans angrier than the suspicion that somebody is looking over their shoulders or peering into their private affairs. And people often describe privacy deprivation with the same words used by rape victims: We say we feel violated, vulnerable and ineffectual." However, Johnson (1985, 1) reminds us that "much to the surprise of many Americans there is no explicit constitutional guarantee to privacy."

But it is a right; we do have a right to privacy. As Philip Zimmerman, the author of PGP (Pretty Good Privacy) points out: "Privacy is a right like any other. You have to exercise it or risk losing it." PGP is software designed to help protect your privacy. It is used to encrypt and decrypt digital documents such as email or other files stored on your computer. The authors of this book have made available a tutorial to teach you how to download a free copy of the software from the Web and how to use it. The tutorial can be found at <http://www.pitt.edu/~poole/PGPintro.htm>.

All over the world, the institutions established by government for the maintenance of law and order, along with most major and many minor corporations and private investigative agencies, use technology to an ever-increasing extent to spy on people. Surprisingly enough, most of the spying is legal, either sanctioned by law or at least not proscribed by it—which does not necessarily make it right. On the other hand, some of the spying is illegal, but because we do not know it is going on we do not become concerned.

Is ignorance bliss, in this case? Do our students need to be sensitized to the reality of privacy invasion? Is there any harm in it anyway, especially if one is behaving oneself? And in any case, is there anything we can do about it?

When it comes down to it, as Rothfeder (1992) points out, "It's an information free-for-all, and even people with little computer expertise can get [most any data they want]." The problem is that in many instances we are content to have our privacy invaded. Hospitals need to keep a record of our medical history so they can more efficiently take care of us when we need treatment. Banks need to keep a record of our accounts so they can help us manage our hard-earned money.

Ultimately you can best control invasion of your privacy by being sensitive to the fact that it does go on more than you think. That awareness alone will give you a healthy skepticism whenever you are in the situation where you are asked to divulge personal data. As teachers we

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should also help our students to become sensitive to this negative side to the otherwise predominantly positive social change brought on by computer technology.

The United States Government as long ago as 1966 passed the *Freedom of Information Act* which, in tandem with the 1974 *Privacy Act*, ensured controlled public access to any database maintained by the federal government. To be more specific, the *Freedom of Information Act* opened up governmental databases to public scrutiny while the *Privacy Act* limited access by making it dependent on the permission of the individual whose records were to be made available.

Meanwhile the *Fair Credit Reporting Act* was passed in 1971 to protect people's rights of access to data gathered by the financial credit reporting industry. The *Family Educational Right and Privacy Act* of 1974 guaranteed public access to student reports in the files of federally-funded educational institutions. The *Right To Financial Privacy Act* of 1978 prohibited federal government access to banking records without either the permission of individuals who are the subject of the search or a search warrant. Other similar legislation has been passed, and there will be more to follow as situations arise in which individual freedoms are violated in more and more creative, and no doubt computerized, ways. Ethics continues to plod along in pursuit of science.

Computing Inequities: The Digital Divide

Rich versus Poor "For computer-based knowledge to become an extension of a human mind, that mind must at least have access to the technology. The poor will not immediately have such access, placing them at a ... disadvantage" (Madron, 1985). Pillar (1992) describes "the creation of the technological underclass in America's public schools." "In 1984," he notes, "white children used computers in elementary and secondary schools at about twice the rate of African Americans and Hispanics. By 1989," Pillar writes, "according to the U.S. Bureau of Census, nearly the same percentages of those three groups [White, African American, and Hispanic] used computers in high schools. Elementary schools also made dramatic progress. And disparities between rich and poor and between public and private schools seemed to narrow just as sharply."

But Pillar was skeptical of the relevance of the United States Bureau of Census statistics and decided to see for himself what was going on in the schools. His findings were somewhat discouraging. "I visited inner-city, rural, and suburban schools in various parts of the country," he wrote, "and after discussions with scores of teachers, students, and school administrators, an inescapable conclusion emerged: Computer-based education in poor schools is in deep trouble. Not only did these schools lack the funds and skills to finance the maintenance of their computer hardware. They also lacked the training to make the best use of the machines. "In most cases," Pillar concluded, "computers simply perpetuate a two-tier system of education for rich and poor."

Right now there are pockets of privilege, so to speak, among the poorer school districts where forward-looking parents, administrators, and teachers, sometimes sponsored by local business and/or by one or other of the major personal computer manufacturers, have taken on the challenge of providing the best possible educational opportunity for the children. The key ingredient of success has usually been the driving force of significant individuals who have galvanized the community and done what is necessary, through grants and donations, to make computer-integrated teaching a reality in their schools.

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Unfortunately, however, there are still many school districts, even in the United States, where a half-hearted acceptance of the value of suitably integrated educational technology, tempered to some extent by economic realities, have resulted in children being denied the opportunity to share in the benefits enjoyed by the privileged few. There is hardly a school in America today that does not have computers for student use; every year the ratio of students to computers improves in the students' favor. Yet, as Pillar (1992) observed, many of the machines in the poorer schools are used "so rigidly and ineptly as to repel students."

Girls versus Boys Women continue to suffer from stereotyping which casts them in the mold of the technologically inept. The problem pervades our social institutions, starting with the home and continuing in school. Sanders (1987) observed that "girls and boys use the computer equally when they are *required* to in class, but as soon as they're allowed a choice—such as after school or in elective computer courses—girls see that boys take advantage of the opportunity far more often than girls do. This reinforces the notion that computers are a male thing."

Jo Sanders has written a 2005 review article (Sanders, 2005) titled: "Gender and Technology: A Research Review" in which she reiterates the sad fact that women continue today to be underrepresented in the field of information and communication technology (ICT). This belies the evidence from extensive research which strongly suggests that girls are at least equal to boys in tasks that involve communication skills and skills related to math and problem-solving. The problem is one of opportunity.

Dorothy Ellen Wilcox (1996), in her Masters Thesis at the University of Alaska titled "Computers and the Internet: Listening to Girls' Voices," presented her findings that girls do need help in overcoming the cultural stereotype that causes them to be less inclined towards technology-based careers than boys. In her conclusion, Ms Cox had this to say:

"Instead of socializing girls toward passivity and docility, non-hierarchical technology like e-mail and the Internet has the capability to assist communication and provoke development of the ability to critique the status quo among adolescents. Education is not apolitical; the curriculum masks prevailing politics and power as natural and results in their maintenance. Freer access to materials that reveal the inequities of power relationships and allow adolescents to unmask and unpack gender and racial issues will encourage debate and nourish the formulation of students' critical cognitive skills. I see educational technology as a vehicle that can initiate and nurture such dialogue, and in doing so, set the stage for inevitable change. In the faceless culture of computer-mediated communication, skilled young people will be able to pass as adults and elucidate their own concerns. Girls who are educated to an activist stance will feel comfortable participating in the networked communications web. After that, they will not need adults to interpret their words; electronic mail and the internet will become the means they can use to speak for themselves."

Cynthia Lanus, Executive Director of the Center for Excellence and Equity in Education at Rice University, quotes a report of the National Science Foundation which found that "Degrees awarded in computer science decreased among both men and women from 1985 to 1995, and **women** went from earning **36%** of those degrees in 1985 to only **28%** in 1995."

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“The problem’s repercussions are staggering,” she goes on to report. “The [Bureau of Labor Statistics](#) lists computer scientists, computer engineers, and systems analysts as among the occupations with the fastest employment growth, 2004-2014. Teachers working with high-school students using technology observe that, in general, girls don't seem to be as intrigued by computers as boys are.” The full GirlTECH report: “*Getting Girls Interested in Computers*” can be read online at <http://math.rice.edu/~lanius/club/girls.html>.

The following are examples of the kinds of strategies that can help to overcome the stereotypes that perpetuate the computer gender gap (Table 13.1).

PRINCIPLES OF COMPUTER EQUITY

Focus specifically on girls.
Target girls in groups.
Design activities around girls' existing interests.
Stress the usefulness of computers.
Eliminate biased computer practices.
Pay attention to your software.
Let others know.
Do it again next year.

Table 13.1 The Principles of Computer Equity
Courtesy Jo Sanders

Whites versus Minorities It seems absurd to have to point out that the color of one's skin makes no difference whatsoever with regard to one's level of intelligence. This author’s experience teaching in schools K-12 in Europe, Africa, the Middle East, and North America has taught him that the range of intelligence among these diverse cultural and ethnic groups is the same. Those who believe otherwise should be helped to recognize one simple fact: that they are guilty of inexcusable prejudice born of unfortunate cultural bias.

Such bias continues to plague our social structures in general, and our educational institutions in particular. African Americans and Hispanics are not expected, and often do not expect themselves, to achieve success in technology fields such as those associated with computers. Much of the problem is that children in these ethnic groups are more likely to come from families living below the poverty line, which translates into a lower likelihood that these children will either attend schools in the wealthier, more technology-rich districts, attend school on a regular basis, or graduate from high school.

The Lack of Equal Access to Information Since knowledge is power, and since not all children have equal access to information because of disparities in the funding and management of different school systems, then it stands to reason that many children are at a serious

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disadvantage. They are on the wrong side of the Digital Divide. Some students are fortunate to attend schools where they have access to libraries of electronic data in the form of interactive text and video¹, with quality educational software to complement other forms of instruction, and with open lines of communication between themselves and students in other schools at home and abroad. These fortunate students are also more likely to have their own computer at home, with on-line, multimedia encyclopedias and access to the Web. Such privileged students will be more likely to receive a more rounded and comprehensive educational experience than students attending less technologically-endowed schools.

SECURITY: HACKING AND CRACKING

Hacking generally describes the activity of computer aficionados who become absorbed with the challenge of pushing computer technology to the limits of its capabilities. The term "hacker" is not per se pejorative. Indeed, it started out as a term of endearment to describe lovable and often "nerdy" individuals who were recognized as benefactors to society because of the innovative computer-based solutions which they created. Hackers were programmers and visionaries. In the mid-1970s these benevolent hackers formed an informal association called the Home Brew Society which included in its membership people like Steve Jobs and Steve Wozniak, who founded Apple Computer Corporation.

Today hacking is generally frowned upon because the term has come to be associated with practices that involve individuals who use computer technology to break the law, specifically to violate the security or privacy of computers and networks². The term used to describe criminal hacking--**cracking**--was in vogue until "crack" and "crackers" became identified with other social ills not related to computing. In the next several sub-sections we will briefly describe the kinds of criminal hacking of which teachers and their students would do well to be aware. Few of our students will ever be guilty of criminal hacking, but many of them will be victims of it.

Computer Viruses and Other Malware

Computer viruses are programs created by hackers. As their name implies, viruses infect other computer systems by attaching duplicate copies of themselves to legitimate operating system or application software with which they come into contact. They are carried from computer to computer either indirectly by way of storage devices (like the currently popular *flash* drive), or directly by way of e-mail attachments and downloaded software.

Any computer virus should be taken seriously. Most viruses are designed to do some kind of damage to a system either by destroying data or otherwise compromising a system's operations in such a way as to make it unusable. Other viruses might appear to be "harmless," perhaps causing a funny face or announcement to appear on the screen at some programmed date and time. But "harmless" is a relative term. Anything that interrupts normal computer operations is

¹ In chapter 8 we discussed online data base retrieval services such as DIALOG Information Services' CLASSMATE™ instruction program.

² There are also "good" hackers, who try to anticipate or decode the actions of bad hackers. These are often employed by governments and by companies that create anti-virus applications.

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cause for alarm because there is no telling what else might be going on in the background, unseen on the computer screen.

Computer viruses are activated in various ways. **Time bombs** are so-named because they are programmed to "go off"--start doing the damage they have been programmed to cause--at a certain time on a certain date (a popular date is Friday the 13th). **Logic bombs**, on the other hand, are usually less predictable because they are triggered when some specific set of switches (bits) inside the computer's memory become electronically set to a predetermined value.

There are now hundreds of decidedly harmful computer viruses capable of anything from changing or destroying data, slowing down or even immobilizing a system or network, or interfering with the system's interaction with peripheral devices such as the screen or printer. One common and annoying virus attacks the Macros that run inside of many Microsoft documents. They may, for example, make all subsequently opened files "Read Only" or "invisible" to *Word* itself. Such viruses spread quickly from home to school and hence throughout a school's network.

Malware: Worms and Trojan horses

Malware refers to malicious computer programs that are run on your computer without your knowledge. A special type of malware, called a **worm**, is, according to Wikipedia, "a self-replicating computer program [which] uses a network to send copies of itself to other nodes (computer terminals on the network). It may do so without any user intervention" (Wikipedia, 2008). Along the way, it deletes targeted file extensions or causes a program to overwrite its own code with nonsense code, often targeting those programs that are essential for the operation of the system itself. Moreover, a worm will often reply to unread messages in an e-mail reader (*Outlook Express* or *Microsoft Exchange*, for example), spreading itself quite handily and looking like messages from *you!* Worms will often masquerade as *.zip* files, media files (*.mp3*, *.gif*) or other file attachments. They are activated, or "installed," by opening the attachment.

An infamous worm called the Slammer was launched at 12:30 am EST on January 25, 2003. Within 15 minutes it "brought down the Internet," causing significant damage to the targeted SQL mega-databases that coordinated global digital commerce. The identity of the hacker is not known, but the effects of the Slammer are known: over \$1 billion in lost revenue worldwide (Boutin, 2003).

Another specialized category of malware is the **Trojan Horse**, named after the innocent-looking giant wooden horse built by the Greeks to gain covert entry inside the walls of Troy. The computer version of the Trojan Horse is a program which looks innocent enough--perhaps a computer game made available on the Internet and often an e-mail attachment--but which has code built into it which inflicts damage of one kind or another once installed on a computer system. This can range from destroying files to altering the appearance of your Desktop. Trojan Horses that are designed for e-mail distribution will generally then attach themselves to messages you send by way of your Address Book.

Spyware and Spam

Although there is some disagreement about when viruses leave off and malware begins, it is generally agreed that **spyware** are hidden malware that sit on your computer and gather

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information about your computer use, preferences and data **without your consent**. Although often created by paid or contracted programmers, spyware programs are of questionable legality. They can also be sinister, establishing a sort of "remote control" over your computer or browser, or logging, and communicating, all of your keystrokes (and thus your passwords and credit card numbers). Spyware presents a serious threat to individual and network privacy and, as such, is currently one of the most actively combated forms of hacking. Spyware also causes problems on the host computer, generally slowing performance, due to the large information files that they create and distribute behind the scenes.

Adware is another pest, a subset of spyware causing pop-up advertisements to appear even when you are not actively surfing. These are the result of a spyware application that communicates your Internet searching and computer activities to advertisers and others interested in such data, who send you pop-up ads geared to your "interests." There are numerous other forms of malware. They are well logged at PestPatrol Pest Research Center (<http://www.pestpatrol.com/pestinfo>).

Spam is another form of malware that is becoming more of a problem than a pest. This unsolicited e-mail is often advertisements, but can also be "pornspam." Clearly, schools want to block both categories. Although there is new federal legislation to reduce and, to some extent, monitor spam, this is malware virtually impossible to police by policy. Keeping alert to and reporting spam (but not opening it!) is yet another responsibility of the computer-using teacher.

Trespass of Computer Systems

This is one of the seemingly innocuous yet potentially most devastating activities carried on by modern day hackers. Skilled hackers are able to obtain the access codes and passwords of institutional computer systems ranging from the local hospital or university to the Pentagon and beyond. The networked world is an open door to hackers determined and skilled enough to get around the various levels of security designed into the systems. Some hackers are motivated purely by the thrill of being able to gain access to these systems; they have no intention of damaging the data stored in them, and no particular interest in the data per se. But the activity is still illegal because it is trespass, an invasion of privacy, and an infringement of peoples' rights.

Other hackers go further, altering data, stealing data, destroying data, or adding data¹. Sometimes the objective is sabotage, sometimes espionage, sometimes thrill-seeking vandalism, and increasingly it is **identity theft**.

Sniffers are programs sometimes written by hackers for the purpose of capturing login id names and passwords as the data packets travel across a network. Criminal prosecutions have been brought against a number of such hackers in the last few years. Sniffers, however, are not normally designed to be malicious. As John Evans of Boise State University has observed: "While sniffers can be used maliciously, packet sniffers (or protocol analyzers) are a legitimate tool used by network administrators and network engineers to baseline network performance and to troubleshoot network problems. Malicious use of sniffers on a network almost always requires the compromise of that network in the first place" (Evans, 2008).

¹ In schools, this is often salary, grade and testing data!

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When the hacker is working from a foreign base and infiltrating US government computers via satellite, the potential for disaster is real. Such was the case in 1988 when a hacker tapped into NASA computers. Fortunately, a NASA computer scientist discovered the intruder early on and, in order to track him down, set up elaborate monitoring procedures which kept NASA apprised of his every move. Eventually the hacker was traced back to West Germany. No serious damage was done.

But it is not only outsiders that breach the security of networked computer systems. Kabay (1992) reminds us that "75% to 80% of all attacks on data confidentiality and integrity are by employees authorized to use the systems and networks they abuse." Much of this in-house hacking, even when detected, goes unreported because companies fear loss of reputation and credibility in the eyes of the public, in much the same way as banks are loath to report that they have been victims of electronic embezzlement.

Similarly, schools will often deal with hackers quietly and in-house. It is helpful, therefore, for a school or district to have a strongly worded, legally viable, and clearly stated policy spelling out the consequences of hacking by students or employees.

Money Theft (Embezzlement)

The bill paid by banks for electronic fraud runs into the billions of dollars per year. The banks, of course, pass the bill on to the consumer. If the bank goes under, the tax payer picks up the tab. What Kabay (1992) has to say about network infiltration applies equally to electronic fraud: most of the theft involves company insiders--"white-collar criminals." The last thing the banks used to want was that their vulnerability to financial loss through credit card fraud and illegal transfers of funds should become public knowledge. Thus much of this kind of crime used to go unreported. Today, however, electronic embezzlement is so rampant that financial institutions are openly and diligently investigating cases when they are detected.

STEPS SCHOOLS SHOULD TAKE TO SECURE NETWORKS AND COMPUTERS

As long as computer networks are vulnerable, hackers will attempt to breach them. The responsibility lies with the designers, builders and managers of these systems to make them as secure as possible against unauthorized entry. This is a mammoth task because networks are communications systems; access is the key to their success. Moreover, even the best computer system and productivity software leaves "holes" through which hackers can gain entry.

The only way to fully protect a computer is to turn it off and/or disconnect it from the network, which is clearly not a viable solution in most cases. However, there are several things teachers and schools can do to combat these menaces, in addition to adhering to the Software Code of Ethics.

- The foremost solution is the purchase and installation of reliable up-to-date anti-virus software, such as that marketed by McAfee and Symantec corporations. In a school, both the network servers and all client machines, including portables, should scan hard drives, external and portable storage devices, all installations, downloaded applications and files, and all e-mail messages without cease. Virus "definitions" are kept up-to-date and made

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available at the website of the anti-virus producer; they should be automatically downloaded to all computers.

- Select an e-mail service or client that provides a spam and virus filter. These will generally either delete questionable messages, mark them, or route them to a discrete folder.
- Special software exists to detect and remove spyware and trojan horses. It is strongly suggested that a school obtain more than one such application, for none will do the full job. It is also possible to access an online anti-spyware service, which will scan and repair your hard drive via the Internet (with subsequent advertisements for the full version of the software).
- "Cookies," a common and generally benign form of spyware, can be manually deleted from within every web browser. Browsers can also be set to "deny cookies," but this has the consequence of making it impossible to access many of the newer websites.
- The school network should be sure to have an active **firewall**, which will help it to detect and log attacks to its security. Often these take the form of random, or purposeful, flooding of the IP address with requests; if that flood reaches critical, the network server can shut down.
- System and productivity application producers make "fixes" available constantly online, necessary generally to close "holes" attacked by hackers. All school computers should be able to download and install these fixes as they become available.¹
- Educate yourself and the school community to a few simple rules:
 - Change passwords often and make them as random as possible;
 - Do not store passwords or financial information on the computer;
 - If you use the computer for financial transactions, do so only from a Secure Site (SSL) option;
 - Because many viruses are spread over e-mail attachments, it is a straightforward solution to **delete without opening any e-mail message and/or attachment from an unknown source**. By setting your e-mail application to "delete attachments with original message" you can further protect yourself;
 - Be alert to any sudden change in the performance or appearance of your computer(s). Report anything odd to network services immediately.
- It is wise also for a school's IT staff to keep all members of the school community informed of new viruses. Such information will sometimes be bogus (there are virus hoaxes quite often), but an ounce of prevention is worth it!

¹ There was a time when Macintosh computers and systems were viewed as "immune" to viruses. This is no longer true. Not even the open source systems are immune these days.

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Moreover, networked schools of the future will have to implement the kind of steps recommended by Kabay (1992) to protect corporate networks. Here are Kabay's recommendations to network managers:

- Have a message displayed at the network log in that warns hackers that the system is for authorized users only and that intruders will be prosecuted. If you do not use such a log in, consider implementing it.
- Have a written plan of network security procedures describing standard operating procedures including counter measures and defense plans for when the network is under attack.
- Make access controls and event logging (maintaining a record of all use of the network) part of this standard procedure.
- Regularly go over the procedures with personnel responsible for system security.

For wireless networks, it is possible to restrict network access to only those MAC addresses¹ that are logged with the network server. Furthermore, all modern networks can be remotely managed. Network attacks and problems often occur after hours; if the managers can be alerted to attacks and then scan, repair and reboot network servers from their homes or laptops, the institution itself will be more secure.

This might read like overkill for many school teachers and administrators, especially in these early days of networked computing in schools k-12. However, computer managers at any college can relate a litany of horror stories that are the result of abuse of computer systems by that minority of students with a personal or societal axe to grind. Remember, trouble most often comes from inside.

A Final Note About Passwords

It goes without saying that protection of personal passwords is essential. You will remember that we advised teachers earlier to teach students not to share passwords. Well, this is even more important for teachers. Further, teachers, who are often somewhat uncomfortable with technology to begin with, often take security protection casually, storing their passwords in a desk drawer or taping them to the computer itself. Many use easily guessed passwords, such as their own names! Some IT departments contribute to security laxity by assigning all teachers the same password for grade report, attendance, and other network operations. How hard do you think determined students have to work to "hack into" these files, to access and even copy teacher applications? It is unfortunate that caution has to reach into schools, but it is a fact of life. The wise teacher follows the guidelines in this chapter for her personal computing life – and keeps her computer out of the hands of her students!

LOOKING BACK

¹ You will remember that each hardware device on a network has a discrete and unique digital address. In this case, the MAC address is on the wireless NIC cards in the laptops.

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This chapter has briefly examined the impact of computers on society. Computers have been incorporated into every product under the sun. They have been woven into the fabric of our systems of transportation, administration, information, communications, manufacturing, finance and government, to name but a few. They have begun to transform the way we live, the way we work, and the way we play. Inevitably they are being slowly but surely woven into the fabric of our education systems, too, and they will transform the way we teach and learn.

This chapter also has argued the case for incorporating into school curricula the discussion of the computer-related ethical and legal issues raised by new technologies. James Truslow Adams pointed out that "There are obviously two educations. One should teach us how to make a living, and the other how to live." Schools should prepare children to address ethical and legal problems when ignorance of them will leave students vulnerable to victimization of the kinds described in this chapter.

Sanders (1986) observed that we can restrict ourselves as teaching professionals to the narrow task of working within the framework of the narrow academic responsibilities that are assigned to us, or we can extend the scope of that commitment to include the parental, counseling, and leadership roles which our students need more than ever today.

The question every teacher must address is this: "Is it fair that just a few of today's children are already enjoying the advantages that computers, used appropriately, can bring?" The objective of this book is to open a window onto the classroom of tomorrow. This classroom is already available for a privileged few; we must ensure that it is available to all.

When they graduate from school, our students will function more effectively if they protect themselves against the unfair competition that comes with privacy invasion. On the personal level our students must learn to be conscious of, and give due recognition to, the privacy and equality rights of others. Girls, in particular, must learn to protect themselves against unequal opportunity arising from a prejudicial stereotype that women lack technological competence.

Stealing software is both easy to do and easy to get away with. Hacking is not so easy, but it presents an irresistible challenge to bright, determined, morally-indifferent individuals who need the boost to their egos that comes with the exercise of the power that their computing skills put at their fingertips. Unfortunately they do not feel constrained by a code of ethics that respects others' security and privacy rights.

The more we understand the realities of the computerized world, the more fully we will be able to function in it. This chapter has discussed software piracy and hacking in some depth not simply because they are interesting to learn about. It is part of our role as teachers to make our students aware, on the one hand, of the constraints on their freedom dictated by the rights of others and, on the other hand, of the extent to which their own rights can be infringed upon by the unethical and/or illegal activities of the kind described. Our students almost certainly will be victims of hacking. They may even be among the few who find these activities "bait which [they find difficult to] resist swallowing." The knowledge that you help them acquire by discussing these issues with them will serve both them and society well

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Chapter 14 examines an important aspect of technology's impact on society: the growing number of accessibility options available to people with disabilities. The computer offers the promise that, eventually, even children with severe handicaps will be able to enjoy the benefits of a free and appropriate public education (FAPE). FAPE is still a dream for many children who have a disability, notwithstanding the Education for All Handicapped Children Act of 1975, which gave such children the right to a free appropriate public education. Chapter 14 examines this and other equal rights law in light of the needs of people with a disability, and reviews efforts that are being made to create a fairer world for all.