THE FLICKERING MIND

The False Promise of Technology in the Classroom and How Learning Can Be Saved

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CHAPTER 1

Education's History of Technotopia

"I believe that the motion picture is destined to revolutionize our educational system," Thomas Edison said in 1922, "and that in a few years it will supplant largely, if not entirely, the use of textbooks. I should say that on the average we get only about two percent efficiency out of textbooks as they are written today." A decade earlier, Edison had been even more pedagogically expansive, saying that film makes it "possible to touch every branch of human knowledge." Now he added: "The education of the future, as I see it, will be conducted through the medium of the motion picture, a visualized education, where it should be possible to obtain one hundred percent efficiency." Three years later, Edison's vision was undiluted: "In ten years textbooks as the principal medium of teaching will be as obsolete as the horse and carriage are now. . . . There is no limitation to the camera."[1]

Almost as curious as this snippet of grandiose soothsaying from one of America's greatest inventors is the context in which it was presented. Edison's outlook was reported in a 1939 book, by which time the author had already found reason to be skeptical of technologists' promises to schools. The book was entitled *Motion Pictures As an Aid In Teaching American History*, by Harry Arthur Wise, who used Edison's quotes to prove an axiom. "Like many new educative devices," Wise wrote, "the motion picture was received into the school with a confidence and an enthusiasm not well founded." Educators' faith in films was particularly unjustifiable, Wise asserted, because

it was "more far-reaching and all-inclusive than can be justified by the findings of more recent educational research." Wise, a specialist on this subject, arrived at this conclusion after reviewing seven previous studies of teaching through films and finding mixed results; he then conducted his own study, which carefully used equivalent experimental and control groups and other measures of scientific validity current at the time. Here's what he found: The group treated to films did the best, with test gains deemed "statistically significant." The films proved particularly valuable in engaging the students' imagination and in giving them a sense of the historical atmosphere of the period. The boys benefited more than the girls did. The films encouraged low-ability students to learn factual information while helping high-ability students in "acquiring spirit and atmosphere."

Overall, however, Wise found the benefit of classroom films so dependent on the circumstances—the particular subject matter, the course objectives, the students' knowledge base, and the skill of the teacher—that they could be endorsed only for use "as a supplement." Nor, Wise counseled, should teachers feel pressured to abandon their normal routines. "The teacher who is interested in making effective use of any type of visual aid does not need to assume that existing courses of study should be thrown aside and that new units should be built up around particular devices." Not surprisingly, Wise closed by stressing the need for better teacher training. The film, he noted, "is not self-operating and its use requires much time for preparation if it is to function effectively." Instructing teachers in how to do just that, he said, "is a matter of paramount importance . . ."[2] As the years progressed, most schools did not follow Wise's advice. Classroom films—as most of us remember—eventually became a rare occurrence, treated more as a welcome moment of relaxation and entertainment than a study aid.

In 1945, six years after Wise's book came out, William Levenson, the director of the Cleveland public schools' radio station, had a whole new technological vision. He claimed that "the time may come when a portable radio receiver will be as common in the classroom as is the blackboard. Radio instruction will be integrated into school life as an accepted educational medium."[3] It wasn't long before the famous psychologist B. F. Skinner joined the chorus. "I was soon saying," Skinner observed while reflecting on the first days of one of his great inventions—the behavioral "teaching machines" of the late 1950s and early 1960s—"that, with the help of teaching machines and programmed instruction, students could learn twice as much in the same time and with the same effort as in a standard classroom."[4]

Soon after the teaching machines' moment in the sun, President Lyndon Johnson spoke, in 1968, to a school in American Samoa about the next

technological hope. The "one requirement for a good and universal education," Johnson said, "is an inexpensive and readily available means of teaching children. Unhappily, the world has only a fraction of the teachers it needs. Samoa has met this problem through educational television."

Johnson's remarks were something of an understatement. Education in American Samoa was in such a shambles that students were being taught in antiquated one-room schools, and not a single teacher on the island possessed a teaching certificate from the U.S. mainland. In response, Samoa's governor, H. Rex Lee, had made the overhaul of the school system his top priority. In so doing, Lee rejected the standard solutions—pouring money into the school system, retooling the curriculum, hiring mainland teachers, and retraining Samoan instructors—all of which had been recommended by his aides and by local educators. But Lee wanted fast and total change. So he set out to invest in television. In 1964, Congress came to Lee's aid, giving American Samoa $1 million for a system of televised instruction—an amount equivalent to approximately $200 per student. Two years later, four of every five Samoan students were spending from a quarter to a third of their class time watching TV. The rest of their day was spent preparing for the telecasts and, later, following up with activities related to the shows they'd watched.

Unfortunately, the proliferation of classroom televisions in American Samoa far outpaced indications of academic achievement. By 1972, three out of four high school teachers and administrators wanted to cut back heavily on classroom telecasts, and over half the elementary school students and 70 percent of the high school students agreed with them. Samoan policy makers soon began returning more control for school management to the teachers, which did not bode well for the TV campaign. In 1979, Wilbur Schramm, a mass-communications specialist, concluded that classroom telecasts had been relegated to "a supplemental enrichment service, to be used when and if the teacher decided it was appropriate."

Back on the mainland, the attitude toward televised learning was on a similar trajectory. By 1961, $20 million had been invested in classroom television by the Ford Foundation's Fund for the Advancement of Education. A year later, President John F. Kennedy plowed another $32 million into the venture. As of 1971, public and private sources had spent a total of $100 million on classroom TV.[5]

The reader of this abbreviated history will undoubtedly notice the parallels to today's hot classroom technology. One could rewrite each of these anecdotes, substituting the word *computers* for the words *motion pictures* or *radios* or *televisions* and most people would think they were recent news re-

ports. Not too many years ago, in fact, President Bill Clinton was in the news with his own rendition of technology's old song. In 1995, during his second presidential campaign, he pitched the nation on "a bridge to the twenty-first century . . . where computers are as much a part of the classroom as blackboards." Despite the fact that this latest technological messiah was estimated at the time to cost somewhere between $40 billion and $100 billion over the next five years, Clinton's Republican adversaries were happy to sing along. Newt Gingrich, talking about computers to the Republican National Committee as Speaker of the House in 1996, said, "We could do so much to make education available twenty-four hours a day, seven days a week, that people could literally have a whole different attitude toward learning."

If history is again repeating itself, the schools are in serious trouble. In a 1986 book, *Teachers and Machines: The Classroom Use of Technology Since 1920*, Larry Cuban, a professor of education at Stanford University and a former school superintendent, observed a pattern in how schools handled each round of technology that mirrored and elaborated Harry Wise's tale. The cycle always began with big promises, backed by the technology developers' research. In the classroom, teachers never really embraced the new tools, and no significant academic improvement occurred. This provoked consistent responses from technology promoters: The problem was money, or teacher resistance, or the paralyzing school bureaucracy. Meanwhile, few people questioned the technology advocates' claims. As results continued to lag, the blame was finally laid on the machines. Soon schools were sold on the next generation of technology, and the lucrative cycle started all over again.

Today's technology evangels commonly argue that we've learned our lesson from past mistakes. As in each previous round, they say that when today's technology (the computer) is compared with yesterday's machine, today's is better. "It can do the same things, plus," Richard Riley, the former secretary of education, told *The Atlantic Monthly* in 1997.[6] In a 2002 interview, John Bailey, the director of educational technology under President George W. Bush, bolstered Riley's view. There is a great opportunity with computers, he argued, that is not yet realized but seems entirely possible: to "personalize and individualize" instruction—pinpointing certain students' weaknesses, for example, or customizing homework assignments—in ways that their mass-media predecessors couldn't.

Considering the obvious power of today's personal computers, Riley and Bailey might appear to be right. However, since schools have been badly burned by so many of technology's unfulfilled promises, it's worth pausing

a moment to ask an obvious question: What does the record on school computing so far really show? Apparently, hindsight has airbrushed its history quite heavily.

A NEW DAWN, TAKE ONE

In January 1975, a new machine appeared on the cover of *Popular Mechanics*. It was a funny-looking device—a square box with flip switches on its front plate, connected to a Teletype machine. The machine was called the Altair 8800 personal computer kit and manufactured by H. Edward Roberts, the president of a small outfit in Albuquerque, New Mexico, called Micro Instrumentation Telemetry Systems, or MITS. The Altair offered 256 bytes of memory, an immeasurable speck by today's standards, and sold for $397. MITS was promptly bombarded with thousands of orders, and the personal computer was born. One of the people captivated by the *Popular Mechanics* story was a young Harvard student named Bill Gates, who subsequently ditched Harvard and traveled to Albuquerque in search of a job. Before long, the Altair was shipping with an old mainframe programming language specially adapted for this machine by Gates and his future partner, Paul Allen. Soon, Microsoft too was born, along with a whole new industry, called software.[7] Two years later, in 1977, a handful of machines, called microcomputers, most of which looked like today's large microwave ovens, were shown off at the inaugural West Coast Computer Faire. One of these was a long, slim, sloping package called the Apple II. The world was suddenly treated to an assortment of computers being manufactured in a form that was relatively small and inexpensive (the first Apple IIs, equipped with a mere 4K of memory, sold for $1,298, a sharp drop from the $18,000 to $20,000 for which a mini-computer had been selling).[8] It was only natural now to start promoting these nimble machines in the nation's classrooms.

Perhaps it's a reflection of the personal computer's increasingly compressed intensity; perhaps it's simply fate. Whatever the case, this machine's history in schools repeats, in quickened and more dynamic form, technology's entire education story. As the years have rolled on, the aspirations attached to each version and function of the computer have washed over the schools in noisy successions of swells and crashes. Indeed, the somewhat quieter discussion we see at the turn of the new century about classroom technology (and computer technology in general) is a predictable ebb, sliding back from the high computer frenzy of the late 1990s. The pattern is not

terribly different, in fact, from the nation's first big flood of computopia, which hit in the early 1980s.

From the personal computer's debut in 1975 through most of 1981, its manufacturers (and their enthusiasts in the schools) primarily busied themselves with getting their houses in order. Commercial breakthroughs and innovative programs steadily popped up, and schools began the slow process of buying and installing these new machines—in computer labs, in school libraries, and, occasionally, in a few classrooms. Not surprisingly, some of the first innovative classroom uses of the PC arose in its Silicon Valley seedbed. Some of those early visions were quite ambitious, aiming for the same pedagogical goals that twenty-first-century technology leaders would be striving toward two decades later.

An example was the Crittenden Middle School in Mountain View, on the northern edge of the valley. In 1981, Crittenden was already using PCs to make simple graphs, execute geometry exercises, and navigate problem-solving activities. As one teacher, Steve King, put it, the computer let students simulate science experiments "that otherwise would be too expensive or difficult to perform." King also said he was taken with the computer's apparent ability to adapt to each student's individual pace—the same gold mine that John Bailey, George W. Bush's technology chief, would still be dreaming about in 2002. Crittenden never found that pot of gold, for reasons that the John Baileys of the world might do well to remember. In fact, despite Crittenden's herculean efforts, computer technology continually failed to take hold at the school in general. Steve King, the technology enthusiast, is of course long gone by now. But Sue Nelson, a longtime language arts teacher at Crittenden, remembers those days quite clearly. "We never got any support," Nelson said. "Anyone who is any good with computers is out working in industry making big bucks." Nelson, who had been at Crittenden since the early 1980s, recalled numerous attempts to scale up the school's computer program that were continually foiled by system crashes, which have continued to this day. "The teachers then spend a day and a half rebuilding everything. The computers have been absolutely frustrating. We've got all this potential with three labs on campus, but that's all it is—a lot of potential."

While plenty of technology obviously did take hold elsewhere in Silicon Valley, it was years before California launched any organized campaign for computers in schools. It wasn't even the first state to do so; Minnesota had seen the digital writing on the wall almost a decade earlier. In 1973, it

formed the Minnesota Educational Computing Consortium (MECC), an ambitious and, in time, a nationally influential cooperative of state agencies and Minnesota colleges and universities. As an early sign of the coming academic attitude, Don Rawitsch, MECC's manager of user services, told a reporter in late 1981, "We've got to get computers away from the image of being separate from everything else."[9]

In the following months, the national campaign in schools for "computer literacy" (a term that had been coined almost a decade earlier, by the computing author Arthur Luehrmann) began to gather steam. One of the best portraits of the technological fever of these years was provided by a small publication called *InfoWorld*. Founded in 1980, *InfoWorld* started its life as a biweekly newsmagazine to cover Silicon Valley's fast-growing personal computer industry. By the fall of 1981, it was clear that biweekly coverage couldn't begin to keep up with this business, and the editors decided to go weekly. That summer, they had also hired a reporter named Scott Mace, whose beat would be technology in education. For the next four years, Mace was the man on the scene—whenever Apple or IBM made big donations to schools; whenever some irreverent little start-up came out with some promising new software; whenever the field's adherents gathered for their first national "educational technology" conferences; and whenever politicians jumped on the bandwagon of the miraculous personal computer. "This was the high-water mark," Mace told me when I spoke with him many years later, in the summer of 2001. "It was the time when people thought, Let's have PCs everywhere." By his own reckoning, Mace was sympathetic to that view. And why not? Almost anytime news broke on this subject, it looked like the dawning of a new age.*

"There's a personal computer being turned out once every six seconds," said Joe Roebuck, Apple's director of sales development, in a keynote address to a Southern California conference on classroom computers in the spring of 1982. "One day's production of them would fill twenty football fields." Amid all the heady new hopes at the conference, there were a few

*Unless otherwise noted, the bulk of references to news events during this first heady period (1981 through 1984), and their related quotes, come from articles written by Scott Mace for *InfoWorld*. My reason for drawing so heavily on this source is that this magazine and Mace were providing the media's most consistent coverage of the suddenly burgeoning world of educational technology during this time. Through the years, the magazine published hundreds of articles on the subject, a complete listing of which would overwhelm these pages. As time went on, other publications, such as *Education Week*, the daily newspapers, and some new publications devoted specifically to this market niche, began more regular coverage. In their cases, they are individually cited.

hints of trouble to come. To those struggling to find cash for computers, for example, one school administrator suggested drawing from school building funds—a recourse that many schools pursued. Over the years, this has caused a number of imbalances in school construction, some of which were recounted at this very conference. Right there in Anaheim, a high school built a computer lab only to discover that the school building didn't have enough electricity to run it. But that wasn't stopping anyone. In a sign of the optimism of the time, Apple's Roebuck issued a strong prediction: "Education," he said, "is the reason people will buy computers."

Hyperbole aside, Roebuck hit a nerve. It's always an artificial science to pinpoint, in hindsight, the exact moment when a world-shaping trend reaches critical mass. It never does, in fact, unless a multitude of factors happen to coincide.[10] But a sure sign of any new trend, if only a temporary one, is a big story in one of the national newsweeklies. Such a moment occurred on May 3, 1982, when *Time* published a cover story entitled "Here Come the Microkids." Written in the newsweeklies' standard breathless prose, the article was full of sensationalist accounts of genius children doing computer programming and other wondrous things with personal computers. "By bits and bytes," the story's subtitle said, "the new generation spearheads an electronic revolution."[11]

The magazine noted that interest in classroom computing had now reached such a state of passion that parents were raising money for computers by staging cake and candy sales, carnivals and tree-plantings, weekend car washes, and in one case a bike-a-thon. In Utica, Michigan, a principal told the magazine, "Moms and dads are coming in and telling the counselors they have to get their kids in computer classes because it's the wave of the future." One survey noted that the number of computers in schools had tripled in eighteen months, reaching 100,000 by the spring of 1982.[12] By 1985, *Time*'s sources projected, the figure might reach 300,000 to 650,000, a number that proved to be nearly on target.[13] Apple chairman Steve Jobs was talking about giving schools, free of charge, more than 80,000 computers. This was almost as many computers as they already had, and a contribution that *Time* estimated to be worth $200 million on the retail market. But it was money well spent. In an interview many years later, Bud Colligan, an early Apple education specialist who is now a venture capitalist, told me that Apple always knew that its school initiative was an ideal way to seed its market. As children became devoted to a brand, the parents would too. And that relationship was likely to last for many, many years.

Mingled among *Time*'s facts and figures were quotes from various technology leaders that undoubtedly stirred a reader's imagination. Bill Holloway, a professor of computer education at the University of Kansas, called the spread of personal computers in the classrooms nothing short of an avalanche. Others believed they were witnessing a leap in human potential as computer programming, *Time* said, promised "to shape—and sharpen—the thought processes of the computer generation." Stephen Toulmin, identified as a University of Chicago "Philosopher of Science," predicted that computers would "re-intellectualize" the television generation. "TV relieved people of the necessity to do anything," Toulmin said. "Computers depend on what you do yourself."

Twenty years later, Toulmin had some difficulty describing how computers had fulfilled his vision of a "re-intellectualized" generation. During a 2002 interview, after he had retired and moved to Beverly Hills, Toulmin said, "To a certain extent, you can't intellectualize people. You can't resolve, for instance, to turn yourself into a mathematical genius." But even those who fell for Toulmin's earlier predictions had plenty of warning that his forecast might not turn out. Buried at the tail end of the *Time* article were a few prescient, cautionary notes. "In a typical computer class," the magazine said, "only about one in five students become seriously involved." This was followed by warnings from several high-level skeptics. One was Joseph Weizenbaum, the renowned MIT professor of computer science. Weizenbaum feared that the sudden emphasis on programming problems was leading children to ignore "a whole world of real problems, of human problems." George Miller, a Princeton psychologist, took the long view. He doubted that "a few years of thinking like a computer can change patterns of irrational thought that have persisted throughout recorded history." George Steiner, described by *Time* as a "Humanist Critic," predicted that children "will be out of touch with certain springs of human identity and creativity, which belong to the full use of language rather than mathematical and symbolic codes."

In its final word, as might have been expected, *Time* put its money on the kids. "More so than adults," the magazine said, "the young know the computer for what it is." It then quoted Shawn Whitfield, an eleven-year-old growing up on the northern edge of Silicon Valley. Every Tuesday night, Shawn and his older brother, Scott, visited the Menlo Park library for computer instruction, because, Scott said, "We'll probably never get a job if we don't learn how to use computers." For young Shawn, it was a matter of destiny. "When I grow up," he said, "it's going to be the Computer Age.

It won't affect parents. They're out of the Computer Age. They had their own age."

The digital fever quickly spread. School demand for "courseware" had grown sufficiently intense that in late May 1982, one education-research firm predicted it would outstrip supply by a ratio of two to one for the next five years. The company, Talmis, projected a $75 million demand for educational software by 1985—nearly seven times what it had been in the previous year. Another consulting firm said that by 1987, the courseware market would increase by a compound growth rate of 71 percent a year—a vision whose exponential proportions didn't quite come to pass.[14]

Before long, IBM, which was fast catching up to Apple's success with personal computers, joined Jobs's campaign in the schools. "As people are exposed to personal computers in the schools, this will become an excellent way to interest folks in home computers as a supporting educational device," Bob Wallace, IBM's manager of education-industry marketing, told *InfoWorld* that summer. Wallace said the purpose of computers in the schools was to "take up the slack teachers are leaving now." He was specifically talking about math and science, which were suffering from teacher shortages at the time. In Wallace's view, computers could fill this gap by adding an extra year of math or biology instruction, even without good teachers. Then he added a reassuring note. "Obviously, we don't want to replace teachers."

As the courseware industry blossomed, the education world grew desperate for experts. One of the first to emerge was a man named LeRoy Finkel, the much beloved instructional-computing coordinator of the San Mateo County Office of Education. Partly because of the fervor of the times, and partly because of Finkel's expertise, by the fall of 1982 Finkel's mornings were often jammed with phone calls from across the country. His tiny operation went by a delightfully unappealing acronym, SMERC (for San Mateo Educational Resource Center), but it quickly developed one of the nation's first public-domain software libraries, called Soft Swap. And educators across the globe were eager to trade. Launched in 1980, SMERC was soon singled out by then-governor Jerry Brown, who eventually scheduled a brief visit to the office and proceeded to spend three and a half hours there.

COMPUTER PROGRAMMING WARS

At the beginning of the 1982–83 academic year, the College Entrance Examination Board (CEEB) made a decision that ramped up the financial stakes in school technology. The CEEB, which oversees the notorious

Scholastic Aptitude Test (SAT) and the tests on Advanced Placement courses, concluded that it was time for AP options in computer programming. And it chose a programming language called Pascal (named after the seventeenth-century French mathematician Blaise Pascal). One problem: As is often the case in the software world, there were warring camps in computer programming. In fact, most schools had begun to use a programming language called BASIC (which stood for Beginner's All-purpose Symbolic Instruction Code). The BASIC loyalists firmly believed their program was more accessible to grade school students than Pascal and that it offered more flexible opportunities to think creatively—a logical argument, since Pascal was a tightly structured language used by university computer scientists and professionals. Perhaps more important, shifting to Pascal's more rigid demands would not be cheap. By some estimates, the schools would have to spend millions, not only upgrading their software but also buying mammoth new "microcomputers," since they were the only sort at the time that could handle Pascal.

In the years following the CEEB's decision, Pascal gradually faded into the wings—but paradoxically enough, only after causing some extra trouble for schools. But that's getting ahead of the story. Actually, in a double paradox, BASIC proved to have considerably more stamina than Pascal. It has held on to this day (most recently, in an updated version called Visual BASIC) and remains one of the programming world's most powerful tools.

When the CEEB first cast its lot with Pascal, one of the many people who disagreed with this decision was a man named Bob Albrecht. In any history of the personal computer's early, Silicon Valley beginnings, there is a small family of irreverent, 1960s-style counterculturalists whose names figure largely in its folklore. Bob Albrecht's is one of those names. It is mentioned alongside his passion for dragons and teaching people Greek folk dancing as often as it is with computers and what they can do for youngsters. The son of an affluent Iowa cattle and turkey farmer, Albrecht taught himself computer programming in 1955, on the "machine language" developed for the early IBMs. In 1966, possessed by the computer's as yet untapped potential, Albrecht headed for San Francisco (suitably, in a convertible VW bug, which, upon arrival, he paired with a red VW van). Before long, he'd moved to Menlo Park, where he, LeRoy Finkel, and several others started a great number of enterprises.

One was the Portola Institute, which served as the seedbed for Stewart Brand's legendary *Whole Earth Catalog*. Another, in 1968, was DYMAX, one of the first educational publishing houses to focus on computing in schools. Yet another was a journal for computer hobbyists called *Dr. Dobb's Journal of*

Computer Calisthenics and Orthodontia: Running Light Without Overbyte. The journal was hungrily received (and, under a shortened title, is still published to this day). Albrecht was known at the time for having a new idea every three minutes, and he was just getting warmed up. In 1972, he and Finkel started the People's Computer Center, the nation's first drop-by shop, where people could buy recreational computer time. The center actually grew out of a raggedy monthly, called *The People's Computer Company Newspaper,* which looked like something published out of a basement in Haight-Ashbury. A look inside the newspaper, which grew fat with ads during its five-year life, proved that it had much more than free computer love in mind. With unalloyed ebullience, it urged readers to support two outfits that it deemed to be educational technology's leaders: Digital Equipment Corporation (DEC) and Hewlett-Packard. From 1970 to 1973, Finkel once wrote, he and Albrecht and several colleagues "barnstormed California in Bob's VW van, loaded down with DEC and Hewlett-Packard support materials." They stopped at almost every University of California campus, from Riverside to Berkeley, offering a class entitled Computers in the Classroom-X402 and "turning on more than 500 teachers to computers."[15]

In 1979, with a man named Ramon Zamora, Albrecht launched another first: ComputerTown USA, a community computer literacy project that worked to get personal computers donated to libraries. Albrecht knew he was more of a starter than a manager, so by 1980, most of these ventures had either migrated into new directions or were safely in the hands of others. Albrecht therefore began studying how children learn and writing books about how their learning might be helped by programs like BASIC and, eventually, other pieces of modern technology.

Today, nearly five decades and more than thirty books later (some of which have sold hundreds of thousands of copies), Albrecht's fervor and vision have hardly dimmed. I noticed the fire in his imagination myself when we met several times during the summer of 2001. Albrecht, seventy-one at the time, still writes about technology and still works with elementary, high school, and college students, as both a classroom volunteer and paid tutor. "I'm just really getting started, in a way," he told me. In the years since *The People's Computer Company Newspaper* put a pencil sketch on its first cover of a tiny ship sailing into a huge, rising sun, Albrecht has seen a plethora of technological ideas travel through the schools. Some have stuck; most have not. This experience has left him with a sobering perspective on technology and education.

For years Albrecht was, by his own admission, a BASIC evangelist, partly because few other computer program options were available. In 1968, he wrote the nation's first textbook on the program and then helped teach it in dozens of schools.[16] Before long, Albrecht noticed that while some students were wildly enthusiastic about the program, most weren't. "As long as the use of computers in school would be tied to learning a programming language—whatever programming language—it wasn't going to do much. It would grow a little bit, mostly involving bright kids and innovative teachers. And then it would level off." Schools that pushed that boundary only asked for trouble. "You're beating your head against the wall to teach teachers programming," he said. And those who seemed to succeed soon discovered they had won at a losing game. "Today's hot programming language," Albrecht said, "is tomorrow's forgotten dialect."

Chastened by these experiences, Albrecht began to roll with the times. As each new software program arrived on the scene, he enthusiastically threw himself into its opportunities—without deluding himself that it was the answer, that it would last long, or that it deserved an entire course of study. "I don't teach any of these programs," Albrecht told me. "I just use them as they come up." His point is that computers, and their software programs, are merely tools, to be picked up and dropped the way a carpenter shifts from a hammer to a screwdriver to a measuring tape. In fact, if he were a school official, Albrecht would suggest avoiding any program built specifically for schools. "Students and teachers should use the same tools in schools that they're using in the real world."

COMPUTERS AND POLITICS, TAKE ONE

Politicians are like everyone else—they like to bet on winning horses. And in the fall of 1982, computers in schools looked like society's runaway winner. Earlier that year, Arizona's then-governor, Bruce Babbitt, placed the political world's first bet on this innovation, proposing a tax write-off for companies that donate computers to schools. Not to be outdone as a futurist, California governor Jerry Brown quickly proposed a similar idea. At a time when his state was projecting a billion-dollar budget deficit, Brown proposed a $48 million education initiative centered on technology. His plan was to create nineteen "Computer Demonstration Centers," which he said would inaugurate "the second American education revolution." In a speech to Computer Using Educators (an organization founded by LeRoy Finkel, widely known by its acronym, CUE, and still very much in existence), Brown spelled out his vision. "This new educational revolution," he told the crowd, "can be a qualitative leap in which we vastly increase the

quality of this public education and realize the age-old dream of empowering each person to reach the limit of his or her ability." In another serving of vintage Jerry Brown earnestness, he described his initiative as being all about "the three C's—computing, calculating, and communicating with technology."

The California legislature was all ears. By September, Brown had a bill signed and ready to go that freed companies from paying taxes on 25 percent of the market price of any computers they gave to schools for the coming year and a half. Weeks later, he added a $1.2 million sales tax refund for custom-software developers. Across the country, political officials were treating audiences to similar messages. At one conference of three hundred educators in New York City, Robert Maurer, the city's executive deputy commissioner of education, said that computers, which he called "brain enhancers," were ushering in a revolution no less dramatic than the industrial revolution.

The popular perception of the technology industry is that it is inhabited by a special breed—a corps of pristine innovators that, until Microsoft's trouble with antitrust regulators, has had little if any need for the dirty business of politics. The record of the 1980s casts this story in a rather different light. In reality, technology's corporate leaders proved to be as quick and effective in learning the game of politics as they were with the microchip.

In October 1982, for example, Congress made several moves to ante up for the computer industry after intense lobbying from Apple chairman Steve Jobs. At the time, companies could take tax write-offs for computer donations, but only when the recipients were colleges and universities. That fall, a Senate committee approved a bill extending the tax break to cover donations to grade schools and high schools. And this tax break would go further than the college measure, letting companies write off roughly one and a half times the cost of each computer. In the House, those carrying Jobs's idea went further still. Representative Pete Stark, a Democrat from Jobs's Silicon Valley district, proposed making the tax break worth up to twice the cost of the computer donations.

As Congress deliberated, the chorus of cheers from California grew. In early November, a San Jose CUE conference gathered a record two thousand attendants—a third more than it had drawn to its previous conference, just six months earlier. During one of the conference's 250 sessions, IBM's Bob Wallace told the audience, "We're confident that [the computer] does teach." Since IBM had only recently begun catching up with Apple's presence in the classrooms, Wallace began by eating a little humble pie. IBM, he acknowledged, is "the new kid on the block." But Wallace also struck a

shrewd note of optimism. IBM was confident, he said, that it had come into the game with an armful of strong products. "We should have," he said. "We took longer to do it." His company made it plain that it planned to back up its boasts with data. Having recently donated PCs to school districts in five states, the company expected positive results soon from various tests. Solid evidence of the equipment's benefits never did materialize. But in the midst of the CUE conference's technological fervor, that possibility seemed remote.

During the conference, teachers and students had a chance to try out some of the software being promoted. To do so, they sat down at Commodores and Ataris and other machines whose names have long since become relics of the PC's stone age. One of the most prophetic of those was the widely sold TRS 80, named after its maker, Tandy/RadioShack. Soon nicknamed the Trash 80 because of how quickly its tinny, monochrome box with green type went out of style, the machine gave schools a small taste of technology's rapid and costly cycle of obsolescence. But those troubles were a long way from anyone's mind in 1982. "There's been a lot of excitement here, and also a sense of historical importance," an aide to Governor Brown said during the conference. In a nod to the urgency of the moment, a state education official told *InfoWorld* that "we're running to catch up" with what he termed "the grass-roots use of technology in schools."

As the year turned, *Time* once again took center stage to define the meaning of the moment. For the first time in fifty-five years, the magazine chose not to put a human being on its cover for Man of the Year. Instead, it chose an artist's rendering of a personal computer. Under the headline "Machine of the Year," the magazine said, "Several human candidates might have represented 1982, but none symbolized the past year more richly, or will be viewed by history as more significant, than a machine: the computer." In recapping its reporting that year, *Time* said the computer was transformed from an image synonymous with Big Brother to a small, highly personalized device. (In an anecdote that the magazine obviously considered a cute sign of the times, it noted that throughout its 1982 coverage the editorial department had been plagued with computer crashes. In fact, in writing the main story for its "Machine of the Year" issue, Otto Friedrich, a senior writer for *Time*, ended up tapping out his copy on his favorite machine of all: a fifteen-year-old Royal typewriter.)[17]

In early 1983, struck by a sudden spread of cheap personal computers, *InfoWorld* decided it was time for a statement of its own. "The public is running out of reasons to hold off on buying a computer," Mace wrote in an editorial. After months of marketing pressure about "computer literacy" (a

term used again in the 1990s, without irony, as though it were an untried concept), the industry had made the idea almost irresistible. It was now producing simplified versions of the PC for $200 or less. "At These Prices, Why Not?" *InfoWorld*'s headline asked. While many of these machines were not yet sufficiently "user-friendly" (another term reinvented in the 1990s), Mace nonetheless urged readers to act now, if only to get a head start on computer programming skills, which were seen as critical for keeping up with the times. The times did indeed seem to be racing in technology's direction; even theater troupes began commenting on the change. In February 1983, the venerable South Coast Repertory started touring Southern California with *Bits & Bytes*, a play about what a young girl can and cannot get from technology. Despite all these signs of people's growing interest in technology, back in Washington the nation's political leaders remained circumspect. Nonetheless, in the months ahead, Congress would toy with numerous ways to help the computer industry reach its goals in the schools.

FALSE PROPHETS

In the midst of 1983's frenzy about computing, a product was announced that would have a very long echo. In February of that year, a company called Digital Research released a new version of a program called LOGO, built for the IBM PC market. LOGO was an ambitious children's programming language developed by BBN Technologies and spread by one particular BBN consultant: MIT computer-science whiz Seymour Papert. The program had been available previously, for Apples and some other machines, but this new release started LOGO on its rise toward wide scholastic use.

From the beginning, LOGO had a lot going for it, propelled as it was by the aura that surrounded its champion. Papert not only possessed a rare intelligence, he also loved helping children work with computers and was fascinated by how they learn. If that wasn't enough (and, as any teacher will tell you, it usually is), Papert had spent five years studying with the twentieth century's first authority on childhood development, Swiss psychologist Jean Piaget. That experience left Papert—a man already prone to grand visions and rarefied theories—with even more lofty ideas about how human intelligence could be expanded, this time by computers. A short, stocky man in spectacles, and now with longish, thinning gray hair and a long, bushy gray beard, Papert looks like—and is—the quintessential math genius. To talk with him is to engage with someone whose mind is only half with you; the other half seems to be wrestling with questions on some faraway, higher

plane. All of this created a compelling package and helped transform Papert into America's leading guru on children's technology. Papert's rise was aided by the comparatively looser laws that surrounded intellectual property in those days. Before long, a number of firms like Digital Research had made their own versions of LOGO and were vigorously spreading them in the public domain.

With Digital Research's announcement of the new version of LOGO, Gary Kildall, the company president, did not miss his opportunity to seek a competitive edge. He contrasted his new programming tool to the schools' current favorite—BASIC. Schools had been heavily investing in BASIC, and in computers that could run it. However, Kildall said, BASIC "turns out to be a very poor approach to teaching someone how to use computers. In many cases, it's very limiting to a child."

Kildall's line wasn't surprising, considering his proprietary interest in trouncing a competitor. In the following years, though, a number of schools bought his argument as it was repeated over and over by IBM, Papert, believers in artificial-intelligence software, and other LOGO enthusiasts. The upgrade parade now went around the block one more time as schools spent time and money junking systems built around BASIC, which now seemed obsolete, for another program that suddenly seemed state-of-the-art.

The LOGO story offers, in hyper-microcosm, an allegory for the whole educational technology tale. As LOGO's leader, Papert has long managed to live in his own semifictional world, shaped by the same prophecy playing over and over again, in an endless loop, for thirty years. The central message is that computers have a perfectly good excuse for failing to have much effect in the classrooms. It's not the hardware or software that's to blame; it's the schools. But thanks to the computer, schools are about to change.

In 1975, for example, Papert delivered a speech to a technology conference in which he said, "If you asked me whether the practice of education will have undergone a *fundamental* change through the impact of computers in either five years or twenty-five years, I could answer with complete confidence 'NO' to the first question and 'YES' to the second . . ."[18] Here he is again in 1980, in his widely distributed book *Mindstorms: Children, Computers, and Powerful Ideas*: "Increasingly, the computers of the very near future . . . will gradually return to the individual the power to determine the patterns of education. Education will become more of a private act."[19] Four years later, in an article for *Popular Computing* magazine, Papert still saw revolution coming sometime soon to a school near you. "There won't be

schools in the future," he stated flatly. "I think the computer will blow up the school. That is, the school defined as something where there are classes, teachers running exams, people structured in groups by age, following a curriculum—all of that. . . . But this will happen only in communities of children who have access to computers on a sufficient scale."[20] Then this, in the late 1980s: "Nothing is more ridiculous than the idea that this technology can be used to improve school. It's going to displace school and the way we have understood school. Of course, there will always be, we hope, places where children will come together with other people and will learn. But I think that the very nature, the fundamental nature, of school that we see in this process is coming to an end."[21]

On and on it went. "The pundits of the Education Establishment have failed to provide leadership in this area," Papert wrote in 1993, in an article for *Wired* magazine, one of the leading chronicles of the recent technological wave. "Perhaps the readers of *Wired*, who can see farther into the future, have a profoundly important social role in stirring up such debate."[22] Finally, by the middle of the 1990s, Papert began to adjust his vision, but only slightly. In a 1996 interview, he admitted that education had not much changed, saying schools had reacted to the invasion of computer technology the way any living organism would. "A foreign body comes along—the computer—and the organism's immune system and defense mechanism takes over. So we saw a shift in the 1980s. Before then computers were being used in exciting ways. They were in the hands of visionary teachers who were trying to use computers because they were dissatisfied with how schools did things. By the end of [the] 1980s, the larger number of computers were under the control of the school bureaucracy. . . . There were still visionary teachers, but they were being neutralized." Papert still had hope, though. Noting that more computers now resided in the homes than in schools, he predicted that households were the new opportunity zones for learning. Once children seized their chance, it was only a matter of time before schools fell. The young, he said, "are the power that will change schools. . . ."

Just recently, during a 1999 gathering of LOGO loyalists at one of his "Mindfest" conferences at the MIT Media Lab, Papert was still at it. This of course was nearly the hour that Papert had first predicted back in 1975—the moment, twenty-five years hence, when he could say with "complete confidence" that "education will have undergone a *fundamental* change through the impact of computers." Despite Papert's italicized certainty about this tectonic shift in education, come 1999 the world was still waiting. And he was still predicting. "School as we've known it has got twenty more years or it's dead," Papert said at one point, ushering in yet another twenty-year wait. By now, Papert had become completely exasperated with the education system, including its save-the-world reform movements. At the MIT conference, Papert dismissively ticked off several: vouchers, charter schools, the rise in home schooling, to name but a few. These, he said, are "not an answer but a symptom of the schools' failure." And the latest obsession—standardized testing—is, to Papert, "the last twitch of the dying dragon's tail."

All of these trends, along with the severe troubles that have recently beset school systems in various American cities and the public's continual concern about schools, are evidence to Papert that he was right—computers *did* change the system. In a 2002 interview, he told me, "If you had asked me ten years ago, I would have said I was wrong, that it will take fifty years. But now, I would say it's apparent the system is breaking down." But did computers cause all these signs of tumult? "The whole digital age has caused them, and anything that goes with that—globalization, the accelerating pace of things, and the changing media."

The incisive sting in all these remarks demonstrates some of Papert's great appeal. Indeed, his line couldn't have drawn such a following for so long if there weren't something to it. Yes of course, schools have needed to change. But what's curious about Papert is that he has long seen computers—and even more strangely, a programming language like LOGO—as the key to this change. In *Mindstorms*, for example, Papert elegantly describes how children's work with LOGO can make mathematical concepts come alive. Just exploring the program's procedures, he writes, leads to physical activities and logistical problems in which children "explore 'naturally' domains of knowledge that have previously required didactic teaching." This, he argues, puts youngsters "in contact with the 'material'—physical or abstract—[which] they can use for Piagetian learning."[23]

For a select number of students, especially those who have received careful guidance from skilled adults, Papert has been gloriously and touchingly on target. (The few dozen young geniuses at his 1999 Mindfest gathering offered an eye-opening illustration. They were nearly delirious from having such a rich, high-end playpen at their disposal and being surrounded by adoring grown-up geniuses morning to night for two days.) Most youngsters, however, have had a very different experience. If the independent studies of LOGO and other academic computer programming languages are any guide, the verdict is as follows: The vast majority of students have never

understood programming, have never sustained much interest in it even if they did understand it, and have never been terribly changed by it in any case.[24]

Papert does not differ with these studies' conclusions; in his mind, they only confirm his hunches about organized education's failure. "I never thought a few hours a week of LOGO would make much difference," he told me. "Nothing will change unless it's complete"—that is, until computers are used intensively, pervasively, throughout the academic day. The "complete" change that Papert wants entails far more than classroom activities; it involves the whole culture of school, which still operates, he believes, on a nineteenth-century design. "School has probably changed less than other major institutions," he said. "The evidence that we got it right in school and got it wrong everywhere else is pretty slight." When making this argument, Papert delights in using a favorite metaphor for what happens when schools introduce computers: It's as though some "nineteenth-century imaginative engineer had invented the jet engine and attached it to a stage coach to see if it would help the horses." Computer technology, Papert acknowledged, really is "a disruptive technology. It should be so. School was designed for a different medium."

During all the years that Papert has hammered at this message, he has regularly worked with small groups of youngsters in one venue or another to prove that his programming visions were more than those of an idle dreamer. At the beginning of the twenty-first century, Papert was still at it—teaching LOGO and other programs to the residents of a juvenile detention center outside Portland, Maine. By all available accounts, Papert (with the help of Gary Stager, a fresh-thinking and similarly irreverent instructor from Pepperdine University) was producing some wonderful results. I tried several times to visit the Portland project, but Papert was always reluctant. I was therefore left to the evaluations of the various professors and other experts who have studied Papert's initiatives over the years. Virtually all of them dismissed the grand conclusions that Papert draws from his success with these tiny experiments. Their assessment, in short, was as follows: Papert and his crew succeed because they are exceptionally bright, energetic, and creative; because they haven't lost faith in children who don't achieve in traditional academic environments; and because they come in with a team that can give each youngster intense individual attention. By extension, this means that any teaching group with similar attributes could produce similar results—with paints, books, Socratic dialogues, any number of materials and techniques, a point that Stager acknowledges would also be the case in Portland. Papert, however, is not so inclined to concede

defeat. During our last conversation, he argued that the "gradual, steady encroachment of electronic media" in the professions, and throughout all of society, still bodes unfulfilled promise for a similar revolution in education. "School textbooks aren't a good way to learn history," he said. "In fact, they are an extremely bad way to learn about history. The best way to handle knowledge and information is through electronic media. It's not that electronic information is anywhere near where it could be. But things are developing."

It's hard to argue with such shiny conjurings of future possibilities—undoubtedly another reason that Papert's pitch has held its magnetism for so long. Actually, some of today's electronic media partly prove Papert's point, having clearly contributed more social good than bad. Documentaries are an obvious example. But what about the Internet and its voracious little brother—e-mail? These media forms are undoubtedly permanent fixtures throughout society and, in some form, in all of our schools. During the course of my visits to schools, I had plenty of chances to examine Papert's beliefs about technology—even in schools that followed his dictum: They had attempted "complete" change, or something fairly close to it, through computing. As it turned out, their accomplishments were probably not quite what Papert envisioned. But that's getting ahead of the story.

At this point, Papert's argument should be assessed in one of two ways. The safest, most conservative approach is to go by the historical record. By that measure, Papert's pitch for technology fails miserably. The history of education and psychology shows that many kinds of study, including the "didactic" teachers that Papert deplores, are required for the full child development that Papert as well as Piaget have envisioned.[25] Computers can of course be part of this mix; for certain mathematically oriented youngsters, they absolutely should be.* But the record also indicates that it may be unrealistic to think that any innovation—technological or otherwise—would bring radical change to an institution as old, as large, and as established as

*The work of Mitch Resnick, a colleague of Papert's and an MIT associate professor of learning research, underscores this point. Resnick developed a name for himself by helping start a national network of "computer clubhouses"—after-school centers where youngsters can explore games and other computer projects, according to their curiosities. Many of those projects, of course, aren't terribly educational. But some are. "If you want to play with math much beyond first grade," Resnick once told me, "you need computational devices of some kind, so you can create and explore patterns, modify a variable, and watch the real effects of that happen."

education. Yes, change is badly needed, and it is possible. But the kind that has succeeded has been incremental, unthreatening, and compatible with education's long-standing organizational structure rather than revolutionary. For all its troubles, and all its vulnerability to silly fads, there is a hard core to America's system of education that has long been immovable. Some of the system's habits (the firm divisions between subject areas; the superficial, fact-laden nature of tests, and sometimes of the curriculum itself; the dusty, deadly quality of most teacher-training studies) would make little sense in a more ideal world. Others (the large number of students that teachers must supervise; the low common denominator of academic goals; the short class periods; the sameness of tasks within each class, despite the great individual differences among students) appear to make little sense, but they actually do—once we remember the schools' enormous job and the public and political demands for measurable scholastic progress.[26]

There is an uncomfortable truth in this history: Education is an institution dominated by the pressures of mediocrity. Schools are places where treating average needs with average amounts of resources has long been the rule—a fact that, unfortunately, has become extremely comfortable and therefore deeply entrenched. Strangely, the educational policies of the nation's most recent president, George W. Bush, merely dig this trough deeper. As will become clear throughout this book, if schools really are going to "leave no child behind," to paraphrase the title of Bush's new education law, and if they proceed to do so on the simple measures that Bush has emphasized, then most teachers will have time and energy for little more than pulling the whole class a foot or two beyond the middle. The syndrome in evidence here is somewhat like Winston Churchill's famous statement about democracy—it's the worst system in the world, except for all the others. Churchill meant his remark as a compliment, but education's policy makers don't generally treat their institutional realities with quite the same respect. Schools might find more realistic opportunities if everyone did.

The other way to evaluate Papert's call is to take society's technological shift more seriously. While Papert's timing may be off, the media evolution he champions does seem to be occurring. If that's the case, there is still a need for adjustment in the classrooms. Significant social trends generally have a way of taking care of themselves; if anything, they sweep across the landscape too quickly, too haphazardly, leaving swaths of damage in their wake. (Modern examples include the industrialization of farming, the globalization of commerce, and, in this case, the spread of electronic media.) As youngsters try to adapt to today's accelerating world, with its rapid onslaught of simulated images, perhaps it is the schools' job to slow things down. Education, after all, is supposed to help youngsters understand and cope with both the positive and negative elements of the adult world they will encounter. It is also supposed to make sure they appreciate its humanist traditions.

THE DIGITAL DIVIDE, TAKE ONE

In the spring of 1983, a report came out that many years later would give some experts a serious case of déjà vu. The document, written by International Resource Development (IRD), a market-research firm in Norwalk, Connecticut, pointed to a growing technology gap between rich and poor children.

Any reader of the news in recent years has seen lots of hand-wringing about today's supposedly sudden discovery of a "digital divide." The contrasts that have created this delineation, as we'll see in the following chapter, do not fall the way the public has been led to believe. Nonetheless, for those who think we should do whatever we can to arm the underprivileged with computer technology, it's not as though we haven't had plenty of advice on how to do this. In an observation that people today are only beginning to appreciate, IRD noted that as schools emphasize computer work, wealthier students who have computers at home would increasingly gain an unfair advantage. IRD considered the problem serious enough that it thought poorer communities and school districts might someday file legal challenges. In making this case, IRD noted that inequities between the academic opportunities for rich and poor have long been known, and traditionally have been solved by the libraries, through bountiful supplies of books. It doubted, however, that the libraries could ever offer an equivalent amount of computer access.

Several weeks later, the mainstream media came out with its first serious report questioning the way the school computer campaign was being handled. In early April 1983, *The Wall Street Journal* published a story in its business section noting that across the country, schools that had invested heavily in computers were often encountering tremendous problems.[27] In Broward County, Florida, for example, the school district bought 900 Apple IIs under a $2.1 million computer expansion plan launched six months earlier. Yet in one elementary school, only a few of the teachers and students had even tried the machines. The computer campaign apparently irritated a number of teachers, whose salaries averaged $19,300 a year and whose school board had recently imposed a labor contract that paid them

even less than they'd been hoping for. In New Jersey, one state official observed a pattern of chaos in his state's school districts. "First they buy the machines, then they buy the software," the official said. "Then they start to think, 'Why did we get into this in the first place?' "

Prophecies of trouble littered the *Wall Street Journal* article. Complaints abounded, for example, about the quality of the educational software. In a typical opinion, the head of the English department at a Florida high school said that nearly all the software she reviewed recently was "horrendous." Her opinion, it seemed, was more than anecdotal. The year before, a newly formed group called EPIE (Educational Products Information Exchange), in consortium with *Consumer Reports*, had begun to offer schools the nation's first independent evaluation of education software. In its first review, of fifty products, EPIE concluded that only a fourth got a grade of 60 percent or better. A number of computer drilling programs in particular failed, said EPIE director Ken Komoski, because they let students "guess their way through." Many years later, the experts' evaluation of the courseware field was much the same, if not worse. In 1997, in a typical comment, Judah Schwartz, co-director at the time of Harvard's Educational Technology Center, told *The Atlantic Monthly* that "99 percent" of educational software programs are "terrible, really terrible." In the fall of 2001, Schwartz, by then a professor emeritus at both Harvard (in education) and MIT (in engineering science and education), considered the situation not much changed. In a note to me, Schwartz wrote, "The overwhelming majority of educational software is indeed terrible, having in large measure not been written by educators nor motivated by important educational considerations." Access to the Internet has "increased the amount of educationally valuable material," Schwartz added. "Unfortunately," he said, "it has increased the amount of mediocre material to a far greater degree."

Compatibility problems proliferated early on as well. *The Wall Street Journal* reported that at Homestead High School, in Apple's own hometown (Cupertino, California), teachers had tried to share software by networking their computers—an effort to stretch the district's $275,000 computer investment. Unfortunately, most software available at the time wouldn't work on networked systems. The article's final note was a prescient word of advice from Marc Tucker, a Washington, D.C., analyst of classroom computer policies. Tucker said schools should spend only 25 percent of their technology budgets on software, 25 percent on hardware and maintenance, and the remaining 50 percent on planning, teacher training, and other support services. Over the years, various technology specialists—including those who advise businesses—have recommended dividing technology spending into roughly the same proportions. If anything, they've suggested reserving the largest pot of money for maintenance and upgrades. But the advice hasn't mattered. Decades later, schools were consistently pouring the bulk of their cash into raw consumption, leaving no more than 10 to 15 percent for both maintenance and training.[28]

As the 1983 school year drew to a close, Governor Bruce Babbitt began to fear that Arizona wasn't moving toward technology's future fast enough. In an April speech to an educational computing conference at the University of Arizona in Phoenix, Babbitt proposed making computer literacy so important that incoming teachers be denied certification if they lacked this skill. Babbitt's panic, shared by many others at the time, was stoked by a national insecurity about the country's place in global competition. This was in the day, brief as it was, when Japan's economy was smugly ascendant and pundits of every stripe were blaming the schools for letting America fall behind. It was also the year that a federal commission published a report entitled "A Nation at Risk," which landed with a loud bang, drawing newspaper headlines across the country for months to come.

The report did not focus on technology but on the state of education in general. In essence, it said, through decades of efforts to make education more fun, more relevant, more sensitive to this crowd or that, schools had gradually corroded their standards of learning. What was now at hand was nothing short of a "crisis." Babbitt clearly agreed, and used the Arizona conference to pile on some additional complaints. He pointed out that Japan was graduating 50 percent more engineers than the United States, and that Soviet high school students took two years of calculus while in the States, only one of ten high school students was doing so. These failures, he argued, had infected the teacher corps as well. In a recent year, he said, his own state had not graduated a single student from its schools of education who had majored in mathematics. Arizona was not alone; other reports later revealed that teachers in training were spending excess time with "methods" courses about teaching and phys ed classes, instead of mastering math, sciences, and the liberal arts.[29] For the country as a whole, Babbitt thought the message was clear: The shortage of teachers properly trained in math and the sciences, he said, amounted to "unilateral economic disarmament."

As parents tried to sort out these various messages, they began to take matters into their own hands—with a little help from another new technology industry. Across the country, entrepreneurs had founded "computer camps," which could cost up to $250 a day. Some were lavish overseas ven-

tures, coupled with special tours of Europe, running at more than $3,000 for a four-week excursion. First started in 1977, the camps initially tried to simply give children a general familiarity with computer technology. By 1983, camp organizers thought it was time to specialize. Some designed programs that focused almost exclusively on LOGO; others concentrated on competitors like BASIC and Pascal. There were spreadsheet camps competing with database camps. A Michigan camp director, fittingly named John Camp, had such high aims that his program read like a school curriculum description. For the media, the camp craze provided a valuable service. Through the years, and continuing to this day, news stories about almost any development in the school computer world have been accompanied by essentially the same photograph: a shot of a computer on a desk, surrounded by one or more adorable young children, a teacher often supportively joining in, all beaming with eye-glistening enthusiasm. Now the papers had a new photo op: a kid at camp, kneeling in front of a mammoth desktop computer inside her tent.[30]

DIGITAL DRILL SERGEANTS

In the heat of that summer of 1983, another innovative product, called Dial-A-Drill, was released by a company called Computer Curriculum Corporation, a firm that was and would continue to be one of the biggest players nationwide in the educational software market. Dial-A-Drill, CCC's first commercial offering in sixteen years, was a little different from most of its competitors. It was delivered as an automatic recording, over the phone, which students (or adults) could pick up at appointed times. They'd then hear a computerized voice that would put them through reading, spelling, and arithmetic drills, which they'd answer by punching buttons on the phone's keypad. As students recorded their answers, the phone-bank computer responded with occasional hints and words of praise ("Excellent work!"). It also adjusted the drill as the phone call progressed, delivering harder problems for skilled children or easier ones for those who were struggling. That made Dial-A-Drill "computer-adaptive," as testing experts call it, a feature that would become all the rage many years later (see chapter 9).

Dial-A-Drill was developed by CCC founder and president Dr. Patrick Suppes, another legend of the academic-computing movement. In the 1960s, while in his forties, Suppes became one of the earliest and most fervent advocates of computer-aided instruction (CAI), the family of computerized drill and practice routines that became widely popular in the 1980s and

early 1990s. One of the things that put Suppes on the map was an influential article he wrote in 1966 for *Scientific American*, "The Uses of Computers in Education," in which he predicted that it would not be long before we had computers that could talk to children—a theory that Dial-A-Drill tried to put into practice. The article was widely reprinted, and translated into at least four languages.[31]

Suppes approached CAI as a science, which he studied intensely and promoted through an unusual double career. During his twenty-four years as CCC's president, Suppes also served as a professor of mathematics and philosophy at Stanford University and the director of its Institute for Mathematical Studies in the Social Sciences. In 1990, Suppes sold CCC to Simon & Schuster. But he stayed at Stanford, and as of 2002, he was still affiliated with the university, teaching classes as a retired professor of philosophy, emeritus. By this time, Suppes's curriculum vitae was as distinguished as his website portrait, in which a lean and tanned Dr. Suppes gazed contentedly at his readers, his fine patrician features and wavy, graying hair nicely crowning the accomplishments underneath. Those accomplishments run for approximately fifty pages. There is a C.V. with scores of academic honors and appointments; a twenty-seven-page "intellectual autobiography"; and lists of hundreds of related papers, from 1951 to present, in six different categories: "Methodology, Probability, and Measurement"; psychology; the brain; the "Foundation of Physics"; "Language and Logic"; and "Computers and Education." This last category is Suppes's most extensive, numbering 146 different journal articles and conference presentations over a forty-year period.[32]

To read through even a slice of Suppes's material is to be treated to a worldview that, while appearing archaic, has cropped up repeatedly in modern times. It is the scientist outlook in the extreme—the assumption that anything worth bothering with can be objectively identified, consciously induced, tightly controlled, and empirically measured. This outlook has often shaped the way American society works—how it evaluates children, as well as adults, and how it awards merit to each of us. Indeed, the recent enthusiasm for standardized academic testing, generously fed by George W. Bush's administration, is but the latest example of the modern appetite for such endeavors. One of the most influential early proponents of this philosophy was James B. Conant, the mid-twentieth-century Harvard chemistry professor and, later, university president who created the Scholastic Aptitude Test. (Conant, widely regarded as the father of standardized testing, also brought the nation its modern culture of large, "consolidated" high schools, as well as a system for labeling student abilities. Such a system, Conant believed,

would help society "track" students, steering them into high scholarship at one extreme or vocational education at the other—a habit that educators are still trying to outgrow.) An equally famous adherent of the ultra-scientist view was a Conant contemporary, the behavioral psychologist B. F. Skinner, whose view that people were—or could be—essentially trained like animals ultimately fell into disrepute. While Suppes took pains to point out his differences with Skinner, he sometimes sided with the old man, describing himself at one point as "the White Knight of the Behaviorists."

If Suppes was right, Dial-A-Drill was going to be his white horse. When the program was released in 1983, Suppes called it part of a "broad societal response" to the need for computer-assisted instruction. The telephone drills, he said, created "a regular and organized time, in clear contradistinction to what you can do with a home computer." The product did have economy on its side. Courses cost $15 to $18 apiece (less in bulk purchases). That fee bought three to five calls a week, with each call estimated to take only six to ten minutes. It also brought monthly reports in the mail and an "overlay" card, which turned the phone's keypad into a simplified calculator. The voice system was a special innovation—"a bit-sliced machine of our own design," CCC said. If students dodged the machine's calls, their parents would hear about it in the monthly reports.

As strange as this product sounds, Suppes based it on a set of purposeful learning theories, some of which he had articulated a decade earlier, in a conversation with the editors of *Saturday Review.* Pictured then as an earnest, young fuzzy-headed professor in heavy black-rimmed glasses and a dark ascot, Suppes faced off in the magazine's pages with Bob Albrecht, whose open-ended approach to computer programming clearly irritated the Stanford professor. "One of our most important concerns," Suppes said, "is the people who say that because they have all these facilities and technology, teachers will write their own courses. I think that's no more true than it's been in publishing—that the average teacher would write a textbook. I think it's less true." What particularly irked Suppes were the idealistic celebrations of the computer as a creative tool. "The real problem with romantics," Suppes said, "is that their intellectual level is so poor. . . . Nobody says that you can produce a first-class basketball or football team just by horsing around. Or suppose we trained pilots that way: let's take an airplane and horse around—it's a nice technological device; you don't need any training—just play around with it, take it up, and see how you like it. That's crazy!"

Condescension aside, Suppes had a point. The problem was translating his theory into computer reality. When *InfoWorld* looked into Dial-A-Drill, it

was less than overwhelmed. After observing a demonstration, reporter Scott Mace wrote that the program's synthesized speech "was noticeably flawed." And certain words and phrases were so patched together that they came through the phone "with abrupt and unnatural changes in inflection." Later, in an editorial, *InfoWorld* called the program "a high-tech hickory stick," likening it to the tool used in the fearsome old nursery rhyme about reading, writing, and 'rithmetic. "It is classic drill and practice," the magazine said, "the ultimate in 'back to basics,' flying in the face of all educational innovations developed in schools and on personal computers during the last 15 years."

As it turned out, most people didn't want to be bothered with automated phone calls anyway. It probably should not have taken the wisdom of hindsight to realize that taking the telephone, a system that mechanizes communication, and layering it with yet another mechanized system was not likely to produce a happy new generation of smart kids. But in Suppes's eyes, the value in the program's automated voice system was never appreciated and was mistakenly shoved aside by classroom computers. "I loved that program," he told me during an interview years later. "I was sorry to see it go." In a concession to the times, CCC then threw its energies into the more standard systems of computer-assisted instruction whereby students could sit in class in front of a real computer to practice their lessons.

The new direction paid off. After some stutters in the 1970s, CCC revenues rose—by 20 percent a year through the early 1990s.[33] In 1997, one of the peak periods of the technological go-go years, revenues for the company reached $128 million. By this time, CCC had become one of the leaders in what was soon called the courseware industry. In the following years, CCC appeared to remain strong, even after the CAI approach to computing faded. As of 2001, its software was reportedly being used by 10 million students in 16,000 schools.

Any instructional system that becomes this pervasive will, at some point, be put through some rigorous evaluation. Throughout the 1970s and 1980s, many researchers did just that with computer-assisted instruction. One such evaluation was conducted by EPIE, the courseware-watchdog group. At the end of the 1980s, a time when CAI software was at its peak, a team of EPIE evaluators set out across the country to survey the whole CAI landscape. EPIE's findings weren't pretty. "Teachers were tending to use the program as a dumping place," EPIE director Komoski recalls. The reason is that the CAI drilling routines relieved the teachers of having to teach. EPIE found that CCC actually encouraged this trend by sending in its own staff to show teachers how much easier their lives could be with CCC software. As

counts on computer gear. Komoski knew full well, however, that the gear alone would accomplish very little. "We're all caught up with, 'Well, I'm going to get my home computer and I'm going to have my youngsters learn as much as they can,'" Komoski said. "If we don't take a broader social vision, I think we're really buying a great deal of trouble."

To make a stab at that broader vision, Komoski planned to give these families computers only after they had come to school for training. He also tried to coax computer companies into helping out—by making donations to high-poverty schools; offering up to 35 percent discounts to those schools' families; providing the families with software evaluations; and building software and hardware libraries. Knowing companies might not be thrilled with this idea, Komoski tried to explain. "The school is becoming a very great help in marketing computers to homes," he said. "Fifty percent of the retail price of a computer is marketing costs. So if a school is helping to reduce those costs, the manufacturer or vendor can well afford a discount." Komoski's initiative did get a little funding from foundations, but it quickly petered out. Apparently, Komoski recalled years later, the whole plan required far too much support, technical and otherwise, to sustain.

COMPUTERS AND POLITICS, TAKE TWO

In the fall of 1983, Apple kicked off its first big school donation. This phase of the campaign was limited to California schools, since Jobs had failed to get a tax break from anywhere but his home state. However, with national subsidy prospects still lingering in Congress, Apple's California campaign was watched carefully by everyone—politicians, educators, and other computer manufacturers.

By all appearances, the computer's moment had arrived. When thousands of educators gathered earlier that year, for the spring 1983 CUE conference, there was a noticeable electronic charge in the atmosphere. Before the conference's big banquet dinner, Jobs worked the room like a political pro, passing out buttons for his computer donation campaign that said KIDS CAN'T WAIT—APPLE COMPUTER. Although Jobs was still waiting for traction on federal tax credits for computer donations, he'd recently scored on a few other fronts. The California giveaway (greased by Governor Brown's 25 percent state tax credit) was set for September, when Jobs hoped 10,000 Apple computers, loaded with the latest software, would land in classrooms across the state. And earlier that spring, Apple had made its first big arrangement with a college—3,000 specially designed Apples were sold to Drexel University, an unusual work/study institution in Philadelphia that had recently required each student and teacher to buy a microcomputer. (The students were paying the school $1,000 apiece for their machines; Apple wasn't talking about what its price was to Drexel.)

"We can actually change the world in a small way in the next six months," Jobs told the CUE crowd. Some players in the nation's capital apparently hoped so, too. In calling for more high-tech equipment in schools, Dr. Nolan Estes, former associate U.S. commissioner of education, told the audience, "By the time kids in your kindergarten graduate, 74 percent of them will become employed in the information industry." Estes's projections were a little off. A kindergartner in 1982 would have graduated high school in 1995. By then, according to the U.S. Census, less than 1 percent of the workforce was employed in "the information industries." (Specifically, 1.13 million people were employed in "computer and data processing services" out of a total labor pool of 124.9 million.) If Estes was talking about the year these youngsters would graduate from college, that would be 1999, by which time the figure had climbed to about 1.5 percent.[36]

Apple began its giveaway in August 1983, with 4,000 machines, expecting that number to rise to 12,800 by the end of September. When the bundles of software and discount coupons were figured in, each computer was valued at $2,300—a total donation worth $29.4 million. To get these machines, however, at least one person from each of the 9,400 schools involved had to go through a little computer training. Those training sessions ended up being something of a crash course. Offered at dealerships, typically with large pools of teachers, they ranged from a half-day's session to, more commonly, brief one- or two-hour overviews. This process made more than a few school administrators uneasy. Everyone realized it was unlikely that the dealerships would continue the training; this would of course leave schools with a new and heavy burden, which they'd been given few, if any, resources to handle. A computer coordinator in a Sacramento-area school district said he was "frightened" about superficially trained teachers coming in to class thinking they could now teach complex programming languages like LOGO.

While the schools struggled with the pros and cons of Apple's gift, the dealers seemed to be in heaven. When *InfoWorld* contacted several stores, they said the giveaway—which put, on average, no more than 1.4 computers into each eligible school—was generating additional sales, to both schools and parents. It was also spawning giveaway campaigns from other computer manufacturers, which generated additional business for dealers—and politicians.

Before the 1983 school year started, Jobs shopped his wares once more in the nation's capital. His prospects looked a little better that year, since President Reagan, after initial resistance to the tax breaks, had finally given the concept his blessing. This led Representative Pete Stark to reintroduce his plan (with some refinements) to give computer manufacturers tax breaks worth up to twice the cost of the machines they gave to schools. Despite the auspicious new signals, the bill's promoters knew it was by no means a sure thing. "There were those who thought the deduction was just too rich," an aide to Stark acknowledged. "They won't be satisfied any more this year than they were last."

In late September, as Apple was shipping its last few machines to California schools, Congress again took up the question of whether to help spread the program nationally. By this time, Jobs was no longer the only Good Samaritan on the block. Other computer manufacturers, such as Hewlett-Packard, IBM, and Kaypro (another feisty dinosaur of the PC's early days), were also getting into the act. Not surprisingly, each company had a slightly different donation plan—a better deal for the schools, in each one's view, in return for the subsidies they sought. In some ways, the timing was not terribly good for the proposals, coming as they did not long after President Reagan's massive tax cuts and simultaneous defense buildup. Those twin initiatives had given the nation a rising federal deficit, which would grow to more than $200 billion a year by the middle of the decade. Neither Congress nor Reagan was keen on granting tax breaks in such a nervous climate; nonetheless, the computer campaign seemed to hold its own appeal. "There is a lot of interest in and out of Congress in expanding the legislation to include other things," said the aide to Representative Stark, who was spearheading what had come to be known as "the Apple bill."

Indeed there was. At least eight different computer-donation bills were now making their way through various stages of congressional debate, all pushed by different corporate interests. (For example, one proposal, pushed by Tandy/RadioShack, would provide teacher training in exchange for a tax write-off on computers worth 125 percent of their value. For its part, Apple was seeking a 200 percent tax write-off on its computer donations, without throwing in any training at all.) Those pushing the "RadioShack bill," as it was soon called, and several others that called for teacher training, were doing so partly because they had learned their history lessons. In the 1960s, the federal government partly subsidized companies that gave schools audiovisual equipment; however, since little if any support services were included, much of this expensive gear sat unused in school closets.

In proposing one of the computer-donation initiatives, Representative

Tim Wirth, a Democrat from Colorado, joined the growing phalanx of observers who were worried about widening opportunity gaps between the rich and poor; Wirth even coined a few phrases that would become major themes a decade later. He spoke of "information haves" and "information have-nots," a description heavily used by former vice-president Gore and myriad lieutenants in the Clinton administration's Department of Education. Interestingly, only one bill focused on getting computers to poor schools. And it wasn't Wirth's; it was pitched by Representative Brian Donnelly, a Massachusetts Democrat and former teacher. In the fall of 1983, the House finally, and enthusiastically, passed Steve Jobs's tax break (by a 323–62 vote), but the Senate demurred. Complaints that the initiative amounted to a one-company bill led to filibuster threats, and the bill never got to the Senate floor for debate. In the end, none of these bills ever made it through Congress, which left computer giveaways to be an isolated occurrence in those states, like California, that decided to be generous.

ORWELL'S GHOSTS

As the fall of 1983 cooled into winter, the technology industry's new roses began to show their first sign of fading. Atari closed its two commercial training centers, before even trying to expand the concept nationally, because of a lack of profits. That year, computer dealers prepared for the holiday buying season with a new sense of hesitation. The easy sells—to what is commonly called the early-adopter or pioneer-buyer market—were over. And some of those customers were now coming in with complaints or complicated needs. Potential buyers hung back, fearing they were in danger of buying a system that would soon be obsolete or, worse, an orphan (that is, made by a company that disappears). "The personal computer market may be nearing a first-phase saturation," said Norbert Aubuchon, a Pennsylvania marketing consultant, based on an October 1983 study of the market.

Aubuchon's study noted that sales of any new commercial technology—cars, VCRs, computers, whatever—often take off quickly at first, because the machinery's technical challenges look like fascinating adventures to the technology pioneers. To the larger contingent of more average buyers, those challenges are ordeals, if not roadblocks. "Right now, the computer people are getting away with their shortcomings," Aubuchon said—an assessment that would crop up again when the general public rediscovered computer technology in the mid-1990s.

By now, the public was being peppered with a few more critical reconsiderations of educational computing. In a small Q & A published in *Harper's* magazine and entitled "The Computer Fallacy," Joseph Weizenbaum, the MIT computer scientist, treated the computer frenzy to a severe dressing-down. Weizenbaum was the creator of Eliza, a computer program he invented in the early 1970s that became famous for its capability to carry on a faux conversation with its user. (He named his program after Eliza Doolittle, the famous flower girl in George Bernard Shaw's *Pygmalion*, who was gradually taught upper-class manners and speech.) Weizenbaum was also the designer of the first computerized banking system and the author of *Computer Power and Human Reason: From Judgment to Calculation*, a bestselling 1976 account of his thoughts, partly sparked by his horror that people began taking Eliza seriously, as a potential new fix in the workplace and even in psychotherapy. In the *Harper's* item (a reprint of an interview with the French periodical *Le Nouvel Observateur*), Weizenbaum offered some devastating observations of the computer's effects on education, including the work of his MIT colleague Seymour Papert:

> **N.O.:** Computers are arriving everywhere—in offices, in schools, in the home. Shouldn't this delight you?
>
> **Weizenbaum:** All I can hope is that the technology I helped to develop be used well. But it isn't—far from it. . . . A new human malady has been invented. . . . Now it's computer illiteracy. The future, we are told, will belong to those familiar with the computer. What a joke this would be if only it didn't victimize so many innocent bystanders. . . . The infatuation with television, that other "educational" instrument, also comes to mind. Thanks to TV, kids didn't make as much noise as before. And from that people concluded that TV taught them good behavior.
>
> **N.O.:** But you wouldn't compare television, which renders the viewer passive, with the computer, which develops creativity?
>
> **Weizenbaum:** Why not? With television, a kid will watch a fighter pilot shoot down a plane piloted by another human being. With video games, the child "becomes" the fighter pilot. The difference? In both cases, the child inhabits an abstract world in which actions have no consequences, in which violence is truly mindless. Video games are, if anything, more harmful than TV, because they *actively* teach dissociation between what one does and the consequences of one's actions.
>
> As for the computer, I think it inhibits children's creativity. In most cases, the computer programs kids and not the other way around. . . . My colleague Seymour Papert claims he has a radically different approach: with his system, he says, the children program the computer. He made a film that was supposed to illustrate his thesis. In it one sees children working on LOGO in Senegal, Scotland, and Texas. As if by chance, they all drew exactly the same picture on their computers: a flower made out of ellipsoids strung together. Strange, isn't it?
>
> **N.O.:** Even so, don't you think that the use of computers reinforces a child's problem-solving ability?
>
> **Weizenbaum:** If that were true, then computer professionals would lead better lives than the rest of the population. We know very well that that isn't the case. There is, as far as I know, no more evidence that programming is good for the mind than Latin is, as is sometimes claimed.
>
> **N.O.:** Would you deny that the computer revolution will affect social equality?
>
> **Weizenbaum:** . . . If you want to reduce inequality, the solution is to give the poor money, not computers.
>
> **N.O.:** Do you think, then, that France is making a mistake by trying to put computers in everyone's hands?
>
> **Weizenbaum:** If that is what France is doing, then, yes, it's making a mistake. The temptation to send in computers wherever there is a problem is great. There's hunger in the Third World. So computerize. The schools are in trouble. So bring in computers. The introduction of the computer into any problem area, be it medicine, education, or whatever, usually creates the impression that grievous deficiencies are being corrected, that something is being done. But often its principal effect is to push problems even further into obscurity—to avoid confrontation with the need for fundamentally critical thinking.[37]

Before long, other seeds, planted only a year or two earlier, began showing signs of rot. That fall, just as the 1984 school year was beginning, Apple admitted that it had run into trouble fulfilling its computer-donation commitments. (Apparently, the company was beset with production backlogs.) This complicated the lives of more than a few teachers, who had planned both training sessions and classes around the promise of an Apple computer. The difficulties of evaluating the material on these computers were also becoming clear. Of the many organizations now attempting this job, one was the National Education Association, the nation's largest teachers' union. For some curious reason, the NEA decided not only to issue "certifications" of software value but also to sell them. (The NEA also charged com-

panies to evaluate their software, and hit one company with a bill for $18,000.) Not surprisingly, teachers were then concerned when the organization started approving a lot of software that EPIE, the independent evaluation house, had rejected. Eventually, after being blasted in the press for conflicts of interest, the NEA tried to establish more distance between itself and its product-evaluation firm, but the link remained, as did the taint. Before long, the union gave up altogether on evaluating software.

That November, in a fitting epitaph for a technologically foul year, the nation's colleges served up some crow for the great College Entrance Examination Board. Two years earlier, the CEEB had started Advanced Placement exams in computer programming and had chosen Pascal as the appropriate programming language for a test. Now that the policy had been in place for a year, the colleges were harvesting the first fruits of their decision. For the past two summers, teachers across the country had attended training sessions in both Pascal and its AP requirements. By the fall of 1984, an estimated 300,000 high school students had enrolled in yearlong computer science courses, many of which focused on Pascal. There were indications that the AP enticement was raising the level of programming work in some high school classes. Overall, however, the program wasn't working terribly well. Large numbers of students had failed the first AP exam, given the previous spring, and educational computing experts were saying it was unreasonable to expect most teachers to learn such a complex program. To make matters worse, many schools found that their computer systems weren't sophisticated enough to run Pascal, as had been predicted. So they had to buy new gear—or give up.

As if all this weren't discouraging enough, a number of top universities were refusing to grant credit for the AP courses, even to students who passed the new test. "I can't look at a score from the Advanced Placement course and know if the student can program or not," said Michael Clancy, a lecturer in computer science and director of introductory programming courses—which included Pascal—at the University of California at Berkeley. The problem, Clancy explained, is that students who pass the AP test have proven they can handle about 50 lines of code; his beginning courses typically required 300 to 1,000 lines of code, plus the ability to make subtle modifications. Those who created the AP course said they were considering making the exam more demanding. But that didn't solve the problem. Leonard Gould, the undergraduate officer of MIT's department of electrical engineering and computer science, pointed out that MIT didn't even use a specific language in its introductory computer science courses. And other universities used such a broad range of programs (Fortran, BASIC, Lisp, to

name a few) that it would be impossible to design an AP test that would satisfy the full gamut of university demands.

This was not quite what the CEEB had expected. Writing in a fall 1984 issue of *The Computing Teacher*, David Rime, chief reader of the test and a professor of computer science at Western Illinois University, said, "Students who make a high score on the Advanced Placement Computer Science exam . . . will be highly recruited by some colleges and universities." By the early 1990s, Pascal had been long since superseded by the next hot programming language (C+, then C++, and so on). This of course forced CEEB to change directions yet again—and left a generation of students with rather obsolete programming skills.

All this mayhem provided a potential moral for schools, particularly where technology is involved, which derives from the old biblical advice about false prophets: Beware of rushed decisions. It has also made for a strange coincidence. The first big school computing boom, which had arrived with the personal computer in the late 1970s, ended in 1984—the legendary Orwellian symbol of doom. The next gold rush, tied to the commercial birth of the Internet, would also last for roughly a half-dozen years, during the latter part of the 1990s. And that one ended at another prophetic moment: during the first months of the new millennium, when Y2K and other disasters were supposed to destroy us all. George Orwell would have delighted in watching us pass both of these trembling milestones.

A NEW DAWN, TAKE TWO

Amid the many stumbles with school technology in its early days, isolated but important victories did occur. With the proliferation of word-processing software, a number of teachers found that students were getting engaged in writing projects that had never much interested them before. As researchers looked more deeply into the phenomenon, they found that while computers clearly boosted enthusiasm for writing, the quality didn't necessarily follow. (Students did clearly write more. But on the whole, they didn't put the work through much revision—a situation that has not much changed to this day. Instead, they generally limited themselves to perfunctory corrections—many of which are automatically performed by spell-check software—then used the word processor's seemingly limitless space to write on and on.)[38]

The one exception to this rule was special-education students. Some researchers believe it is due to the simplicity of the machine's functions; some

think it's because of the computer's infinite patience, which lets students calmly attempt the same task over and over and over; and some think that the computer's assortment of stimuli, visual and auditory, can suddenly reach a student who has long since shut down to the idea of trying. Whatever the reason—and whatever the individual nature of the problem—students with learning disabilities have, on the whole, made strides on computers much more consistently than has the general school population.*

Hanging around these accomplishments, unfortunately, were a few old ghosts. One popped up in California in June 1989, concerning the grant program started by Governor Jerry Brown that had furnished schools with more than $50 million of computers and electronic learning aids. Backers of the program now wanted to continue the grants for another three years, starting with $14 million in 1990. None of this sat too well with Brown's successor, Republican George Deukmejian. During the program's four years of operation, it had produced no evidence of having any effect on learning. And, according to a report from the state's legislative analyst, black, Hispanic, and rural students had been slighted during the grant distributions. To make matters worse, there was a widespread sense that the donations had turned into a boondoggle. "The spending has been extremely haphazard," said Ken Hargis, a spokesman for one of the legislators who was championing a bill to keep the program alive. Many in state government viewed the concept, he said, as "a pork-barrel bill to provide VCRs for vice-principals' offices."[39] The criticism stalled the technology initiatives for a while, but it didn't kill them. Within a few years, the legislature was approving new programs that would spend far more on school technology than Jerry Brown ever did.

*There is a small but consistent assortment of research literature on this topic. Examples include a 1989 experiment with laptop computers, which drew a 10,000-word essay out of a special-education student in Seattle who had previously had trouble composing a single sentence. "Print is an exclusionary medium," David Rose, a neuropsychologist who heads the Center for Applied Special Technology in Peabody, Massachusetts, explained some years later. "Print just can't work for some kids. They can't hold a book, or don't have vision, or they can't decode printed material." The modern computer, he found, could combine text, sound, pictures, and animation, increasing chances that these children could find some "access route" to literacy. Other specialists, from Rutgers University and the University of California at San Francisco, have used computers to draw out sounds, like an old record playing too slowly, so that children with language problems can hear the components of consonants and vowels. Laura Meyers, a research linguist at UCLA, has found that with the proper sequence of text and computer-generated speech, children with disabilities eventually could learn to work freely, without being dependent on machines of any sort. See "Expanding the Literary Toolbox," by David Rose and Anne Meyer, Scholastic Research Paper, Vol. 11, 1996; "Your Child's Brain," by Sharon Begley, *Newsweek*, February 19, 1996.

California's chaotic spending spree may have been eye-opening, but it wasn't unusual. A year earlier, in 1988, it became clear that most schools weren't giving much thought to how to tie their new technology in to the daily business of teaching. This conclusion was offered in a report compiled by an unusually heavyweight team: the Control Data Corporation and the National School Boards Association's Institute for the Transfer of Technology to Education. "We asked for technology plans. We tended to get computer documents," said James Mecklenburger, director of the NSBA Institute.[40]

Anyone who has followed the news on technology in the years since the NSBA report has seen its findings repeated throughout the 1990s. The conclusion would seem to be that school officials are incompetent spendthrifts. The real explanation is that like most of us, they're just trying to do their best. Faced with pressure from all sides to computerize, and staffs and budgets stretched thin to begin with, they don't have a lot of options. Their standard solution? Buy first and plan later—if they have the time.

When the education community entered the 1990s, it was greeted with a new, improved technological opportunity. For many teachers and administrators, videodisks were the answer they'd long been waiting for. And Texas, which loves competing with California for front-runner status, jumped on this innovation quickly.

In January 1990, Optical Data Corporation, a New Jersey–based firm, pitched the Texas Textbook Committee with a bold idea. It wanted the state to consider using its videodisk series *Windows on Science* as an alternative to textbooks for grades one through six. When Optical Data made this proposal, videodisks had already failed in the home market, partly because they couldn't take recordings and therefore got trounced by VCRs. But the industry thought the disks' huge stores of information made them ideal for schools. (Each disk could hold text, audio files, and either an hour's worth of film or 54,000 photos, along with a system for searching the material.) Equally important, the disks were on the forefront of technology's next new wave: multimedia. And virtually everyone thought multimedia would be hot. "Expansion, rapid expansion, is the best way to characterize the videodisk industry today," wrote Richard Pollack, president of Emerging Technology Consultants, in an introduction to a 1990 compendium of 600 videodisks from 94 different companies.

And schools were their new, very willing target market. In California, the Department of Education proposed making videodisks an integral part

of seventh-grade science instruction and was working on some slick productions with the National Geographic Society and Lucasfilm Ltd., the production studio of *Star Wars* fame. In the South, the Florida Institute of Technology was developing a science videodisk with $169,000 in state and university grant money. In Ohio, the legislature dedicated $1 million to set up interactive videodisk learning centers in each of the state's vocational school districts.

Despite the size of these funds, they didn't cover much ground. A single computerized videodisk player—which used the old analog technology rather than a digital system—ran about $1,100. And a full package for a school curriculum cost considerably more. (A fifteen-unit physical science curriculum, for example, had recently sold to the Texas School Boards Association for roughly $17,000.) Even the individual disks were expensive—as much as $90 apiece, ten times the price of their counterparts for the home market. But educators weren't looking at costs. "We're going to see stations where kids are using disks themselves as resources, like encyclopedias. And that is when we're really going to see the power," said Geoff Fletcher, director of educational technology in the Texas Education Agency. George Peterson, the director of educational media for the National Geographic Society, agreed. Videodisks, he said, "have the potential to be the presentation tool of the '90s."[41]

Eleven months later, in November 1990, the Texas Board of Education adopted Optical Data's *Windows on Science* for its elementary-grade science curriculum, along with two science textbooks. The decision was widely cheered, even by traditional publishing houses. The videodisk industry estimated that the decision could lead to the purchase of 10,000 videodisk players in Texas alone. William Clark, Optical Data's president, was so delighted that he indulged in technology's time-honored tradition—a bit of prognostication. Basking in a surfeit of glowing national news media coverage, Clark said Texas's move was likely to have a "lasting national impact."[42]

A few years later, the videodisk industry tanked. Texas stuck with its investment as long as it could, spending some $16.2 million on videodisk technology over the course of ten years. But it wasn't long before no one was creating much new material for what was supposed to be "the presentation tool of the '90s." Of course, Texas has never let itself be hobbled by the lessons of the past, as evidenced by its lead role over the decades in boom-and-bust economic cycles. So too with the state's approach to schooling. As but one example, in 2001, the Texas Education Agency set off in a whole new direction with a handful of educational publishing firms. For an annual cost that started at approximately $1.7 million, the publishers started

replacing the old videodisk machines with CD-ROMs—just in time to get in on the tail end of that round of high technology.

PUTTING APPLE'S MONEY WHERE ITS MOUTH IS

Of all the various initiatives to put computers in schools, none was as focused on changing the art of teaching as a special project initiated in 1985 by Apple Computer. Called Apple Classrooms of Tomorrow (ACOT), it was coordinated with experts at twenty different universities and research institutions. The project wrapped up ten years later, in 1995, at which time it was perhaps the most ambitious effort to date, and the most intensively studied, to teach core academic subjects using computer technology.

After picking a handful of schools that represented a national demographic cross section, Apple set out, as one of its evaluation teams put it, to "install and operate computer-saturated classrooms as living laboratories in every grade [K–12]." ACOT planned to accomplish this by weaving "state-of-the-art technologies into the instructional fabric of schooling." Each student and teacher started out with two computers—one at school and one at home. The ACOT home-computer program eventually proved unmanageable, as did previous home-computer initiatives, and was mostly dropped. But the classroom array remained: There were printers, scanners, laser-disc and videotape players, modems, CD-ROM drives, and abundant choices in software. Whenever new technologies became available, new machines appeared in the classroom. Throughout the project, Apple provided training to every teacher and put a staff member at each site for both technical and instructional help. Over the course of a decade, ACOT encompassed thirteen different schools and cost Apple $25 million.

Once all the evaluations were compiled, in 1997, the feedback was mixed but ultimately positive. Getting to that point, however, was not easy. In the beginning, ACOT managers had taken a very relaxed approach, merely supplying the teachers and students with gear and sitting back to see what would happen. The result was something of a mess. No real advances in learning or teaching occurred. In fact, the time and trouble the new technology required were causing some of the more innovative teachers to regress. (These teachers were already doing what education experts often recommend—divide classes into distinct groups according to students' individual needs, then create and supervise different activities for each group. Now, to compensate for the time they had to devote to mastering the technology—and teaching it—they had resorted to the standard method of

teaching to the whole class.) In time, however, as teachers grew accustomed to the machinery—and as Apple staff members offered more active assistance—progress seemed to blossom.

The view from Apple of what had been achieved, and from most (but not all) ACOT teachers, was well summarized one day early in 1996. The *San Jose Mercury News*, published in Apple's Silicon Valley home, had just run a series pointing out that high-tech schools in the state were actually faring worse on test scores than low-tech schools.[43] Several weeks later, the *Mercury* published an opinion-page response from Terry Crane, an Apple senior vice-president. "Instead of isolating students," Crane insisted, "technology actually encouraged them to collaborate more than in traditional classrooms. Students also learned to explore and represent information dynamically and creatively, communicate effectively about complex processes, become independent learners and self-starters and become more socially aware and confident."[44]

There were two facts that Crane did not mention: After a decade of effort, Apple had found scant empirical evidence of greater student achievement. (While test scores for the ACOT schools did not decline, as those in the *Mercury*'s sample did, they did not rise, either.) Worse, one follow-up study by four well-credentialed professors from Memphis State University found that after the ACOT students returned to their normal classes, what improvements they had shown disappeared. "Overall, the ACOT students were indistinguishable from their peers on the basis of school accomplishments," the evaluators said. After returning to a "traditional environment," they were once again "educationally at-risk."[45]

To many critics, that would constitute a final verdict. But in today's education world, it's just the beginning of the inquiry. Consider the test-score issue. Educators on both sides of the computer debate acknowledge that tests of student achievement remain so crude that the picture of learning they offer is extremely limited. They're especially weak in measuring intangibles such as enthusiasm and self-motivation, the hallmarks of ACOT's accomplishments. But those victories only obscure the deeper story, which concerns two questions.

The first regards the quality of Apple's evaluations. In the years since the ACOT reports were published, independent researchers have had trouble judging the meaning of what Apple found. Not only is there an absence of quantitative measures (on standardized tests or on other admittedly limited scales), there is also a paucity of objective assessments in general. Throughout the many journal articles, company reports, and, finally, a 210-page book on the ACOT experience, almost all of the evaluations came from paid

Apple consultants, who were reporting little more than the anecdotal evidence that teachers told them.[46] These teachers volunteered for ACOT, and did so at least partly because they had faith in technology.

The second question regards the quality of the ACOT schoolwork, by whatever assessment one uses. This issue will be more fully dealt with later, during visits to one of the ACOT schools in Silicon Valley. For now, this much can be said: While it's clear that the majority of ACOT participants (teachers and students) were charged up by the project, Apple's computers bear less responsibility for that change than Terry Crane suggested. As Jane David, a consultant Apple hired to study its classroom initiative, once told me, all this "had less to do with the computer and more to do with the teaching. If you took the computers out, there would still be good teaching there." ACOT's leaders admit the same thing, although not quite so boldly. Keith Yocam, a longtime ACOT leader, noticed that as time wore on, whenever he gave presentations on educational technology, he'd end up saying very little about computers and talking almost exclusively about teaching.

A NEW DAWN, TAKE THREE

By the latter part of the 1980s, as the novelty of the computerized classroom fell to the side of the media's attention, schools reached a saturation point—at least on their first-round goal of putting at least one computer in each school. There were now approximately 1.5 million computers in the public schools and as many as 400,000 more in private institutions. This meant an average of one computer for every thirty students and at least one machine in 95 percent of the nation's schools.[47]

To one relatively obscure bureaucrat in Washington, D.C., Linda Roberts, this wasn't nearly enough. Roberts at the time was a project director in the Office of Technology Assessment (OTA), a respected but now defunct operation that long served as Congress's private scientific think tank. In 1986, when Congress commissioned OTA to examine technology's status in the schools, Roberts got the lead role. She responded two years later with a 246-page document that made no pretense of being neutral: Entitled "Power On! New Tools for Teaching and Learning," the report said students were currently getting only "spotty access" to computer technology, and it challenged the federal government to take "principal responsibility" for fixing the problem. Its job, as Roberts saw it: "make the computer a central element of instruction."

OTA called on Congress to require agencies to focus their research efforts

on educational technology and suggested putting an additional 12 million computers in the nation's public schools. By the OTA's count, this would give one computer to every three students. At the very least, OTA said, schools should have one computer for every six students, which would cost a 600-school district like Chicago $130 million. To OTA, those sums were peanuts. If the schools were going to have sufficient access to computer technology, the OTA said, the government, over the next six years, would have to spend $25 billion—an amount equivalent to a third of the Department of Education's entire budget for instructional materials.

Despite the weight of this request, OTA thought the timing was perfect. Its report asserted that students in poor schools had "significantly less" access to computers than their counterparts in wealthy schools and that limited English speakers had the least access of all. But now, suddenly, the nation had the resources to solve this problem. "Research in cognitive science," the report stated, "allied with developments in computer-based technology in the schools and teachers willing to experiment, create today's 'window of opportunity' for improving education."

Anyone who hears the term *window of opportunity* should always pause for a moment of reconsideration. The image suggests an important, sudden opening—some marvelous chance that won't last long. The opportunity may well be real, or at least some part of it may be, but its imminent disappearance is often a fiction. It is the pitchman's rhetorical device, and it plays gorgeously to the American penchant for urgency and novelty. This was certainly the case here. In fact, anyone who had been watching would have realized that OTA had been crying wolf about the need for one version or another of school technology for a long time. In 1983, the agency urged teachers to show students how to program computers using BASIC. In 1984, LOGO was the answer. In 1986, the agency pinned its hopes on computerized programs of individual instruction. Now, in 1988, OTA was pushing computer proliferation, coupled with word-processing programs. (In the ensuing years, OTA would continue this routine, promoting curricular specifics like history databases in 1990, hypertext multimedia programming in 1992, and the miracles of the Internet in 1994.[48] Mercifully Congress finally put the agency to death in 1995.)

At first, Linda Roberts's 1988 report met with great enthusiasm in the education world. Then, shortly after its release, the nation was treated to a change in presidential administrations and a White House (headed by George H. W. Bush) that had little taste for futuristic approaches to academics. For the next few years, Roberts's labor of love sat on the shelf like so many other earnest Washington reports. Then, in the mid-1990s, the nation discovered the Internet. Before long, such cultural luminaries as John Perry Barlow, a former songwriter for the Grateful Dead, were calling the Internet "the most transforming event since the capture of fire."[49] For a while, it seemed as if the country had fallen into a permanent state of technological obsession. In a poll taken in early 1996, teachers ranked computer skills and media technology as more "essential" than the study of European history, biology, chemistry, and physics; than dealing with social problems such as drugs and family breakdown; than learning practical job skills; and than reading modern American writers such as Steinbeck and Hemingway or classic authors such as Plato and Shakespeare.[50]

That summer, a California task force responded in kind. It urged the state to spend $11 billion on computers in its schools, which had struggled for years under funding cuts that had driven academic achievement down to levels that were among the lowest in the nation. The task force, composed of forty-six teachers, parents, technology experts, and business executives, concluded: "More than any other single measure, computers and network technologies, properly implemented, offer the greatest potential to right what's wrong with our public schools." Other options mentioned in the group's report—reducing class size, improving teachers' salaries and facilities, increasing hours of instruction—were considered less important than putting kids in front of computers.[51]

By this time, a number of other states, as well as some private organizations, seemed to agree. In 1990, Kentucky legislators had passed an ambitious education-reform law that committed their state to spend $230 million on technology over the next five years. (Two years later, the state was still struggling with the program, the cost of which had grown to $400 million.) In 1991, the Annenberg Foundation and the Corporation for Public Broadcasting announced a $10 million grant program for math and science instruction with technology. The same year, Service Marketing Group, of Garden City, New York, reported having given $100 million worth of computers to schools across the nation. The donations were financed by an ingenious sequence of consumer purchases, which started at the local grocery store, and that ultimately proved to be quite lucrative for the marketing firm that organized the campaign.* Two years later, in 1993, Robert-

*The program, widely known in the early 1990s as the Apples for Schools program, worked this way: First, customers collected their cash-register receipts from participating grocery stores and brought them to school. In the meantime, the grocers bought computers to have on hand from the program's organizers, Service Marketing Group. Once the school had a sufficient pile of receipts, school officials would return to the grocer, which then gave the school a computer. In the end, however, there wasn't much of a free lunch. It took $160,000 in receipts, for

and in the nation's computer stores. Aside from some word-processing programs and other simple tools, for a huge swath of the American public, the power of the computer was unidirectional: what it delivered from the Net.

In early 1996, an eye-opening perspective on the Internet age appeared in the pages of *Wired* magazine. It was a lengthy Q & A conversation with Steve Jobs, Apple's restless, provocative, charismatic co-founder. The interview took place toward the end of Jobs's forced hiatus from Apple, while he was head of NeXT Computer, Inc., and was trying to position NeXT to take advantage of corporate activity on the Internet. That new focus left Jobs free to look at school computing without considering his self-interest in its development—a fact that made for a bold moment of candor. "This stuff doesn't change the world," Jobs said at one point. "It really doesn't. . . . The Web is going to be very important. Is it going to be a life-changing event for millions of people? No. . . . It's certainly not going to be like the first time somebody saw a television [or] as profound as when someone in Nebraska first heard a radio broadcast. . . . We live in an information economy, but I don't believe we live in an information *society*. People are thinking less than they used to. . . . We're already in information overload. No matter how much information the Web can dish out, most people get far more information than they can assimilate anyway."

Eventually, Jobs—who accurately boasted that he had "probably spearheaded giving away more computer equipment to schools than anybody else on the planet"—was asked about technology in schools. "I used to think technology could help education," he said. "But I've come to the inevitable conclusion that . . . what's wrong with education cannot be fixed with technology. No amount of technology will make a dent. . . . You're not going to solve the problems by putting all knowledge onto CD-ROMs. We can put a Web site in every school—none of this is bad. It's bad only if it lulls us into thinking we're doing something to solve the problem with education."[53]*

*It's worth noting that several years later, after Jobs had returned to Apple, he somehow managed to find religion again. An example occurred in the spring of 2001, when Jobs sealed a historic $18.5 million deal with a Virginia school district. The arrangement let the schools lease 23,000 Apple laptops, one for each of its middle and high school students, as well as their teachers, with an option to buy them after four years. In announcing the project, Jobs said, "This is mammoth—the single largest sale of portable computers in education ever. Some people have wondered if our commitment to education was as strong as it once was. I can assure you, if anything, it's stronger." See "Laptops to Transform Learning for 23,000 Virginia Students," *eSchool News*, June 2001, p. 12.

COMPUTERS AND POLITICS, TAKE THREE

In the pages of the Clinton administration's Kickstart report are profiles of a dozen select schools from across the country, most of which suffered from a history of poverty or academic failure—until computers arrived on the scene. The most interesting example of this political interpretation of history involved the Christopher Columbus Middle School, just outside New York, in Union City, New Jersey, the nation's most densely populated city.

In 1989, the Union City schools were failing on almost every front. Roughly 75 percent of the district's students were poor or did not speak English. State auditors checked 40 of 52 categories measuring a school district's educational and physical health; Union City failed miserably on many of them. (Among other things, facilities were worn down; finances were a mess; many teachers weren't certified or even properly evaluated; and test scores were abysmal.) The situation was so dire that New Jersey officials gave the city's schools an ultimatum: Improve within five years, or we take over. Union City responded with a massive improvement campaign. A $27 million bond initiative in 1990 helped refurbish aging classrooms. The district also got $9 million of extra state aid, roughly $2 million of which was dedicated to the district's purchase of 775 computers—enough, the Kickstart report claimed, to provide one computer for every eleven students. Then, in September 1993, Christopher Columbus launched a two-year trial, which gave all 135 seventh graders even greater access to computer technology. Courtesy of Bell Atlantic, the school put additional computers in their classrooms and in their homes, and did the same for all of the students' teachers. Throughout the Kickstart report, the Clinton team wove electronic rhapsodies about the network's "very high-bit rate digital subscriber lines and audio/visual server technology," and how this let students, parents, and teachers communicate, and carry out "a wide range of curriculum activities."

By 1995, the Clinton team was ready to declare victory. "Recent test scores and other data demonstrate just how successful the program has been," Kickstart concluded, noting that scores in reading, math, and writing were now more than ten points above the state average. Absenteeism was down as well, and the dropout rate, according to the report, was "almost nonexistent." To dramatize the story, President Clinton paid a visit to Christopher Columbus Middle School himself. The media responded enthusiastically, splashing TV newscasts and newspaper stories with scenes of students happily making great strides on their computers.

The academic strides were true; the problem is that they had little or nothing to do with the technology. The computers didn't actually arrive until 1994, but eighth-grade test scores had doubled and tripled by 1993. So what did turn the school around? The answer is a handful of embarrassingly well known, basic changes: smaller classes and longer class periods; new books and extra time for teachers to prepare their lessons; encouragement of exploratory reading instead of sticking to drills and textbooks; an emphasis on school projects and student collaboration; strict dress codes and behavior rules; and an after-school program for help with homework. All of these changes cost considerably less than the computers, recalls Bob Fazio, the school's principal during those years, who was later moved to another school to carry out the same low-tech approach. "Bell Atlantic has not in any way, shape or form, in my opinion, changed in a basic way what goes on here," Fazio said. And Bell Atlantic executives agreed.[54]

How did this story get so tilted? Part of the answer obviously lies in the power of political spin; the other part involves the public's unflinching gullibility and the media's role in the pattern. For illustration, consider the coverage by ABC News. ABC was one of the television networks to jump on the Christopher Columbus story, broadcasting heartwarming scenes of students' recovery through technology. Several years later, after the print media had disclosed the rest of the story, ABC returned to update its coverage with a decidedly critical report on *Nightline*. During the Q & A that followed—with Linda Roberts and Jane Healy, an educational psychologist—an aggrieved Ted Koppel put the screws to Roberts.

Koppel: Let me just ask you, Dr. Roberts . . . if you've got all that evidence [that computers boost learning], why in heaven's name was the president taken to a school that disproves it?

Roberts: You know, I was there at that school and the kids are continuing to learn and their test scores are accelerating.

Koppel: But the test scores went up. They doubled before the computers showed up.

Roberts: But they have . . .

Koppel: Why take the president there to make that particular point?

Roberts: Because you have to look at how the kids are spending their time in that school and you have to look at how the tool, the computer, is an amplifier of the goals that this school has. I think . . .

Healy: It's a very expensive one, I might add.

Roberts: Well, it's a very important tool, and you should talk . . .

Healy: Well, teachers would be the best amplifiers.

Roberts: That's right, but teachers and parents and kids in this school really believe that computers have added, have added to the quality of education for them.[55]

THE DIGITAL DIVIDE, TAKE THREE

As the 1990s drew to a close, public discussion of the digital divide had become so incessant that it was almost a cliché. Almost every school district, and any organization involved in putting computers into these districts, had some piece of its program dedicated, in one of former president Clinton's favorite phrases, to "bridging" this fabled divide. And passionate crusaders were not far behind. "If we're going to resolve this achievement gap between students of color and white students, and high-poverty and low-poverty students, we have to give them access to the same educational opportunities," Lugene Finley, Jr., the chief technology officer for the Illinois state school board, said in 2001. "And technology does that. It can be an equalizer when you provide the tools."

Things weren't quite so simple. By this point, the great divide actually had become something of a fiction. An expansive review of technological offerings in schools across the country in 2001 by *Education Week* found that computer gear was now so common that student-to-computer ratios were much the same in poor schools as they were in wealthy schools (roughly five to one). The same was true of Internet access, which existed in almost every school in the country, whether rich or poor. Even when fancy high-speed connections became the criterion, the divide was virtually nonexistent. (About 68 percent of schools that primarily draw whites or the wealthy enjoyed high-end Internet services; among schools that mostly serve the poor or minorities, the percentage was about 63 percent.) Beyond school walls, a comfortable 95 percent of the nation's public libraries now offered Internet access. These facts led Michael Powell, the chairman of the Federal Communications Commission, to describe the digital divide as being more of a "Mercedes divide." In other words, *Education Week* said, "everyone would like to have one, but you can still get where you need to go with a less expensive machine."

The divide somewhat reopened, however, when it came to finer questions. One was the matter of teacher savvy. Principals and other administrators in wealthy, white schools classified only 25 percent of their teachers as technology "beginners," whereas more than a third got this tag in schools

heavily attended by the poor and minorities. Not surprisingly, the kind of computer activities that students pursued in advantaged schools as compared with disadvantaged institutions fell along similar lines. One study done in Hawaii found that private school students were often engaged in sophisticated simulations or were off on field trips, tying technology to complicated, real-world inquiries. Students at poor schools, meanwhile, tended to get stuck trying to master the technology itself (with word processing or Web-page designs); when they did get around to doing projects or papers with computers, the work tended to lack academic rigor. No one could say, however, that these concerns weren't getting attention. One group (the Benton Foundation) listed no fewer than 20,000 different services devoted to eliminating technology's inequities; the services included free Internet access and technology training, computer gear in youth-service organizations, and hordes of other options. And the corporate world was largely to thank for these opportunities. The library buildup, for instance, was partly created by $2 billion in equipment and software donated by the Bill and Melinda Gates Foundation. Late in 2000, Gates followed up with $100 million from Microsoft to help put technology centers in every Boys & Girls Club in the United States.

All of this activity led some education activists to get sick of the whole digital divide discussion. "Clearly, the vibrant PC market is doing more than an adequate job of providing computing technologies to all Americans," wrote Adam Thierer, an economist with the Heritage Foundation, a Washington, D.C., think tank. "Free computers and inexpensive technologies are filling any digital divide that remains." Some thought the issue was getting too much attention at a time when schools were struggling with teacher shortages, inadequate salaries for those teachers they had, overcrowded classes, and buildings in need of basic repairs or wholesale refurbishment. Others meanwhile resigned themselves to the issue, seeing it as a cultural constant, a sociological offspring of technology's upgrade parade. Andy Carvin, the Benton Foundation's specialist on questions of technological equity, told *Education Week* that the problem may never be solved. "At the point where you get low-cost Internet access, there's a new technology that comes along that recreates the divide, such as broadband or wireless technology."[56] Indeed, the wireless systems were already on the march—a cruel joke on the enthusiasts who had just spent billions wiring all the schools.

Toward the end of President Clinton's second administration, he gave the digital divide one last high-profile stab. When people make repeated efforts

to solve a problem, they usually learn from their previous mistakes, which helps them move forward. The Clinton team seemed to go in reverse. In exchange for a remarkably transparent giveaway to the computer industry, the Clinton team got what turned out to be a dumbed-down version of the 1983 EPIE plan, which tried, in vain, to put computers into the homes of the poor in San Francisco.[57]

In his final State of the Union address, on January 27, 2000, President Clinton offered the nation a cousin for Kickstart, his big technology initiative in underprivileged schools. Dubbed Clickstart, this venture was designed to arm whole families of the poor across the country with computers and Internet access. January 2000, of course, was mere weeks before the Internet high of the 1990s began to wear off. So there was little reason at this point for the government to pick its digital shots with great care. It was the end of the party, a hazy, intoxicated time when no one was paying much attention to loud belches of largesse.

The plan sounded great: For the next three years, the government would hand out monthly vouchers, at $10 apiece, to some selection of the nation's poor families. Each family would then chip in $5 a month of their own money, and—*voilà:* They'd have a full-service computer with Internet access. The initial sum was paltry—$50 million, a mere asterisk in the budget of the Commerce Department. Not surprisingly, this would cover only a small percentage of the nation's poor. But the plan was supposed to grow substantially, eventually reaching all 9 million households that received food stamps.

The catch was in where the money went and what it bought: During his State of the Union speech, Clinton said, "I thank the high-tech companies that are already doing so much." For whom? All of the money here, from the families and the government, went solely to the companies that were "donating" the computers. Coincidentally, after three years, those contributions would total $540 per household—precisely what these low-end computers were going to be worth on the open market. Garrett Gruener, a Silicon Valley venture capitalist and the founder of Ask Jeeves (a dot-com that soon had one of the Internet age's most dramatic moments of rise and fall), admitted that one company was planning to build a computer specifically for this market and would happily fulfill every order.

No wonder. During the three to five years envisioned for this initiative, the price of computers was expected to drop precipitously, which meant that any firm that got in on this deal would do quite nicely. Gruener hoped that as prices dropped in the ensuing years, the program sponsors would compensate—by giving away more computers or by dropping the families' con-

tribution requirements. But there was nothing in the Clickstart business plan spelling that out. In fact, the Clickstart initiative was never supposed to be philanthropic. "I don't have any problem with these companies making money," said Gruener, who incidentally sat on the board of Be, Inc., the company slated to be a supplier of the computers. But once again, the technology leaders managed to sell their plan on a grander plane. Eric Schmidt, a software development executive at Novell and another Clickstart organizer, said, "Our feeling is that while this is good for us, it's also good for the world." His comment recalled the famous line from Charles E. Wilson, the former president of General Motors: "For years, I thought that what was good for the country was good for General Motors, and vice versa."[58]

Citizens today would, obviously, debate the proposition that Charlie Wilson gave the country a good deal whenever he helped General Motors.* As regards Clickstart, while the plan might help computer suppliers, there was precious little indication it would help many others. As a reflection of how intoxicating the prospect of just having a computer was in 2000, the Clickstart plan included no provisions for training, maintenance, or any other sort of support from government overseers or from the computer suppliers. It left this job entirely to community groups—without giving them any of the resources needed to handle the job.

Those who organized Clickstart had plenty of warning that their plan might not work. Not only were there the lessons from earlier failed efforts in this realm, but there was also advice aplenty from community group leaders, who knew what this work entailed. Daniel Ben-Horin, president of CompuMentor, one of the nation's largest providers of technology assistance to non-profit organizations and schools, pointed out that the kind of assistance a poor household needs is not the sort the computer industry is used to—what's typically referred to as technical support. "Support doesn't mean waiting for people to call with questions," Ben-Horin pointed out. "Often, they'll never call. They accept the hype about computers being plug-and-play machines, and they feel stupid for having problems." In a large

*While the arrival of the automobile has brought its share of rewards, it is worth noting that among the various titans of the car industry, General Motors holds what may be the industry's golden distinction in doing the most to serve its own technological interests at civic expense. In the 1920s, GM was the company that persuaded cities throughout the country to make room for cars by tearing up their old trolley tracks, which at that time were the nation's sole system of inner-city mass transit and which produced considerably less pollution than automobiles did. See "The StreetCar Conspiracy," by Bradford Snell, a former counsel to the U.S. Senate. The article originally appeared in *The New Electric Railway Journal*, Autumn 1995, and is currently available at www.lovearth.net/gmdeliberatelydestroyed.htm.

household with one phone line, he explained, a computer and a Net connection "can be a source of conflict and frustration rather than empowerment."

In the end, no one remained terribly committed to the Clickstart plan. In the spring of 2000, one company, People PC, launched a tiny debut of the initiative, giving away about fifty computers at a community center in Oakland, California. As Ben-Horin and others had anticipated, the center soon found itself with a few uncovered support expenses. But when Congress failed to fund the initiative, the computer companies found themselves with responsibility for a sustained philanthropic campaign. No one was up for that, so Clickstart quickly died.

A few years later—as the economy faltered and as yet another presidential administration took hold—school policy toward technology shifted once again. But the changes were slight. As might have been expected, the collapse of the Internet boom shook out a number of commercial technology suppliers, dropping private investment in "eLearning" from $2.7 billion at its peak in 2000 to $400 million at the end of the year.[59] This of course left more than a few schools in the lurch for technical support and equipment upgrades. As for federal policy, Rod Paige, the new education secretary, didn't take on many new technology initiatives, as befitted his boss's preference for local control of school decisions. There were, however, a few notable exceptions. One of those was to insist that a larger percentage of federal funding be spent on training teachers in technology. Coupled with that directive, the administration contributed $10 million to create a brand-new program for teacher training at Western Governors University, the college started in the 1990s by a collection of governors in the West, at which courses are taken entirely online. Although enthusiasm for the initiative was generally high, a few errant observers wondered about the worth of teaching credentials gained through a modern-day version of correspondence courses. As we will see, this medium has never had a great track record, and it might be particularly inappropriate for a profession that is about personal interaction, as teaching is.[60] When I asked John Bailey, President Bush's director of educational technology, about those questions, he acknowledged the online medium's limitations. The goal, he said, was simply to offer an alternative for aspiring teachers who cannot get to, or who cannot afford, a campus education. "It's a niche," he said.

During a lengthy conversation with Bailey, it was clear that aside from the online university, the Bush administration was trying to take a small step back from the buying frenzy that characterized school technology policy in the Clinton years. "There's been way too much hype," Bailey said. Schools "need to tell us what they're going to use [computers] for, more than

just access to the Net. What is that doing for the students? You need to proceed cautiously with all this stuff." To help schools do that, the Department of Education launched yet another round of study (this one was expected to consume five years and $15 million) to see what kinds of computer applications really do boost achievement.

Despite Bailey's cautionary tone, there was not much indication that the school technology world was slowing down. Large, bureaucratic institutions like those that oversee education are similar to oceangoing tankers: Once they set a course, they don't change directions as quickly as the commercial winds do. In the 2002 budget, the Bush administration dedicated $850 million for school technology—about the same as what schools received in the final year of the Clinton administration and considerably more than the annual average for the previous decade. This turned the schools into one of the technology industry's most stable markets in the midst of a recessionary economy. The software industry association happily reported, therefore, that in 2002 it expected to see school spending on technology "continuing the general upward trend." As one software research executive put it, "education and educational technology expenditures are not going to go away overnight."[61]

At the close of *Teachers and Machines*, his 1986 history of technology in schools, Professor Larry Cuban draws an analogy between the schools' approach to technology and the widespread release of the mentally ill from state institutions during the 1950s and 1960s. The latter initiative occurred because of another promising technology—tranquilizers and other new drugs, which suddenly gave hospitals hope that they could treat the mentally ill quickly and cheaply, without having to care for them day in and day out. Hordes of tranquilized troubled souls soon began appearing on the street. Cuban quotes a number of health specialists who grew to regret their decision, realizing that they should have put the "de-institutionalization" program through tougher questions at the beginning. Others admitted they had "oversold" the idea, partly because the political community wanted to save money.

"The push for classroom computers is certainly not as dramatic or as wrenching as what happened to hospital patients," Cuban acknowledged. Yet he saw enough of a link to draw a lesson. "In dealing with lives, young or old," he wrote, "patience and public reflection on both the anticipated and unanticipated consequences of policies are in order, rather than the headlong plunge into change followed by a heartfelt apology years later."

In 1941, just a few years after the publication of Arthur Wise's warning about the schools' rush toward "educative devices" such as motion pictures, the great essayist E. B. White offered some perspective. White wasn't thinking about technology, or even about education. He was in Florida, enjoying a brief respite on the beach, and this had set him to meditating on modern society's peculiar restlessness. "The sea answers all questions, and always in the same way," White wrote, "for when you read in the papers the interminable discussions and the bickering and the prognostications and the turmoil, the disagreements and the fateful decisions and agreements and the plans and the programs and the threats and the counter threats, then you close your eyes and the sea dispatches one more big roller in the unbroken line since the beginning of the world and it combs and breaks and returns foaming and saying: 'So soon?' "[62]

ews students practice playing their recorders one morning, I understood what Thomas's grandmother meant. When the students hit a difficult section, some gave up and a few stomped out of the room. Most soon returned. "I screwed up too," the teacher told them, "but I don't let that stop me. Just play through. Persevere. That's what this is about." They tried again and then again, did better, and smiled.

Conclusion

After decades of disappointing experience with education's quick fixes, from new math to new technology to new standardized tests, it should now be easy to take a long, sober look back to see what counts in the classroom—and what doesn't. One state that affords one of the clearest hindsight views is, not surprisingly, California—arguably the nation's most adventurous state, and unarguably the birthplace of the personal computer. Curiously, one of the most comprehensive looks at what computers have done, or not done, for California's schools was produced some time ago, in 1996, by the *San Jose Mercury News*, whose Silicon Valley headquarters puts the paper at ground zero of technology trends. That winter, reporters examined test scores at a range of schools up and down the state—227 in all. About 10 percent were "model technology" institutions—schools that won big state grants for intensive technology programs. "In general," the paper said, "the analysis showed no strong link between the presence of technology—or the use of technology in teaching—and superior achievement." The newspaper's study, which went to great pains to control for outside influences such as family income, parents' education, and language background, found two exceptions to the flat pattern.

One was that the schools that did best, when compared with their peers, were in fact the model technology schools. But this wasn't true of the group as a whole, only those that serve unusually poor students. (Educators evaluating the study hypothesized that poor students' success with technology could come from "the motivation of having nice tools," the sense of freedom that technology unleashed, and the general jolt of novelty.) The other exception involved non-model middle schools with big technology budgets. This group actually scored worse than middle schools with smaller technology budgets. Computer promoters tend to jump on such findings, saying they only prove that merely having technology will do nothing unless it's intelli-

gently woven into the curriculum. Knowing this, the *Mercury* controlled for this argument, too. Schools that had gone to the trouble of making computers part of the daily work still underperformed when compared to other schools.[1]

Among the state's thousands of schools, one might have served as an exceptionally radiant object lesson of the *Mercury*'s findings. In fact, it could have done so almost a decade before the paper embarked on its study. In the late 1980s, the Belridge Elementary School in McKittrick, a small, cookie-cutter subdivision near the southern trough of California's agricultural heartland, took a huge step into the future. Flush with cash from the local oil field, Belridge invested $4.3 million in computer technology over a four-year period for a student body of no more than sixty children. The investment filled the school with futuristic gear of all kinds—laser-disk players, television production studios, shiny new Apple computers, piles of software, even e-mail accounts at a time when most schools hadn't even heard of the Internet. Teachers modernized their instruction methods too. They got students collaborating on projects to challenge them to think. They had students produce their own television news shows and simulate a computer-based presidential election. "We bought the very best money could buy," recalls Steve Wentland, a teacher at the time and later the school's combination principal and district superintendent. "I have not heard of one thing, even today, that another school is doing that we didn't do." Visitors soon poured in from all over the country.

Several years after everything appeared to be in place, it all came crashing down. When the annual district test scores were reported, they showed that students' performance had actually declined during the computerization years, falling slightly below the national average. Outraged parents picketed the school and elected a new school board. The new board promptly hired another principal, who cut back the computer program by selling off many machines and shoving the rest in a corner. "It was a dismal, miserable failure," Wentland recalls. "And they did everything right."

So what went wrong? "Technology will not fix what's wrong with schools," Wentland now says, sounding very much like his supplier, Steve Jobs, during that brief period of candor when Jobs had no affiliation with Apple. Wentland is a man unusually confident in his own judgment—so much so, in fact, that he's occasionally gotten into some local trouble for aggressively pursuing his own agenda.* But he knows technology and is well

*At various points, Wentland has been accused of muscling his underlings, trying to secretly purchase religious textbooks, making unauthorized use of school funds, and swinging a sweetheart deal that got the school board to pay for his doctoral education. See a series of front-page articles by Steven Mayer in *The Bakersfield Californian:* "School District Got Warning on Textbooks," September 1, 1999; "Belridge OKs Cash for Superintendent's Tuition," September 10, 2000; and "Report Thrashes Wentland," May 11, 2001.

traveled by now in the education-conference world. Perhaps most important to the residents of Belridge, ever since the school abandoned its high-end approach to computing, test scores and other measures of academic performance have risen substantially.[2] The school accomplished this by doing little more than return to the basics, a move helped considerably by yet another simple solution: small classes.

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It will be tempting to read these stories, and the many that preceded them, as a dismissal of classroom technology, a biased selection forming another jeremiad in the thin but long line of Luddite literature that sees nothing but evil in machinery. To do so would be off the mark—and unfair to our schools. If any generalization can be made, it would be that technology is used too intensely in the younger grades and not intensely enough—in the proper areas—in the upper grades. Like it or not, computer technology is also here to stay in some fashion. The challenge for schools, therefore, is to be smarter about how and when they use technology, and how they separate its wheat from its chaff.

Most educators know this and believe they are doing so. But the computer industry has managed to survive on such a plethora of hype, habituating all of us to accept such a string of unfulfilled promises that we've long since lost the ability to see what new inventions really can and cannot do. Schools as a result have become industry's research-and-development labs as well as its dumping ground—while asking very little in return. Considering the sacred public trust that we bestow upon our schools, they have every right to expect more from this machinery, or any other innovation, before they let it in the door.

Before tying up this indictment, let's be clear about the good things that computers can do for schools.

Obviously, many programs—such as computerized vocabulary exercises and foreign language drills; graphing software for geometry; data managers and scientific simulations; and basic word-processing software—are already capable of being useful supplements. The same is true of diagnostic software, which, in select cases, is capable of offering unusual portraits of how

different students are handling their classroom challenges. These devices now join the long sequence of tools that have helped teachers throughout time—the tablet, the pencil, the pen, the ruler, the slide rule, the calculator, the overhead projector. All of these can be effective when they are used only as needed, when students are at the right age for them, and when they are kept in their place. This won't be easy. As Steve Grineski, the interim dean of the College of Education and Human Services at Moorhead State University, in Minnesota, put it, "It's hard to find a balance when you spend half a million dollars and then you say, 'Well, you're only going to use this minimally.'" But the challenge will not go away. The priority in each classroom is not the technological process but the human one. Those teachers who sit back and delight, as Napa's New Technology High School and scores of its followers do, in the way the computer lets the students "take over" their own learning are merely fooling themselves. Worse, they're fooling their students. As we've seen, the students aren't taking over in most of these classrooms. The computer is.

Obviously, certain programming languages (such as BASIC, LOGO, and, today, C++, among others) open fascinating windows of opportunities for students who are inclined toward math and the sciences. But school administrators need to remember that computer programs are nothing if not transitory, and that students with an aptitude for the technological must learn its fundamentals, rather than hot programs of the moment that are likely to be passé by the time the students enter the workforce. Those fundamentals are best learned in the upper grades, through following the example of some of the schools in this book. I'm speaking in particular of those few that bother to teach students enough of the principles of digital technology that they're able, among other things, to build their own computers and computer programs. Schools must also realize that activities like this are not interesting, or even helpful, for everyone. Equally important, those who enjoy technological challenges need to be guided with a wisdom and balance that schools have for the most part forgotten. The members of this crowd—who used to be called math nerds and are now referred to as computer geeks—seem to be increasing in number. And they are typically drawn to high technology's horizons with a passion. The schools' job, therefore, is to infuse the rest of their curricula with enough power and relevance that those students who are obsessed with the technical sciences will develop varied interests and skills. As the world grows increasingly technological, and increasingly strained by social inequities and human suffering of all kinds, we are going to need a different kind of employee in the technology industries. We'll need

people, in short, who are as sensitive to the culture's humanistic needs as they are to its electronic possibilities.

And obviously, the World Wide Web—the über-program of the modern age—is a useful if not invaluable research source for all of us. But we all must realize that opening the Internet's door to youngsters also requires teachers to accept additional responsibilities. This does not just involve watching out for pornographic or violent material; that's the easy part. It also concerns watching what values and beliefs students develop about what knowledge is; how it's built; how it's used; and what it demands of them, as students and as citizens. Downloading a captivating live software applet from a NASA site, which some Web designer has loaded with a few earnest questions to satisfy somebody's grant requirements, does not a satisfactory lesson make. Nor does simply writing a paper about this material, based on some extra Internet "research."

This is not real work in today's high-speed, "global" society. It's where real work *starts*—for both students and teachers. The Internet, as we've seen, is filled with such a myriad of sites—many of which don't last long (and go on for pages and pages when they do)—that it is completely unreasonable to expect teachers to check every Internet source. A teacher's job today is therefore very different from what it used to be. Actually, it's somewhat like it was in the old days, but even more so. Ken Komoski, the longtime director of EPIE, the educational-products watchdog group, puts it this way: When a boy turns in a paper today, he asks, "How would you know if he knows *anything* until you *talk*?"

In the end, the legions of education critics who incessantly pester the schools to make dramatic changes would do well to remember one central fact: At its core, education is a people process. Yes, youngsters need tools, but most of all they need people. This is particularly the case with society's most disadvantaged children—the group supposedly suffering from this cruel "digital divide" and which educators are desperate to supply with gizmos. Survey after survey indicates that schools that serve the poor are doing fine as far as supplies of computer gear are concerned. They're not doing so well when it comes to teaching. From California to Harlem, from the hollows of poverty in West Virginia to the polished suburban corners of Montgomery County, Maryland, the presence of state-of-the-art technology is in general making matters worse. During the final years of the twentieth century and the opening years of the twenty-first—a time when computer technology has reached record levels in the schools—student performance on national and international achievement tests in subjects such as math,

science, and history has either declined or remained flat.[3] School policy makers could easily attend to these troubles by other means. If they did so, those who suffer from education's divides—intellectual or digital—might have a much easier time closing the gaps on their own.

When confronted with criticisms of this sort, technology promoters incessantly point out that it doesn't have to be this way, that all kinds of sophisticated uses of the computer are possible, if only schools would pursue them. Those pursuits involve sufficient funding, proper teacher training, sufficient classroom control—the list goes on and on. In theory, the technovangels are right. But as we have seen, they have been making this case for years—for decades, in fact. At a certain point, everyone—teachers and taxpayers, parents and policy makers—has the right to stop and invoke the famous ad line "Where's the beef?" If computers are so great, why aren't we seeing great things by now in our schools?

THE PRIMACY OF TEACHING

During high-minded discussions about what matters in education, nearly every conversation suddenly gets wonderfully focused and simple when someone issues the following challenge: Think of a memorable moment from your old school days. What was most inspiring? Most helpful? Nearly everyone suddenly recalls that it revolved around a great teacher.

This is not news. Education insiders have understood and preached this boring truth since the beginning of formal education. Yet in some bizarre act of cultural sadomasochism, we continually pretend it isn't true. We let teachers twist in the breeze seemingly forever. For decades, we have taken people whom we hold responsible for the intellectual and moral development of our children, put them in chaotic, overcrowded institutions, robbed them of creative freedom and new opportunities for their own learning, imposed an ever-changing stream of rules and performance requirements that leave them exhausted and hopeless, and paid them about $40,000 a year for their trouble—far less, proportionately speaking, than teachers earn in most other industrialized societies. (Those societies include such economic middleweights as Spain, Portugal, Greece, Ireland, and Mexico. In countries where the GDP per capita begins to compare with U.S. levels, South Korea being one example, teacher pay in relation to average national income is nearly three times what it is in this country.) To make matters worse, during the economic boom of the 1990s, U.S. teacher salaries declined. Meanwhile,

our teachers have had to carry almost a third more classroom hours than their foreign counterparts.[4] Then, when our children seem aimless and turn to machines and violence to feel some sense of power and self-expression, we wonder why. No we don't, actually. We blame the teachers.

Or we forget about them. In 1984, when *Forbes* magazine engaged in an internal debate over its coverage of school computing, senior editor Stephen Kindel, who was responsible for the magazine's technology section, wrote a cautionary memo. If computers let students do more and more of their work by themselves, Kindel asked, "what would happen to class discussion—and, more important, the sense of rubbing against other minds? I think that the best schools will eventually recognize a fact that's been apparent since Plato sat on Socrates' knee: Education depends on the intimate contact between a good teacher—part performer, part dictator, part cajoler—and an inquiring student." Kindel concluded with a comment that was noted in the second chapter of this book. "In the end," he said, "it is the poor who will be chained to the computer; the rich will get teachers." The author of the story in question, *Forbes* senior editor Kathleen Wiegner, made an equally passionate case supporting computers. This machine, she said, was merely taking its place in history's long line of world-changing machines. The printing press, the steam engine, the car, the telephone—each of these machines has empowered the individual, she argued, and thus helped dethrone centralized authority. "The day of the high priest in data processing is already waning in corporations, as the masses of employees become adept," she wrote. "Why not in the schools as well?" The editorial staff ultimately agreed with Wiegner, concluding, as the editor put it, that "computers will change the world."[5]

The magazine was right, of course, but only in one sense. As *Forbes* and most of the media joined in high technology's hype, they continually forgot that schools are not like the rest of the world. Youngsters need a quality of guidance that data processors don't—guidance that, as we have seen, is not much of a fixture in most classrooms, especially those that are heavily computerized. And as the family structure has weakened, or has at least been diluted by modern-day distractions, the only dependable place to which students can turn for such guidance is a teacher. There is even evidence on this score for those who worship test-score gains: In Tennessee, exhaustive longitudinal studies over the years have indicated that good teachers can raise students' test scores by as much as 50 percentage points. Interestingly, the Tennessee data also indicate that those gains last long after students have left a good teacher's classroom. Having more teachers might help as

well, since studies have fairly conclusively proven (despite some occasional equivocation) that students learn more in smaller classes.[6]* Steve Wentland, the veteran of technology's rise and fall at Belridge School, puts the argument boldly. "Ninety percent of what a kid learns," Wentland says, "he learns from the teacher."

The lengths to which this country's leaders will go to ignore this simple fact are remarkable. Some of the latest examples come from the policies of the George W. Bush administration. The president has gotten tremendous mileage out of his incessant pledge to "leave no child behind." While Bush has, as we've seen, made some long overdue moves to build up the teaching force, his primary route for arriving at this state of grace—standardized testing for students and harsh accountability for their schools—is rather curious in today's age. Educators now have volumes and volumes of knowledge at their disposal about what really makes youngsters excel. One would think the nation's policy makers, armed with this information, could come up with something better than a lengthier sheet of multiple-choice questions, millions of new test essays, and a corps of evaluators who don't have the skill, or the time, to do their job.

One sample of the wisdom that's readily available is a book written nearly two decades ago, in 1985, a year after Kindel issued his warning at *Forbes*. Entitled *Developing Talent in Young People*, the book was the 550-page result of an intensive four-year examination of some of the nation's most accomplished citizens. The researchers were a team of professors and Ph.D. candidates from the University of Chicago, directed by Benjamin S. Bloom, a professor emeritus at that university and a professor of education at Northwestern. Their study focused on 120 stars in a handful of fields—specifically, musicians, artists, athletes, mathematicians, and scientists. How, they wondered, did these people rise to the top? In assembling their answers, the authors arrived at an interesting combination of new and old truths.

*From time to time, research surfaces suggesting that smaller classes do not make much difference. The studies making those claims have, however, been generally discredited. As but one indication, after California reduced class sizes in the late 1990s, test scores in some of the state's poorer, high-minority schools, especially in Los Angeles, fell. The reason, researchers discovered, is that the reduction required more classes and thus more teachers. This increased the prevalence of unqualified teachers—and gave good teachers new job opportunities in wealthier schools. And while other factors may have played a part, across the state's large urban districts as a whole, test scores did generally rise for low-income students after smaller classes were initiated. See "Some Calif. Test Scores Fall Along with Class Size," *Education Week*, July 10, 2002, p. 12.

The new discovery was that very few of these stars exhibited unusual natural gifts before embarking on their course of mastery. Many showed promising proclivities, and, of course, all possessed sufficient interest in the field and enough drive to carry them through many long years of relentless practice and study. Beyond that, however, these masters started out in life as average children. These facts, and Bloom's prior research, led him to hypothesize that "what any person can learn, *almost* all persons in the world can learn, *if* provided with appropriate . . . conditions for learning." The old news was what those appropriate conditions were: "a long and intensive process of encouragement, nurturing, education, and training." The concert pianist, for instance, grew up in a home that prized music and the arts; that stressed the values of hard work and self-discipline; that carefully staged the child's study and practice to progress from basics to gradually more sophisticated challenges; and that sought out master tutors and trainers all along the way. When this staged style of instruction is practiced in schools, it's sometimes been called "mastery learning," because students are taught to thoroughly master each step before progressing to a more advanced task. (Students who learn this way, Bloom noted, outperform 85 percent of the students taught through conventional instruction.) The scholastic version of the last piece of this process—the mentor—is even more common. It's called tutoring. In study after study, whenever tutoring is matched against some competing pedagogy, including technology, tutoring wins handily. In his own research, Bloom found that tutored students outdistance 98 percent of those taught in conventional group instruction.[7]

The message here is pretty plain. Education's opportunities lie primarily in the teachers' hands, not in technology. In a world that, by a 1995 count, produced 17,000 newspapers, 12,000 periodicals, 40,000 new book titles each year, 400 million television sets, and 500 million radios, it is clear that education's frontier does not consist of more information.[8] We may think it does when we see students become glued to computer screens. But just as we've learned with television, youngsters need to be taught how to evaluate what they see on the screen. The fact that very few of us, young or old, exercise much judgment in this direction suggests that media guidance is in short supply all around. It also suggests that some students may be drawn to computers partly because teachers and parents aren't giving them much attention.

One phenomenon that continually struck me while I worked on this book was how frequently I found people who shared this worry, and several others like it. Even among people who are favorably inclined toward computers, many sense that this is not an innocent innovation; that, with only a

few exceptions, computer technology has become one more feature on an already crowded landscape of high-stimulus consumer items—TV, video games, pop music, action films, high-caffeine coffee shops on every urban corner, the list goes on and on. The primary function of that topography is to keep people buying; a side effect is that it keeps people perpetually hyped up and distracted from activities that might be more soothing and reflective. We have become, in a sense, a society of masochists. We bemoan youngsters' turning to violence while pouring millions into making suffering human beings the stuff of their entertainment. We criticize them for their poor self-discipline and short attention spans; then our commercial enterprises do everything possible to crowd and fragment their minds still further.

"We need *less* surfing in the schools, not more," David Gelernter, a professor of computer science at Yale, once wrote in *The Weekly Standard.* "Couldn't we teach them to use what they've got before favoring them with three orders of magnitude *more?*" Other educators, responding to policy makers' continual urgings that schools invest in what some were now calling "netricity," bemoaned the repetitive emptiness of these suggestions. One foundation invented another term for the schools' state of affairs in 2003: "technology fatigue."[9] Sentiments like these are much of what motivated Theodore Roszak, a history professor at California State University, to write *The Cult of Information,* his well-known "Neo Luddite Treatise," as he called it, "on High-Tech, Artificial Intelligence, and the True Art of Thinking." Roszak argued that learning operates on successive levels—information being the most elementary. Following from there are the demands of imagination, then insight, then knowledge and judgment. To propel this process, information must be put through constant synthesis and analysis—which is done best through projects that are complicated (not simulated), lots of writing, and face-to-face discussion. Roszak's last stage is wisdom, which is supposed to round out the process with deep and varied experience.[10] Computers can certainly be helpful devices throughout this evolution. But the most effective tools are likely to be much simpler things—books, field trips, test tubes, paper notebooks, microscopes, hammers and nails, conversations, and energetic teachers.

REAL HELP

After spending five years researching and writing this story, and many hours struggling painfully with its meaning, I have boiled down my feelings about the subject into a small set of hopes for schools. I hesitate to turn these hopes into formal recommendations for a reason. For decades, teachers and administrators have been battered with such advice—pretentious edicts from governmental commissions, business leaders, aspirants for national office, congressional panels, all manner of "experts" who do not spend their days cooped up in a room with dozens of unruly youngsters, some of whom will dedicate their entire classroom hour to getting under your skin. These teachers are doing God's work. Politicians and the media have long been telling us that this work is America's top priority (at least until September 2001). Yet it is work that very few of us have been willing to take on. The irony is that if we are going to avert more international violence, the solution lies in teaching youngsters how to deepen their human relations—which are very different interactions than the faux relationships conducted over the Internet. The teachers we depend on to teach these lessons could use some help. I therefore offer them these hopes.

I hope that at some point, the public breaks its habit of amnesia when it comes to promises that are sold to schools. One would think that adults—all of whom have gone through many difficult years of experience in school and most of whom have children of their own—would pay more attention when politicians and school administrators start buying in to quick fixes for education's troubles. But people rarely think unless they are forced to. And education doesn't require the same concentration of thought as would a business, whose failures create oil spills or drops in stock prices. No, the price of education's failures is conveniently amorphous, spectacularly delayed, and of little consequence to all but the poorest among us.

In particular, I hope that the next time teachers and administrators hear an expert making predictions about what school will be about in the future—especially concerning technology—the first thing they do is hold on to their wallets. While they're holding tight, they might pause a moment to review the accuracy of the soothsayer's past predictions. Because the record in the prediction market—not only in education but also in politics, in business, in any sphere where these storytellers peddle their wares—is not a glowing one.

With schools, and with technology in particular, the pattern has become relentless. Every few years, right around the time that educators have forgotten yesteryear's predictions, the schools are treated to a whole new definition of the landscape. All those old computer programs were no good anyway, they're told. Now we've finally got something that's truly useful. It's easy to handle; it's less expensive; it finally opens up some powerful learning opportunities. On and on it goes. The message is so seductive—no wonder

schools fall for it. A few years and many millions of dollars later, here come the computer hucksters again with yet another offering. But what about that last generation of "educational" software? Oh, the computer promoters say, it turned out to be harder to use than we thought. It was difficult to integrate into the curriculum. It was too expensive. It taught the wrong material. It didn't coordinate with the new state tests. It was too demanding. It wasn't demanding enough. The list of excuses is endless. The schools hear them again and again, year after year. And they fall for them again and again, year after painful year.

It's a lethal combination, this alliance between education and technology, because it joins two domains in which people are particularly gullible. With both schools and consumer technology, people—particularly American people—are especially susceptible to idealistic pitches. The visions of what might happen with a new style of teaching or a new computer look so fabulous, so promising, so irresistible. Sometimes, as we've seen with the sophisticated sleights of hand devised by Renaissance Learning and other companies, the promoters of these visions are self-interested manipulators. Most of the time, however, the salesmen—be they software vendors, telecommunications company officials, or education's very own technovangels—fervently believe in their products. But that's half of what makes the educational-technology phenomenon so seductively effective—and thus so sad. When everyone in the game is being duped, everyone is both guilty and innocent. (To fight this syndrome, I certainly hope that when schools are tossed fancy research claims, they get in the habit of thoroughly checking them out.) The onslaught of fraudulent educational pitches is steady, and it is exacerbated by their salesmen's inexperience with the institutional and daily classroom realities their buyers face. By the time a school has spent a few years trying in vain to adjust to its new purchase—a laptop program or special reading software, a new distance-learning network, a "comprehensive" education reform model, or some combination thereof—the salesmen are long gone. So are their real consumers, the students, who must limp toward the next phase of their education on a flimsy crutch. By then, of course, some new prospect has captured everyone's attention and the potential lessons in this pattern are obscured yet again.

Perhaps all this gullibility is unavoidable—the flip side of the American coin, the dark part of our innate spirit of adventure and ingenuous, relentless optimism. If so, I hope it's not long before we realize that we have lived as reckless teenagers on the world stage long enough. Maybe this is one of education's great unmet challenges. Maybe it should fall to schools to lead the way in showing all of us how to grow up. Maturity is based, in part, on

the ability to handle conflicting information. When truly wise souls confront a choice that poses both positive and negative consequences, they can comfortably stare its mixed reality in the face, feeling no need to dismiss one side or the other. That mixture defines computer technology. But if school policy makers have not learned enough to shrewdly pick their way through its obstacle course, they have no right to pass that task on to the nation's students.

I also hope that before schools sink much further into the computer world's unpredictabilities they at least attend to their basic responsibilities. Those obligations start with fixing leaky roofs and crumbling playgrounds and erecting enough buildings to offer uncrowded classrooms. They move on from there to include funding the many valuable curricular priorities visited throughout this book—music and the arts, books, physical education, field trips, "wet" science laboratories, modern-day shop classes, additional teachers—all of which have been cut back to make way for technology. In today's rushed, work-oriented world, school is often the only place where students can engage in some of these experiences. Once our basic responsibilities on these fronts have been met, schools can begin thinking about computing—an activity, it should be remembered, that is clearly not in short supply outside of school. But here, too, educators should do their homework. No school has a right to stuff classrooms with computers unless it also has an equal amount of money set aside for smart teacher training and technical support. That support involves far more than mechanical maintenance. It also means at least one staff member who knows educational software thoroughly enough to help trusting teachers steer clear of the junk.

To pay for these multiple obligations, I hope that at some point politicians start funding schools more generously. In 1995, investment in public education, kindergarten through college, made up a minuscule 4.99 percent of the gross domestic product. By 1998, as our economy rolled in wealth and schools were filling with a record number of students, the funding level actually fell slightly, to 4.82 percent. (In the following years, federal investment in schools did not much improve; in fact, despite President Bush's fervent promises to "leave no child behind," he actually cut funding for poor schools in 2003 by $6 billion, or 30 percent.)[11] When these figures are compared with the portion of GDP that other developed nations devote to public education, the United States comes in below average—stingier, for instance, than governments in Canada, all the Scandinavian countries, Portugal, Poland, and a half-dozen other nations.[12] This is why teachers, despite their sorry salaries, must continually reach into their own pockets to buy class-

room supplies—an act of generosity that is steadily growing, averaging $521 per teacher in 2001, or more than $1 billion nationwide.[13]

It would be nice, of course, if this sorry trend could begin to reverse. But education activists have pushed for significant expansions in education funding for decades, mostly in vain. (Perhaps if their myriad competing camps got together and pushed in unison, politicians might start listening.) Should the stinginess continue, state and federal governments could at least devise a method of school funding that is more equitable than what they have now. Strangely enough, property taxes remain the schools' primary revenue source, even though everyone knows that these taxes are far more bountiful in rich communities than in poor ones. Everyone in education also knows about the government's primary mechanism to offset this imbalance: Title I, a federal subsidy program started during President Lyndon Johnson's War on Poverty that sends nearly $9 billion a year to schools with low-income children. However, through a magnificent shell game of tax loopholes and other governmental favors, wealthy communities continue to squeeze more school money out of Washington than their poor cousins get. One recent study found that in 1989 (the most recent census year available at the time), tax outlays that lean to wealthy communities in New Jersey, for example, were $1,257 per student. Those that concentrate in poor New Jersey communities were only $237. "There is something perverse," wrote *The New York Times*'s Richard Rothstein, "about both parties proclaiming that they wish to leave no child behind, when the federal government plays so big a role in pushing affluent children farther ahead."[14]

In the midst of this gaping landscape of school poverty, perhaps the saddest irony of all is that schools keep on purchasing fancy new gear that continually needs fancy new upgrades and repairs. In the face of this devil's bargain, schools, and the many different people and institutions involved in schools, will have to keep finding ways to live with halfway measures. They could do so if they simply scaled back their technology campaign and promised schools nothing more than a set of last year's computers and an assortment of recycled machines. If these commitments could be coupled with today's level of technical support—and if teachers and computer maintenance staffs could be trained on equipment that wasn't upgraded as soon as they mastered it—then schools might finally reach a long-needed level of equilibrium. Technical support would match the equipment. Reality would match politicians' promises. And education reform, at least on this front, might achieve a goal that has always been elusive: stability.

Whatever we do about school funding, I hope the country someday offers teachers a decent living. One longtime technology activist, Bob Albrecht, casually suggested that if we really wanted to solve education's troubles, we'd double teacher salaries. Hyperbolic as that sounds, it would merely put those salaries in the $80,000 range—a figure comparable to average pay for engineers, lawyers, and many other strivers in the private sector.[15]* Such an increase may be a bit slow in coming considering the country's myriad competing priorities, not the least of which is the bill for the massive defense buildup that followed the 2001 terrorist attacks. Additional local financial distractions further cramp school administrators. These expenditures include not only fancy computer systems but also high-priced reform plans that fly in and out of the schools like cafeteria trays. The many schools profiled in this book that have gone nowhere with these reforms, and the many that have made giant strides without them, should be proof enough that the keys to good learning don't reside in some huckster's seminar kit. They are everywhere, throughout education's long, abundantly documented history. And they are not expensive.

One of those keys, in the absence of money for big teacher raises, is to give teachers psychic raises. Society is full of professions that demand sophisticated work but don't pay well. These include social work, nursing, even architecture and politics. They also include the vast majority of careers for people in the arts—musicians, independent filmmakers, writers of all kinds. The institutions that do this work know full well that if the money is thin, the work has to be thick with something else. Often, these people toil away based on the faith that they're helping to save the world—a satisfaction that certainly graces the teaching profession. But successful institutions that are short on cash have learned to offer more than this—a sense of power or autonomy, ample room for creativity, an opportunity to learn, or just pure fun. Many offer some combination of all of these. Not so in most schools.

"The big problem is: *Good people don't take and stay in jobs that don't entrust them with important things,*" says Theodore Sizer, a former school principal, the chairman emeritus of the Coalition of Essential Schools, and a leading

*The salary prospects for teachers are so bad that in the fall of 2000, Harold O. Levy, chancellor of the New York City public schools at the time, wrote an op-ed column for *The New York Times* pointing out that teachers between the ages of 22 and 28 earn $7,894 less a year than their college-educated counterparts in other professions. "The gap increases threefold by the time they are 44," Levy said. See "Why the Best Don't Teach," by Harold O. Levy, *The New York Times*, September 9, 2000.

voice in school reform, speaking with his own emphasis. "Smart college graduates look at the way the system works now and say, 'Well, maybe for a few years, Teach for America or something, but the system doesn't trust me, and there is no way I am going to make this a lifelong career.' So any solution to the teacher-quality problem has to reflect the movement of authority *downward.*"[16]

MAKING CITIZENS

Immediately following the September 2001 terrorist attacks on the East Coast, Richard Rothstein visited with a handful of high school students in central Florida. All of them were high performers and members of a church youth group, with well-educated, middle-class parents. If adolescents anywhere had the skills to discuss the meaning of the attacks and the complicated message they sent to America, Rothstein figured these should be some of them. But that's not what he found. When he asked students why they thought the nation had been attacked, one said it was because people elsewhere were jealous of Americans' freedoms, a comment that provoked wide agreement. Another said that Palestinian schools had brainwashed their children; a third said the terrorists didn't know the facts because they lacked the freedoms that Americans have.

When Rothstein tested out how the school's teachers were making use of America's freedoms to give their students the facts, the answers weren't encouraging. All the English teacher could say was that the attacks stemmed from crazed hatred. "She had no further explanation," Rothstein wrote in his weekly education column. When the school's history teacher tried to offer some material on Afghanistan, all she had was a fifteen-year-old film strip made when the Soviet Union still occupied the country and a video on world religions with fifteen minutes devoted to Islam. Nor did matters much improve in the years after the attacks. In a survey conducted of eighteen- to twenty-four-year-olds in late 2002, roughly half drew a complete blank about Afghanistan's geographical location.[17] It is not surprising, therefore, that the Florida history students did not know that Israel was a relatively new nation; nor did they realize that any compromise to achieve Middle East peace would likely displease both Palestinians and Israelis. Absent for many weeks—from this class and from leading voices in the national media (especially television news anchors and commentators)—was information that might help explain some aspect of the terrorists' motivation. This mattered. As experts on the Middle East continually pointed out at the time, simply

blasting terrorist organizations might help a little. But it wasn't going to stop terrorism; there would always be more terrorists behind these angry souls until we somehow becalmed their motivation, or at least becalmed the sympathies of the societies that surround them. One might justifiably wonder how youngsters are going to learn this kind of multisided perspective when the adults around them lack the knowledge and wisdom to do the same. But that's what social evolution, and school, are all about: arming the next generation with deeper perceptions than the previous generation had. This requires an entirely different approach to social studies—a subject that many students in this Florida school weren't even taking. In fact, it requires a different concept of learning in general.

"Critical thinking," as Rothstein argued, "requires sources with conflicting viewpoints." To illustrate, he recalled the historic moment in 1971 when *The New York Times* and *The Washington Post* jointly published what came to be known as the Pentagon Papers. These were classified documents showing that policy makers had knowledge of Vietnamese motives that was far more sophisticated than the simplistic lines about Communist invaders that American officials were publicly proclaiming. "Thousands of lives might have been saved," Rothstein observed, "if ordinary Americans better understood the other side."[18]

The point here goes beyond the importance of balanced, sophisticated understanding. It revives an issue that's the bedrock of our country's foundation: the need to question authority. "We hold these Truths to be self-evident," states the Declaration of Independence, introducing America's familiar bedrock principles, "that all Men are created equal," and "that they are endowed by their Creator with certain unalienable Rights." It goes on to say that "whenever any Form of Government becomes destructive of these Ends, it is the Right of the People to alter or to abolish it, and to institute new Government . . ."

Students cannot responsibly answer this charge unless they're given the tools to do so—intellectual tools, not mechanical ones. And the work that needs to be done with those tools goes somewhat beyond what passes for critical thought today. One form is the polite, mildly informed, but ultimately superficial discussions that university professors increasingly observe in their classes, where students with a "whatever" attitude and a consumer's approach to education are unsettled and often offended by discussions that challenge their fundamental beliefs.[19] Almost equally pervasive is the cynical tendency to reflexively challenge any idea based on nothing more than one's instinctive reaction. Real questioning of authority—whether it be of classic figures in literature or of current leaders in gov-

ernment—breaks through both of these habits. It comes from a charged base of knowledge, a historical appreciation of the fine points, implications, and contradictions in history, in science, or in any other field. Those capabilities are difficult to acquire, however, when teachers are all rushing in one direction to satisfy the government's increasingly standardized definitions of skill. "There is less and less interest in preparing people who have the intelligence and the habit of mind to ask the unfamiliar and perhaps painful questions," says Theodore Sizer. "Our long-term economy depends on the informed skeptic, that person who says, 'That's interesting—it seems to work, but gee, if we looked at it in a different way, it might work better.' So it's the increasingly standardized values that trouble me the most. Feisty people are the people who have made this country special."[20]

I hope, in short, that the many different people involved in schools, and school policy, can someday find their way back to education's basics. Those basics do not mean years of feeding youngsters little more than facts and procedures related to the mythical three R's, then fawning over regurgitations that produce high test scores. I'm talking about an educational philosophy that was first mentioned in this book's Introduction, one that might be called enlightened basics. For at issue here are nothing less than the foundations of learning—building blocks that are increasingly important yet increasingly ignored.

These blocks can be broken into three simple parts: The first is an atmosphere of high expectations, tied to sophisticated, creative inquiries in the real world. To accomplish this, schools can follow some version of the gentle, artistic models of the Waldorf schools and New York's P.S. 234; or they can choose the grittier, no-nonsense approaches we've seen at the Expeditionary Learning Schools and Urban Academy High School. What is important, though (and occasionally missing in the experimental schools), is a kind of teaching that makes sure students' creative inquiries are backed and amplified by a broad base of knowledge. This leads to the second missing building block: a national collection of teachers who are not only well trained but also sufficiently well paid to attract the world's best and brightest—that is, people who can put good training to efficient, creative use. The third and final new element would be an educational culture that is first and foremost about people—and that trusts people, rather than numbers, to be the primary judge of a youngster's progress.* Ideally, this school-

*While it may seem idealistic if not heretical for a state to evaluate its students through some method that goes beyond standardized tests, it is not impossible. In late 2002, New Jersey Governor James McGreevey did just that, kicking off a five-year plan whereby teachers would start using student projects and other "performance" measures to assess scholastic progress. In endorsing the plan, which was partly developed by the state's chamber of commerce, McGreevey said tests have their place, but merely as "diagnostic" guides to help teachers adjust to students' needs. See "Governor Takes N.J. Down Testing Road Less Traveled," by Catherine Gewertz, *Education Week*, December 4, 2002, p. 20.

is-about-people message would be broadcast so clearly that students and teachers aren't the only ones to get involved in schools. America's parents will too.

It would be easy to characterize popular criticism of computers as merely another chapter in the world's oldest story—humanity's natural resistance to change. But that would minimize the forces at work in today's technological transformation. This is not just the future versus the past, uncertainty versus nostalgia. It is about encouraging a fundamental shift in priorities—institutional and personal. "In a very real sense," wrote Theodore Roszak, "the powers and purposes of the human mind are at issue."[21] I don't know why this lesson must be learned again and again. The only explanation I could come up with is that there is something about the nexus of technology and those untapped powers of the human mind that continually sets people to dreaming. Over the years, however, as technical reality has continually taken its toll, the more realistic of those visionaries have conceded defeat.

The pattern is perhaps best illustrated by the outer reaches of education's visionary history—its chronic dreams of wired Super Kids computing their way to the heights of human ability. One such visionary was George Leonard, the prolific chronicler of the human potential movement, a veteran education writer for *Look* magazine, and the author of *Education and Ecstasy*, a 1968 bestseller that envisioned a utopian learning environment, set, coincidentally, in 2001. The new schools Leonard described were going to be made of arboreal geodesic domes and computerized touch screens, complete with advanced CAI software that could communicate with children's brain waves.[22] Looking back, some thirty years after making this prediction, on society's inability to bring such a world into being, Leonard was now struck by technology's inherent limitations. "It's not that computers are so dumb," he told me. "It's that we've discovered that the human brain is much more complex and beautifully organized than we'd ever dreamed."

Some, unfortunately, have not discovered this fact. In late 2002, the departments of Commerce and Education jointly issued yet another report

that dared to outline education's high-tech future. Written by a collection of scholars and technology experts and entitled "2020 Visions: Transforming Education and Training Through Advanced Technologies," the report sounds very much like Leonard's old predictions for 2001. It describes students learning through a variety of digitized media, such as simulations, game playing, and "tele-immersion" environments that would completely replace classroom teachers and make school buildings obsolete.[23]

Interestingly, two decades after composing his own breathless vision of edutopia, Leonard, by then a man in his sixties, wrote an essay for *Esquire* magazine that took a much calmer approach to this question of human potential. While Leonard didn't spell it out, there was another message here for the institution of education, a coda of sorts to University of Chicago professor Benjamin Bloom's findings on mastery. In Leonard's essay, which drew from his arduous years of experience learning the martial art of aikido (and which was later expanded into a book entitled *Mastery*), he divided people into four categories: dabblers, hackers, obsessives, and masters. His point was to delineate the different ways each of us deals with significant challenge, be it in a job, a sport, a relationship, or whatever. In Leonard's view, when people reach moments of great frustration, many unnecessarily give up and turn to a new pursuit—a different sport, a new lover, another job, and so forth. Though Leonard didn't question it, his theory could even include education's approach to the art of teaching, dominated as it's been by a continual search for new tricks. Whatever the pursuit, Leonard classifies those who bounce through them as society's dabblers. Hackers tend to be on the lazy side; they stop struggling altogether, contenting themselves with mediocre experiences. The obsessives take what feels like, and often looks like, the bravest approach: They begin pushing harder. Before long, they've injured themselves on the field, ruined perfectly good relationships, or spoiled prospects for career advancement; if they are in positions of authority, they often damage their professional institutions as well. (Grave illustrations of the obsessives' pattern in the business world occurred with the accounting scandals of 2001 and 2002, especially the Enron collapse, many of which were led by a corps of impetuous financial "stars.")[24] The master, meanwhile, avoids all these pitfalls by understanding one simple truth: Excellence is not about peak experiences; rather, it's defined by how we handle life's plateaus. Because that, after all, is where people spend most of their time. When masters feel progress stall, they see challenge for what it is—unavoidable, ubiquitous, and a gift. They know their task is to simply keep working, pushing gently and patiently toward the next momentary step up on life's endless series of plateaus.[25]

Learning, obviously, is not like a sport or a marriage or a job. But the fundamental lesson here—the virtue in achieving a balance between diligent effort and patience—applies to any difficult task. Education might even be one of society's most difficult, most complicated, and most troubled undertakings. One would think that its leaders might therefore approach incessant offerings of reform with an air of sobriety—and an appreciation for the long art of mastery.

In the end, the scenes described throughout this book come down to a set of unsettling truths. Computers can, in select cases, be wonderfully useful in school. But over and over, as we've seen, high technology is steering youngsters away from the messy, fundamental challenges of the real world—and toward the hurried buzz and neat convenience of an unreal virtual world. It is teaching them that exploring what's on a two-dimensional screen is more important than playing with real objects or sitting down to a conversation with a friend, a parent, or a teacher. By extension, it downplays the importance of listening carefully to people and of expressing oneself with acuity and individuality. And this leads all of us to sideline activities that have long helped youngsters develop fundamental human capacities, particularly the imagination, that sustain society over the long haul.

To get some final, visceral sense of the stakes in the computer era, it helps to recall what's known about the rest of electronic media. By now, most people understand the limitations of the vast bulk of material broadcast on television and in the movies. As for video games, educational technology's most vigorous ancestor, the harmful effects of the more violent products in this genre (boosting children's propensity to hostile behavior and constricting their imaginations) are well documented by now, as we've seen. But how many decades of gullibility did it take for us to get here? How many rounds of damage did we have to endure? One would think that the many warnings we've heard about our increasingly short attention spans—from teachers, from parents, and from employers—would have given education's policy makers some pause about expanding electronic media's influence even farther, into one of our most hallowed halls—the public school. One would think that the steady encroachment of the consumer culture, to the point where schools consider it perfectly acceptable to pepper textbooks with brand names and to make lucrative deals with companies like Coca-Cola and ZapMe!—the firm that promised schools free computers in exchange for the freedom not only to put advertising on their computer screens but also to sell students' consumer data to companies—would provoke real alarm.[26]

One would certainly think society's increasing turn to violence, especially among the young, many of whom commit horrific acts without showing the slightest sense of their gravity, would have stopped national leaders, or educators, or someone, in their tracks. If these trends are not enough to move us to rebuild the boundaries around our institutions of learning, one can only wonder what, if anything, will be. Maybe in the end, in the true American tradition, it will be money—misspent money, lots of it. The computer certainly makes for that.

It would be nice if books that sound stern warnings could save schools from years of costly mistakes. But they don't. Perhaps the final piece of this argument needs to be a submission to one of its own themes—that wisdom can come only through rich experience. And experience becomes rich only when it is fertilized with mistakes.

Like all of us, I suppose, schools have to fall for the latest thing, make blunders, and learn from there. If educators are swayed by a new mantra—that computer technology can be treated as "just a tool"—perhaps they'll also remember an old one. At the outset of this book, the campaign to put computers in schools was described as a *crisis* in the Chinese sense of the word, defined by two characters—one standing for danger, the other for opportunity. Thinking back on that duality, and everything I've seen while exploring it, I'm reminded of another ancient pairing of powerful forces. In an eighteenth-century book entitled *The Marriage of Heaven and Hell*, the poet William Blake wrote, "You never know what is enough unless you know what is more than enough."[27] Let us all hope that it is not much longer before that time comes, when technology's road of excess will have led our schools, and the rest of us, to a new palace of wisdom.

Acknowledgments

To write a book is an act of almost unbearable presumption—a search for large, elusive truths, which one dares argue that most of the world has been missing. To the extent that this book succeeds at some of that mission, much of the credit must go to my editor at Random House, Jonathan Karp. As this story was evolving, Jonathan continually saw possibilities for a longer reach and a more solid argument. For that, I am eternally grateful. I must also thank the family of expert editors at *The Atlantic Monthly*, which published the original article on which this book is based (and a follow-up story about Waldorf schools, an expansion of which became the book's final chapter). In the process of composing this story, one particular editor, William Whitworth, *The Atlantic*'s editor emeritus, generously read through multiple early drafts of the manuscript with painstaking care. Whether his suggestions were small or large (and there were plenty of both), his comments were always laced with a kind of literary judgment that has become almost extinct and which left me with conversational memories I will not soon forget.

During the lonely toil of book writing, often is the time when all a writer wants to do is step outside the door to run a few pages, or just a sentence, past someone who has sharp eyes and an understanding ear. Fortunately, I have been able to do exactly that throughout this project because of the existence of the San Francisco Writers Grotto. This collective, where my office sits, houses a number of insightful authors and artists, who have advised and supported me in this endeavor in countless ways. Sometimes, of course, an author craves outside assessment of an entire chapter. I occasionally inflicted this pain on fellow Grotto writers Po Bronson and Mary Roach; two former colleagues, Garrett Epps and Steve Schewel; Jonathan Rowe, another fellow scribbler; and Judah Schwartz, professor emeritus at Harvard and MIT and the former co-director of Harvard's Educational Technology Center. Each of

CHAPTER 12

A Word from the Army: KISS

Say what one will about the military, but when it comes to organizational management—a challenge that bedevils any large enterprise—it has learned a thing or two. The reason is obvious: The consequences of failure in a military organization can be fatal for hundreds if not thousands of people. This concentrates the mind of any manager. And it undoubtedly accounts for why, among all of society's large, modern institutions—medicine, government, the media, education, and industry—the military has been quickest to take a long, hard look in the mirror after a stumble. The most recent moment that provoked such self-correction was the Vietnam War. In the following years, each branch put itself through a period of intense, ethical self-examination that led to wide-scale reforms.[1] Clarifying many of these efforts was a catchphrase from the Army, the military's largest branch: Keep It Simple, Stupid, which was quickly popularized through its delicious acronym, KISS.

The power of simplicity obviously has appealed to more than the nation's lieutenants and drill sergeants. Some educators, even those involved in technology, have been drawn to the concept too. One such person is Tom Snyder, a former educational software maker, who consistently delivered an unusual message to audiences at some of the myriad conferences held each year on educational technology. During one such presentation in San Francisco not long ago, Snyder said, "If you guys had all been really committed to technology in schools back in 1984, *really* committed and well funded and everything, your schools would all be permanently wired for Commodore 64s. Thank you for not doing it!" Snyder's gambit prompted a huge laugh. Everyone in the room knew that Commodore 64s are ancient machines whose manufacturer has long since gone out of business, leaving thousands of orphans that could no longer be upgraded.

Snyder was something of a lone crusader for a radical idea: one computer in each classroom. The computer's job, in his view, is not to break up the traditional classroom group endeavor but to stimulate it. "Schools may be the last place," Snyder once said during a speech, "where the government is funding us to gather together into public forums to have conversations. We have got to protect that." Snyder doesn't pull any punches on this topic. In ten or fifteen years, he fears, employers will increasingly ask whether applicants were computer trained or teacher trained. Those who were computer trained, he believes, will be left out—because "they won't be able to make sense of the world."

In support of this view, Snyder designed software packages that help teachers conduct discussions. During his tenure, he says, when the members of his firm sat down to create a new product, they began and ended with one question: "Does the computer actually contribute to having conversation?" An example of how Snyder's materials tried to accomplish this is a social studies package that stages a hypothetical international crisis, complete with multiple options for the president and his advisers. Coupled with each option is screen after screen of historical information, analysis, context, further questions, and other material that forces students and teachers alike to grapple with complexities. But the overriding point is that the exercise is conducted as a group, with the teacher leading at every stage. The same format applies to the company's other products, in subjects such as history and science.

Snyder arrived at his epiphany partly out of frustration, after he and his partners once tried to design a course on the Internet, structured as most are these days, through a number of website hyperlinks. "At the end of this orgy of webbing," Snyder recalled, "my partner said, 'We still haven't figured out what the course is.' We often forget about that, because the Internet is so seductive, you can just link all day." To illustrate, Snyder pointed out what would happen if a boy wanted to study the history of the civil rights movement and began his work with a website devoted to Martin Luther King Jr.'s famous "I have a dream" speech. One popular site, he said, would

send the boy on the following path: "I have a dream . . ." (hyperlink, click); this sends him to a site featuring fires during protests in Atlanta, Georgia . . . (hyperlink, click); now comes a compendium of famous, early fires . . . "You see how far away he now is from the topic?" Snyder asked. The great irony, Snyder noted, is that parents and teachers watching this boy would be thrilled by what he was doing. But, Snyder asked, "what will he be able to contribute about Martin Luther King at a party when he's twenty?"

Snyder's message clearly flies in the face of high-tech orthodoxy. Over the years, computer enthusiasts have continually celebrated the computer's ability to break up the old, constricting, linear forms of information. At the peak of "new media" hopes, in the early and mid-1990s, many in the publishing world thought that an entire new industry would be born with CD-ROMs full of multimedia material that was so interactive it would make traditional linear storytelling obsolete. Swayed by this vision, authors rallied around new companies that tried to design stories that could be structured and finished by the reader. Most of these ventures tanked along with the CD-ROM market. And they never made a dent in schools. There is a reason, according to Snyder, and his view is widely shared by education experts. Apparently, learning remains a relatively linear process.

This is not to minimize side connections, which are critical to creativity and innovation. But even the most innovative among us learn the principle of what Snyder calls "slogging through." In other words, understanding and mastery come to those who can stay on topic, face the challenges, and resolve the contradictions. (To illustrate this point, Snyder likes to repeat a story from a comedienne who, after watching television with her boyfriend, finally realized why he kept changing channels. "He clicks whenever something complex comes on.") "Let's not come back in ten years," Snyder pleaded at the San Francisco conference, "having spent the last decade congratulating kids for *leaving* ideas."

To underscore his argument, Snyder cited an old Harvard study that tried to ferret out predictors of success. Among other things, the evaluators looked at which students did well at reading comprehension from third grade on. One factor proved to be consistent: "They come from families that talked at dinner," Snyder said. "The end."[2] Obviously, it's not quite that simple; families that enjoy lengthy dinner conversation typically can indulge in lots of the other finer things in life. And almost every educator knows that family privilege and academic success are joined at the hip. However, schools can compensate for many of these gaps, as we're beginning to see.

TEN-DOLLAR TECHNOLOGY

Another great believer in a simple approach to the complex art of learning was Alfred North Whitehead, the famous English philosopher and mathematician of the early twentieth century. One afternoon, I had occasion to test out some of Whitehead's views during a visit with Bob Albrecht, the impish godfather of scholastic approaches to BASIC, the first programming language built for personal computers. Albrecht, seventy-one at the time, had been treating me to a cornucopia of academic possibilities with today's computer technologies—spreadsheet activities, the latest website-building software, and documents overflowing with hypertext links, which let students, as he put it, "just click and go, click and go." After listening for a while to Albrecht's worldview, I pulled out one of Whitehead's quotes. "The best education is to be found in gaining the utmost information from the simplest apparatus," Whitehead wrote in 1929. "The provision of elaborate instruments is greatly to be deprecated."[3] Albrecht heartily agreed, with one caveat: An extra phrase should be added to the first sentence, he suggested, so that it read: ". . . the simplest apparatus that is capable of doing the job."

Albrecht's revision wouldn't add much complication, at least not in his mind. Whenever he volunteers in schools, which he still does regularly, Albrecht arrives with an unusual assemblage of materials, the primary piece of which is a knapsack full of gizmos and gadgets. He also packs sets of documents on computer disks, which he calls his backpacks. (There's an Algebra Backpack, a Physics Backpack, a Measurement Backpack, and several others. The disks carry all those files and articles that he litters with hypertext links.) Yet when it comes to teaching, say, the laws of probability, Albrecht pulls out a Tupperware container full of dice. Some are standard, six-sided dice; some are dodecahedral (with twelve faces, each of which is shaped like a pentagon), and some are icosahedral (with twenty tiny, triangular faces). "Here," he says, waving his dice box in the air. "This is educational technology." Cost? About $10. Another Albrecht favorite is "base-10 blocks," used to teach math to very young children. "I do a lot more of that than I do with computers," he says. "Because they are powerful and they are cheap. And teachers can learn to use them."

Albrecht's point about blocks is more profound than it appears. A good many schools, including those considered models of intelligent computer use, have enthusiastically bought computer programs that simulate blocks

and beans and other physical materials that have long been staples of math instruction in the early grades. "That," Albrecht argued, "is not appropriate technology." Even now, with computers in almost every school, the product exhibits at math-education conferences feature table after table of blocks in different colors and patterns, counting chips, fraction tiles, puzzles, building kits, and assorted other manipulatives—"manippies," in teacher lingo. "I could harp about tool selection all day," Albrecht told me. "If we could teach teachers appropriate tool selection, we wouldn't have these problems."

Albrecht has thought a lot about tool selection. When we first sat down together, he tossed a pile of catalogs at me—from Texas Instruments, Vernier, and other suppliers of what he calls data grabbers: small devices, with electronic sensors, built for fieldwork. A student with one of these in her hand can record, say, how far away a bird is and how fast it flies, or the temperature in the water of a polluted stream, and then plug this data into a computer for analysis. But he usually just packs the simple stuff—even when teaching advanced college mathematics.

After digging a little deeper in his knapsack, Albrecht pulled out dozens of measuring devices of various shapes and sizes. There were protractors with holes for drawing circles of different sizes; one had a little wheel on the end. There were also calipers, mostly plastic, but one was a beauty—made of solid brass. He also carries a few books, including a 276-page volume, roughly two inches square, entitled *The Pocket Professor: Over 1000 Physics Formulae: Mechanics, Thermodynamics, Electromagnetics, Optics.* Then he brought out his favorites: a set of tape measures and folding measuring sticks, all calibrated in meters. "That one will just about take you out to Mars," he said, pointing to his 1.5-meter tape. Discussing the reason with him quickly gets you to a math-and-astronomy lesson, involving the translation of solar distances to meters and millimeters. As I listened to Albrecht explain the devices piling up on my coffee table, I found myself confused, as I always was about math in school, and at the same time fascinated in an unfamiliar way.

Obviously, computers are brought into classrooms for more than math and science. But these two subjects, which have been discussed regularly throughout this book, merit an extra moment of attention for three reasons. First, they are the subjects that technology advocates usually point to most vociferously as the ideal domains for exploration and invention with computer technology. Second, the sciences are arguably the fields that are visiting the most change upon modern society at the moment and, perhaps, the most opportunity in the near future. Biotechnology, genetic engineering, pollution control, exploration of the climate and the atmosphere—all these fields are screaming for qualified graduates, a shortage that federal policy makers aren't doing much to alleviate.* If only by mental association, computer technology is seen as intimately connected with advancement on each of these fronts. Third, a sense of the sciences, and a firm grip on mathematics, matter a great deal, as we have seen, to any student who is looking into computing as a career option.

Albrecht is in stride with each of these points, although he steps more lightly than most academics do. In his classes, students generally have a ball with his bags of "technology," the total cost of which (absent the data grabbers) comes to less than $50. Not long before our meeting, for instance, he taught a class with one of his metric measuring sticks. "Every single kid wanted to use it," he said, "because it *folds out.*" What's striking about this story is how similar it is to the accounts from schools that invest heavily in computer technology. Almost every news account on these schools is filled with gleaming anecdotes from teachers and parents about how enthusiastically the youngsters have taken to the technology, and about the vast scholastic possibilities it opens up. What they're not seeing is the enduring truth underneath every new toy. It's not the computer that has excited the students; it's the physical machinery, the presence of a real tool, and a real-world activity. As Albrecht's experiences indicate, this excitement can be achieved with a $50 collection of hand tools as easily as it can with a computer, a single one of which can cost twenty to thirty times as much.†

*An illustration of this blindness occurred in 2002, when President Bush submitted his education budget. Bush initially sought $450 million for a partnership program between K–12 schools and universities that has tried to improve the quality of math and science teaching in the lower grades. That fall, the Senate Appropriations subcommittee that handles education approved a mere $25 million for the partnership.

†An interesting illustration of technology's sometimes false allure in the sciences came up in a *New York Times* review of a software package called Studyworks Science. The software aimed to equip students with all manner of sophisticated tools—a chemistry library, complete with both principles and formulas, and a worksheet full of advanced math functions—all of which moved *The New York Times* to headline the review GIVING STUDENTS SERIOUS HELP WITH SCIENCE. Yet the company claimed it would take students only twenty minutes to master the program. "That may be true, but probably only for the best students," the reviewer concluded. "And that raises a basic question about the program's usefulness. The students who are most able to make use of it probably need it the least—they know the formulas and laws, or if they don't, they at least know how to find them. Those students who have difficulty coping with science will probably find it hard coping with Studyworks Science as well." See "Giving Students Serious Help with Science," by Henry Fountain, *The New York Times*, September 23, 1999.

The message in these simple tools could alter the debate about how to close the great "digital divide." As we've seen throughout this book, the computerized activities that schools generally offer to poor or struggling students in an effort to expose them to technology are thin at best, which only puts these students at further disadvantage. That syndrome greatly troubles Judah Schwartz, the professor emeritus of MIT and Harvard, and the former co-director of the latter's Educational Technology Center. The problem, Schwartz says, is that when schools serving the underprivileged rush from one new technology application to another, at some point "the newness wears off. And then the whole system reverts to its previous inequities." In his decades of teaching, Schwartz has long tried to counter this trend with his own version of simplified technologies. He was an early practitioner, for instance, of devising math lessons for students in the primary grades around a broken calculator. (Schwartz realized that if he broke or taped over all the buttons except for zero, one, and the plus key, then told second graders to see who could be first in tallying up, say, 2,312, a very interesting lesson would ensue. As students realized they didn't have to add one 2,312 times and could in fact create combinations of 10, 100, or 1,000, they would discover, quite on their own, the meaning of place values.)

The prevalence of options like these, and their wide neglect, have left Schwartz with no great fondness for education's standard approach to calculators and most other current forms of classroom technology. "The calculator as a surrogate for how numbers work is a fraud," he says. As dismissive as his criticism sounds, Schwartz is actually aiming at a finer point. Some of the calculator's weakness, he explains, derives from the way its tiny screen condenses, and thus distorts, the arithmetic process. Those limitations, Schwartz points out, afflict every tool, even multi-gigabyte computers. And therein lies their opportunity. "All tools have their prices," Schwartz says. "A useful strategy is to turn their price into a teaching occasion." The pedagogical goal, he says, is to figure out "what *are* the limits of this particular device?"

There's something rare, delightfully realistic, and empowering in Schwartz's attitude. He persistently points out, for example, that technology is not going to go away. So we might as well learn to confront its powers—and its weaknesses. At the same time, Schwartz heartily agrees with those who want to limit very young children's exposure to computers—partly because they are not yet up to seeing through the computer's limitations.

This suggests an interesting new way of defining school policy when it comes to technology purchases. Perhaps student access should be limited to those computer programs they can fully understand. Such a policy would

rule out a lot of children's software, such as the fancy multimedia programs with high-end production values that overwhelm children's imaginations. It could keep powerful geometry programs away from high schoolers who know only enough to use their shortcuts. And it could encourage simple, sensible activities. By the same token, a policy of this sort might encourage certain sophisticated simulations—but only for older students and teachers, who are capable of critiquing their omissions. Some schools have already taken this route. In Denver, Colorado, the school district set up an ingenious program that taught high school students to take apart and reassemble computers, upgrade the hardware, and diagnose problems—all on used computers donated by Dell Computer. (Pleased with the schools' success with the program, Dell subsequently expanded its initiative, giving four thousand used computers to fifteen districts across the country.) In Beverly, Ohio, the Fort Frye school district tried a similar idea, teaching its high school students to build new computers from scratch. The program soon saved the district $30,000 in computer costs.[4]

One of my discussions with Bob Albrecht makes the case for KISS-ing in another technological sphere. At the time, Albrecht was in the middle of explaining his graphing calculator, a high-end but increasingly common classroom tool that can negotiate arcane concepts such as sines and cosines, graphical analysis, statistical regressions, algebraic equations, financial functions, and matrices. Once again, I was having a little trouble following the explanation from a man who calls himself a "metric evangelist" and who does advanced algebraic equations every morning because, he says, "it relaxes me." So I asked him what he did if a young student had trouble following these concepts and if he further determined that this youngster's math foundation was weak. Does that student have to go back to working basic math problems, either by hand or with drilling software? Or is the answer to use more advanced pieces of technology, with all their possibilities for graphic explanation?

Neither one, in Albrecht's experience. "If you give him more math problems, it will destroy him. That's what got him where he is now," he said. As for the fancier technological approach, while computers offer a few new options, he's found them to be generally too abstract. The best answer, Albrecht believes, is some activity that appeals directly to the student's interests. "Hands-on experiences are great," Albrecht said. "A lot of those kids are great with their hands." These experiences include, on the higher end of the scale, Albrecht's data grabbers (if schools can afford them and have the skill to manage them). But many of the same lessons, he says, can be learned quite happily with Albrecht's knapsack and a set of real-world

problems. As evidence, one of Albrecht's co-teachers told him that when he walks down his school's hallway, students who haven't exactly been the class stars often approach and say, "When are you going to do another one of those investigations?" Sometimes they even bring in their friends from other classes.

Albrecht delights in contrasting this picture—steeped as it is in the traditions of John Dewey, the legendary school reformer—with education's current fixation: standardized testing. "Whenever I go out into the real world," he likes to say, "I never see people making a lot of money sitting at their desks answering multiple-choice questions." Albrecht's folksy tale fleshes out an old truth about standardized tests: They don't, in and of themselves, predict later success—on the job or in life. Granted, good scores may build confidence (just as poor scores reinforce a struggling student's sense of inferiority). It is also true, with some notable exceptions, that general success in school usually contributes to success later; any adult can see that just by looking at the varying amounts of progress that former classmates have made. But scholastic success could be measured through any number of endeavors. The fundamental question concerns what happens to the human psyche when it repeatedly succeeds (or fails) at challenges. The result, of course, is a change in one's level of confidence. And confidence can be built many ways; yet for some reason, in today's sophisticated world, education policy makers have chosen to confine it to selecting among multiple choices on a piece of paper.

One thing that struck me about both Albrecht's and Schwartz's approaches was how similar they are to the one practiced by Wally Warshawsky, the Zen master of math at New York's Urban Academy. With all three instructors, the priority is each student's need for physical, sensual, and often idiosyncratic engagement with academic concepts. Beyond that, of course, Warshawsky couldn't have been more different from his two peers, particularly Albrecht: Warshawsky is only a step away from being a Luddite; Albrecht is a technology lover. Yet when it comes to engaging students, they're on the same simple page.

While arguing his various points, Albrecht regularly reaches into one more bag—a small, well-worn, Velcro-fastened fanny pack that seems to reside permanently on his left hip. In one motion, he whips out his graphing calculator, snaps it open, and holds it in front of your face. The speed with which he does this reminds me of a movie gunslinger; it even has a touch of the cowboy's bravado as Albrecht talks for a moment about the different things he can do with this device, then snaps it shut before you can answer and slides it back in its holster. Albrecht's delight in all these tools is plenty

obvious, and plenty infectious. When I was a boy, I would have loved being equipped with backpacks like these. I would also have wanted a teacher like Albrecht, who could show me when to use the tools inside them and when not to.

Toward the end of one conversation with him, I got nervous about drawing too much meaning from his arguments. Albrecht is obviously not your average instructor. He's rarely seen without a shirt emblazoned with a large dragon, his lifelong icon; one of his hobbies is fatiguing much younger friends on hikes in the California woods. This childlike energy travels with Albrecht whenever he visits schools. (Even his face gives it away. One of his ears is curiously misshapen—by birth, one presumes. But it curls at the top into a slight point, much like a dragon's.) All of this moved me to ask him if he thought it realistic to expect average teachers to duplicate his experiences. "If you really want to solve this problem," he said, "double the teachers' salaries." To most people, that sounds about as realistic as cloning an army of Bob Albrechts. But he's onto something.

PRESERVING REFORM

One of the great privileges of being a journalist is the legitimacy it confers on one's secret desire to be a Peeping Tom. While reporting this story, I was welcomed into dozens of schools of all kinds, many of whose administrators let me wander from class to class, freely choosing either a brief glance or an extended visit. A number of these schools were among those, mentioned only passingly so far, that have become famous in education circles as exemplars of today's most effective approaches to public school reform: Some are designed around Howard Gardner's well-known theories about multiple intelligences. Some are the cream of New York City's intense traditions of progressive education. Some are called Expeditionary Learning schools, whose emphasis on real-world investigations is patterned after the Outward Bound program, which believes that the rigors of the outdoors put steel in teenagers' spines. And some are Core Knowledge schools, which follow proudly old-fashioned traditions.

Throughout all these visits, I was continually struck by a bizarre constant. No matter how varied and ingenious the pedagogy was (and in many classrooms the creativity was phenomenal), it rarely carried over into the technology program. Not surprisingly, most of these "exemplary" schools put very little emphasis on technology. But in one model school after another, once students did sit down in front of computers, the scene became

strangely reminiscent of the superficial chaos at most of the high-tech schools I visited. Even more surprisingly, these observations almost always followed lengthy conversations with no-nonsense teachers and principals, who seemed to understand technology for what it is—a perfectly nice supplement but one that requires an exceptionally firm hand.

An example was New York City's P.S. 234, the innovative elementary school in the city's Tribeca neighborhood. P.S. 234 uses no textbooks, workbooks, or grades, preferring students to do their own original research, starting in kindergarten. It also hires virtually all its teachers from New York's Bank Street College of Education, which has long served as the seedbed for some of the nation's most sophisticated progressive teaching methods. (Bank Street teachers are so prized that upon graduation, they generally have their pick of jobs anywhere in the country, at both public and private schools.) During my visit to P.S. 234, I quickly saw why. In class after class, clusters of students had their noses in complex projects, even in the youngest grades. Kindergartners and first graders were designing a city block; third and fourth graders were learning geometry fundamentals in art class (sometimes their shapes are constructed with yucca, corn, and iris fibers grown by the students in the school garden). When teachers spoke to the students, they tended to do so as respectful coaches, in keeping with the "guide on the side" philosophy that propels "constructivist" pedagogy. As noted earlier, these methods are valiantly but unsuccessfully attempted at many progressive schools these days, including those that are proudly high-tech, such as Napa's New Technology High School. But here, constructivism seems to truly work, for a number of reasons, one of which is the fact that P.S. 234 projects aren't plagued with technical complications. As teachers visited each group, they quickly understood what the students were doing and what materials and challenges were involved, and they offered just enough questions and thoughts to get students to struggle toward their own discoveries.

P.S. 234's approach to reading and writing provided an eye-opening contrast to the narrow approaches taken by educational software companies, particularly Renaissance Learning and its widely used product Accelerated Reader. Throughout P.S. 234, classroom walls were covered with challenging reminders of what it takes to be a perceptive reader and thoughtful writer. In a fourth-grade class, for example, one poster noted that literature has both an explicit "over-story" and a quieter "under-story," where a writer's subtle, sometimes most enduring, messages reside. Another told students "how to linger with a book." (The tips included talking about it with somebody, just sitting back and pondering the story, rereading the first and last

chapters, writing an epilogue or a new ending, or expanding on a meaningful passage—a process that teachers here call "writing off" the book.) Other advisories noted methods of finding connections between different texts to experiences in one's life, and so on. To facilitate this process, teachers do make use of a little technology: Post-it notes. This technique, advocated by Columbia University reading expert Lucy Calkins, creates an open-ended but simple way for students to capture moments of inspiration. It's also delightfully ironic. Computer advocates love to talk about the computer's capacity to facilitate creative, nonlinear work. Here was a method of doing the same kind of open-ended brainstorming, so simple that a first grader could do it—without the system crashing on her.

The intellectual vitality at P.S. 234 is so strong that it continually spills outside the classrooms. As but one indication, an atrium on the school's first floor is filled with several huge 3-D models, the results of students' semester-long endeavors. One of the more impressive was entitled "The Hudson River Study," produced by a class of second and third graders. When I told the class teacher, Lynn Handelman, that I was looking into computer use in schools, she said, "I felt bad that we didn't use the computers for this. But we used our hands and our minds. They were touching everything, looking at things under a microscope, looking at photos, reading stories." The class's curiosity was intense enough, Handelman said, that she ended up bringing in factual texts that were so advanced that she had to read them to the class aloud. "It allowed them to use their imaginations," she said. "It's a very active kind of learning." The cost? About $500.

When I spoke with Anna Switzer, P.S. 234's principal, the conceptual framework for this abundance of activity became even clearer. Switzer, who has two degrees from Bank Street, does not count herself a strict adherent to constructivism; its pure form is too relaxed, in her experience, for keeping up with today's hard-nosed state standards. So P.S. 234's version includes a touch more teacher guidance. The mix seems to have paid off. When city test scores come in each year, P.S. 234 is routinely near the top, and sometimes in first place. The power of this school's pedagogy, and its fragile subtlety, makes Switzer circumspect about computers. "I think less and less of computers as time goes on," she told me. "What discourages me is the *reality* of their possibilities. Their potential is enormous. But the reality of what teachers and students can do is another thing entirely. With the Internet, for example, I have huge concerns about the student as the consumer. In almost every class, someone gives me fifty pages from the Internet that no one wants to read. And they haven't done anything with it. Kids should be *producers* of knowledge, not just consumers. The computer is an enormous tool

for that, or it has the potential to be. But not enough of it can happen without enormous adult input."

In keeping with these views, Switzer had managed to keep computers to a minimum in P.S. 234 classrooms (there are roughly two per room, and they often sit relatively neglected in the corner). But she couldn't keep an ambitious technology plan out of school entirely. Thanks to a parent drive, P.S. 234 now has a state-of-the-art computer lab.

It should be noted that most students at P.S. 234 come from educated, relatively well-to-do families. That puts some limit on how much other schools can duplicate their low-tech intellectual achievements. So once again I went searching for answers in schools that dare to test their models of reform with the disadvantaged. One of those is Harbor Middle School, in the notoriously poor Dorchester section of Boston, where one of the strangest moments of contrast popped up.

Harbor, a brand-new school, belongs to the Expeditionary Learning family. The practice of "inquiry" learning, somewhat akin to the approach taken at New York's Urban Academy, is at the heart of Expeditionary Learning methods. And Harbor is considered one of the family's up-and-coming stars.* Harbor, being so new, was living out of temporary digs when I visited. Overlooking the noisy Massachusetts Turnpike, these comprised several floors of a local electricians' union office, which Harbor's teachers had to completely empty at the end of each day so that the union could hold its own classes. Harbor's phys ed classes consisted of students skipping rope in the parking lot, where the teacher, a former gymnast, showed them how to do flips on a strip of lawn next to the cars.

Despite the mayhem and the school's infancy, Harbor's principal, Scott Hartel, had no trouble showing me thick piles of the students' in-depth reports on a variety of topics. One recent project was an intense study that sixth and seventh graders did of the Boston Harbor Islands. Students camped out on the islands four or five times over the course of two months, studying their history and ecological health. Their final step was to draw a set of pictures of island scenes, which were turned into postcards. The state

*In light of the pummeling that many schools have suffered in these pages for doing poorly on standardized tests, it is only fair to note that Expeditionary Learning schools, which have been part of the ill-fated New American Schools project, have never distinguished themselves on this front either. While this is a sign of some real weaknesses, at some of these schools students have learned to handle scientific inquiries and other "investigations" like professionals—a practice that many schools might do well to follow.

park service was so impressed with the students' work, which compiled information that the service itself had never had, that students were invited to speak at fancy dinners and display their postcards for sale at park sites.

In setting up this project, Harbor made sure that computers would be used only in the simplest of ways. (During the writing, for example, teachers stripped the computers of all but one font choice, so students wouldn't waste time toying with typeface designs.) And Hartel, an engaging, fresh-faced young man, was adamant that all the artwork be done by hand. "Clip art will not be used in our school," he said. Hartel expects computers to play a growing role in Harbor academics, but he's leery of these machines. "If we're going to encourage beautiful work, clip art will only cheapen that," he told me. "Electronic portfolios are not for us, either. We will use computers, but I fear that eight out of ten times, they cheapen rather than deepen the work."

Hartel's determination to hold the barricades made me curious to see what students *were* doing on computers at Harbor. I was particularly interested in how they might approach writing—a big priority here.

Much like at P.S. 234, Harbor puts students through a carefully layered approach to writing, which includes an initial period of random brainstorming and multiple stages of revision. In the process, students must focus not only on basic grammar but also on advanced concerns such as content, structure, and style. Many schools talk this game; very few really practice it. But Harbor does, and its piles of student reports were proof. Every one included at least three drafts, in pencil, many of which were heavily adorned with a teacher's red marks. In report after report, it was clear that no matter what level of skill or motivation students brought to the table, they were indeed pushed to "deepen" as writers. "Our writing is mostly tied to projects, because these kids have got to have something to write about. They're experience-poor," Christina Patterson, an eighth-grade teacher, told me. Since the computer's copy-and-paste functions can so easily facilitate both writing and editing, I assumed that a visit to Harbor's computer lab would be a special treat. But I was surprised to find that students weren't making the slightest use of these functions. "They basically just come in here to type up their final drafts," the lab instructor told me.

When I later shared this encounter with Hartel, he was equally surprised. At this point, I was getting pretty discouraged. If good progressive schools can't get this machine right, what's going on? I began to think that computers had become education's cultural imperialists. They were now the McDonald's of the schools, bringing a vanilla shake and a greasy burger to every culture they touch. Hartel woefully agreed.

An even stranger illustration of this syndrome occurred across town, at Cambridge's Morse Elementary School. Morse follows the back-to-basics Core Knowledge program, which was founded by E. D. Hirsch, the conservative professor of education and humanities from the University of Virginia. As an experiment, I spent most of my time at Morse just hanging out in the computer lab to see how different classes functioned here. Morse runs from kindergarten through eighth grade, and most of those classes tromped in and out of the lab when I was there for their regular computer hours. Morse, like most Core Knowledge schools, is generously funded, and this was abundantly reflected in its lab, which was filled with twenty-four brand-new Apple iMacs, all of which were networked and connected to the Internet. Yet, oddly, whenever a whole class tried to log on to the same program or website, this state-of-the-art system promptly stalled, sometimes for up to twenty minutes.

As powerful as these machines were, despite the system jams, almost every class used them for little more than typing practice. They would stumble in full of excitement, log on to whatever program the teacher chose, pull out their penciled rough drafts, wait for the computer to make a connection, wait some more, and eventually start typing. Most of these students had never had any typing instruction, a reality in virtually every school I visited. So their writing on computers, even in the upper grades, was painfully slow. After an hour or so, their screens would be full of a couple clean-looking but syntactically awkward paragraphs. Then it was time to call it a day.

While observing students in this lab and in a few Morse classrooms that use computers, I was particularly surprised at the lack of traditional academic rigor—the attribute for which Core Knowledge schools are most famous. So at one point I asked the principal, David Coady, to explain the school's approach to computer technology. "I think we're a pragmatic school," Coady said. "My priority is an orderly climate." This was not surprising. Coady, a former elementary school teacher and football coach, is a clean-cut, exceptionally fit man in his sixties; he has a military bearing, highlighted by a white shirt tailored with tucks at the waist. His explanation of the school's technology program left me a little unsatisfied, so I asked him again, this time trying to be clearer. What kinds of things was Morse specifically trying to do with technology, I asked, to carry out the Core Knowledge philosophy? Coady looked at me blankly for a moment, then said, "I more or less leave it up to the teachers to work that out."

One of the Morse teachers who had put the most effort into working that out was Karen Spalding, a science teacher. Spalding was actually something

of a mole at Morse, favoring student projects that smacked more of progressive teaching methods than those espoused by Morse's back-to-basics godfather. During my visit, for example, she had eighth graders out gathering weather data for a project on hurricanes; for the sixth grade, she had set up projects drawn from a National Science Foundation program called Genscope. The program let students play around with simulated DNA combinations to create fictional dragons, to amplify a biology lesson in genetics. Interestingly, the day I watched her genetics lesson, the computer network was down. This meant that students couldn't play with the DNA combinations on their own, at the bank of terminals that lined the classroom walls. As an alternative, Spalding loaded the program onto her own computer and projected it on a screen at the front of the room. The DNA choices then became a group game, which provoked considerable anticipation, laughter, and lots of discussion. Tom Snyder would have been pleased.

The bottom-line message of this landscape is disturbingly simple: The challenge of school culture is complicated enough; invasions that further complicate the picture, such as computer technology, should be kept to a bare minimum—perhaps at even more of a minimum than the way these relatively low-tech schools use them. Much the same conclusion has been drawn by a few education experts that have studied school reform. An illustration occurred in early 2002, when the Brookings Institution convened a panel of school-reform analysts in Washington, D.C. In the new federal budget, Congress and President Bush had once again codified the need for "comprehensive school reform," increasing spending on broad reform plans to $310 million. But as the panelists exchanged thoughts, many noticed the evidence that most "comprehensive" reform plans were failing because they were trying to do too much. "Less dramatic reforms"—such as summer school, teacher training, and basic curriculum changes—"may not get the attention they deserve," said one panelist, Jeffrey Mirel, a professor of educational studies and history at the University of Michigan. These ideas, Mirel said, "could be as or more effective than whole-school reform."[5]

NAVIGATING THE SEAS OF COMMERCE

One of the great conundrums of technology is that a machine's opportunities are inextricably connected to its problems. You can't, for example, introduce students to the latest in multimedia graphics tools without also getting embroiled in befuddling technical glitches. And you can't let

students freely search university scientific research on the World Wide Web without also giving them access to bogus scientific claims, to say nothing of the rest of the Internet's trash.

Then again, a few well-compiled Internet sites or a challenging software program can be worth more than a bad book. In other words, navigating technology's good and bad options may be difficult, but in the end the challenge is pretty straightforward: Technology simply presents more choices. And there ought to be a dependable "KISS" way to filter them. Indeed there is. In most cases, all that's missing is the will to do it.

An interesting illustration of this fact grew out of a meeting of the American Psychological Association in October 2000. The group had convened at the National Press Club, in Washington, D.C., to call attention to the paucity of knowledge about how media technology affects children, both positively and negatively, and to the need for substantive research. At the end of the day's presentations, the participants divided into eight groups, each of which was supposed to come up with a plan of action. Most groups made relatively obvious calls for more research on this issue or that, but a few went further. Two groups suggested creating some sort of review board for the various media products that are marketed to children, both in homes and in schools. One idea was to give this review board some real muscle, signified by its proposed acronym: PCMA, for President's Council of Media Advisors.

Before we balk at the scent of government interference, it's worth pausing a moment to consider its possibilities and its precedents. First, there is no need to saddle this process with any regulatory authority; it can instead function much like the Green Seal certification that is given to various products deemed to be environmentally safe. No company is forced to submit to Green Seal review—they do so voluntarily, when they believe their products warrant it, knowing that this seal of approval will add immeasurably to their marketing appeal. Second, as noted earlier, an organization called EPIE (Educational Products Information Exchange) once conducted a promising campaign of this sort in the 1980s but had to abandon the project because the time and costs required far surpassed what a tiny non-profit could manage. Considering the exponential growth in computer media today, reviving this process with some government funding and coordination seems perfectly sensible.*

*Interestingly, there already has been one version of this idea, published on the Internet by the Entertainment Software Rating Board (*www.media-awareness.ca/eng/indus/games/esrb.htm#works*). The ratings are organized much the way movie ratings are—with six general categories, according to what age level the material is suited for, from early childhood to adults only. But as everyone knows from experience with the R and PG ratings of movies, this doesn't offer the most informative system of guidance.

Improving this process should not be difficult. The first step is to assemble a range of experts on media and child development including media enthusiasts as well as skeptics. The council would solicit submissions from those who produce electronic media for youngsters that they consider educational (movies, TV shows, computer software, websites, etc.). The submissions could include studies or other material that the producers believe proves the products' value. Then, much as the Green Seal determinants do, the PCMA would review the material and issue an Educational Seal of Approval to those deemed worthy. The council might also issue periodic reports of these evaluations, with rankings, so consumers could learn more, particularly about products that caused the council concern.

Following the APA meeting, its organizers considered proposing the PCMA idea to the National Science Foundation (NSF), along with its requests for research funding. As it turned out, the NSF wasn't interested in the organization's questions about school computing, so the APA dropped its momentary sense of urgency. Subsequent APA conferences focused on reviews of past research and discussions of its members' favorite school software. Curiously absent was any burning desire to look further into this material's effects on a youngster's mind—presumably the question that a psychological association would be most suited to address. This left the prospects of any broad action to anti-technology activists, who have always been on the issue's fringes and will likely remain there. It also leaves schools to battle the forces of commerce on their own. From all indications, it's not been a terribly even match thus far. So perhaps a few simple guidelines can be of help.

Each school, obviously, has its own curricular emphasis, and thus a slightly different priority for how computers are used. But each school might also help itself tremendously by setting up the simplest system it can. This could be a one-computer classroom, à la Tom Snyder; a few drawers full of open-ended, low-tech devices, like those Bob Albrecht uses; a handful of Internet connections in the school library for online research; and, for high schools, a true, modern-day shop class—that is, one full of computers that students can take apart. In fact, if schools wanted an extremely simple technology that could teach high-order reasoning skills, they could invest in a bunch of $15 chess games. Since the late 1800s, chess has been proven in study after study to expand players' capacity for concentration, visual memory, quick calculation, logical thinking, problem-solving, and even creativity.[6]

JAPAN'S EXAMPLE

Over the decades, America has expended a lot of energy worrying about Asia, and especially Japan, during periods when its economy has been ascendant and ours has been moving in the other direction. In the early 1990s, James Fallows of *The Atlantic Monthly* found that much of America's insecurity in this regard was gravely misplaced, an argument that seemed to pan out as Japan faltered and the United States strengthened during the latter half of that decade. Fallows argued that chasing Asia's model was a cultural impossibility anyway; as with any society, Asia's peoples are shaped by conscious and unconscious values that we can never understand, let alone imitate. In a 1989 book, *More Like Us*, Fallows urged American policy makers to renew their attention to our own values—the spirit of adventure, experimentation, and egalitarianism that are among the basic attributes of our democracy.[7]

Today, Fallows's advice could apply to American schools. Over time, in fact, Japan's educational system has stolen and refined so many of America's most powerful education traditions that we'd have to become more like them to be more like us. There might be some percentage in going this route. According to the Third International Mathematics and Science Study (TIMSS), Japanese and American students are roughly on a par in science in the fourth grade; by the seventh grade, though, Japanese students are far ahead. They rank near the top of all countries that participate in this study, while American students score roughly in the middle. This puts American seventh graders 23 points lower than their Japanese counterparts—nearly the equivalent of one American grade level.[8]

In the late 1990s, a team of American researchers traveled to Japan to figure out why this was happening. They studied Japan's educational system, then spent many weeks observing science classes in the elementary grades. What they found was an approach steeped in the values of America's great education philosophers—principally, John Dewey and the Harvard psychologist Jerome Bruner. In essence, the class exercises they witnessed revolved around active exploration, argument, analysis, and reflection. Rather than rushing from topic to topic as most American schools do, in an effort to keep pace with mounting government standards and assessments, Japanese classes lingered on discrete problems, examining them from every angle, sometimes for weeks on end. Curiously, this environment is firmly at odds with the common American image of Japanese schools, which presumes that students do nothing but memorize late into the night.

As it turns out, a relentless ingestion of facts does occur in Japan, but it's part of high school culture, as a vetting process for Japan's competitive universities. In the country's elementary schools, life has been very different indeed.*

Take classroom scenes as examples, where students embark on a study of matter. As the class begins, the teachers don't start with a lecture or a reading to supply students with the facts. Instead, they started with questions. For instance, one teacher asks, "Do you think all matter has weight?" Another, launching an aquatic biology lesson, wonders aloud what killifish eat in the water, then pauses to hear what students think. The goal is to provoke students' curiosity, bring out their existing knowledge or misconceptions, and spark their imagination. From there, the teacher sends students off on a preliminary project to test their hunches. This leads to rounds of group discussion, which helps students plan formal investigations. Throughout the process, the teacher offers comments that help students see distinctions and distortions so that they can lay out their work systematically. On and on it goes, mirroring the labors of professional scientists as closely as youngsters can.

Not surprisingly, the intellectual groundwork that goes into this experimentation is equally multifaceted. Tom Rohlen, a Stanford professor of education who has studied and written extensively about Japan, has found that Japanese teachers tend to emphasize textbook work much more than American teachers do—largely because Japanese texts are so much more thorough than ours. "There aren't all the illustrations and the desperate efforts to make learning fun," Rohlen says. "They're really wonderful, elegant texts, especially in math and science." In each of these subjects, Rohlen found that where American instructors teach a topic in a few steps, the Jap-

*In yet another twist in the endless competition between the United States and Japan, it appeared that the tranquil atmosphere of reflection in Japanese classrooms that American researchers found had begun to fade in the early years of the twenty-first century. Students were increasingly disorderly, even violent, and dropout rates were suddenly high. Japanese started referring to the phenomenon as "classroom collapse." As educators searched for reasons, some blamed Japan's failing economy, which was sapping students' faith in the future; some blamed insufficient funding of the schools, which was leaving classrooms understaffed; and others blamed Japan's parents, who were starting to spoil children with diversions like cell phones instead of spending time with them. The result, according to one teacher, was a generation of students who were lonely and materialistic. In other words, Japan was becoming more like the United States. This of course opens up an opportunity for America to learn another international lesson and finally get ahead of Japan, at least academically, and stay there. See "Educators Try to Tame Japan's Blackboard Jungles," by Howard W. French, *The New York Times*, September 23, 2002, p. A6.

anese break the process down into numerous stages. As Catherine Lewis, a senior research scientist in the Department of Education at Mills College and the leader of the Japanese school research team, put it, "In the U.S., we do things quickly. Then we have to do them over and over again."

As Japanese science classes progress, the teachers continually invite criticism—from students and from fellow teachers, who frequently observe the instruction. Sometimes the criticism is harsh. In one class, the teacher had set up an uncontrolled experiment, in which students constructed pendulums to sort out the effects of weight, speed, and distance. In a video of the seventh of nine classes on this project, children as young as ten or eleven stood up and offered withering critiques of their classmates' procedures—and their teachers'. As they spoke, the teacher beamed with pleasure.[9]

It is complicated stuff to dissect the process of science in such detail. To allow room for the complexity, the Japanese—a people whom many Americans regard as technological fanatics, if not geniuses—stuck to simple physical materials. In each classroom, there wasn't a calculator or a computer in sight.

CHAPTER 1

The Human T

Driving down out of the foothills of Yuba past wide, frosty fruit orchards and ab asked my escort, Ruth Mikkelsen, the princip nile offenders, what the area's main industr she said with a chuckle. No wonder. Yuba Cou nia's most dismal demographic statistics. Its ered around 12.8 percent, twice the state a and the proportion of children on welfare are county consistently sends a larger percentag any other county in California. It's also had t youngsters who go to college, its highest prop low income (68 percent), and the state's sti child-support payments.[1]

Down in the flats, the fields are bordered by river levees, built by the Chinese in the late 18 to this part of the world to construct the railr county seat, we pass a scattering of burnt-o dry, broken boards—reminders that until the mous for its healthy economy of bars, brothe houses. Descendants of those unruly days n

for the students, many enjoyed the program at first, but they "tended to get bored after a while," Komoski said. As an indication, Komoski remembers a thirteen-year-old in Michigan telling him that all the work seemed to be the same thing, over and over. Others had horror stories of wrong answers, which it took the companies months to correct, if they ever did. All of this might be understandable if the programs saved schools money; but they didn't. They started at around $100,000; Komoski recalls $800,000 price tags being typical, with some programs costing well over $1 million.

In the mid-1990s, when the latest wave of computer enthusiasm rolled in, CCC's "drill-and-kill" model of learning began falling into disfavor. The company's cause was not helped much by the growing number of more empirical studies that had been accumulating on CAI, most of which indicated that any boost in academic skill brought on by these programs was superficial at best and often only temporary. Not surprisingly, these gains often showed up in standardized tests, whose rather one-dimensional material was well suited to computerized drills. As researchers looked further into these gains, they found that the students doing the best with CAI were the low achievers. This group always has lots of academic room to grow and its members can often build their skills with computerized drills. In the ensuing years, studies also found that these low achievers could be helped by drills in any number of formats: oral exercises, flash cards, or—best of all—with a tutor. High achievers, meanwhile, whose skills generally can't be much expanded (or measured) without sophisticated work, made little discernible improvement with CAI programs.[34]

Curiously, in Patrick Suppes's C.V., there is no mention of the company he led for nearly three decades. And despite his voluminous papers on computerized instruction, there is only the briefest discussion of this work in his lengthy "intellectual autobiography." There's an even shorter reference to his tenure with CCC; not until page 22 does he even bring it up.* (He does, however, thank Stanford for assisting his work with CAI. "Without the sophisticated computer facilities at Stanford," he writes, "it would not have been possible for me to pursue these matters in such detail and on such a

*When Suppes founded CCC, in 1967, he did so with several partners, one of whom was Richard Atkinson, who went on to become the president of the University of California system. Strangely, Atkinson is as reluctant to talk about the company's history as Suppes was in his autobiography. When I called Atkinson to talk about CCC, he sent word that he did not want to discuss that phase of his history.

scale.") What Suppes does emphasize are his prodigious efforts to improve student performance and its evaluation.

How does he think he did? Like Papert, Suppes accepts the academic community's grim verdict of his programs. And, also like Papert, he blames the schools' weak bureaucracy for these failures. When asked in 2001 about his 1960s prediction that computers would soon talk to children, Suppes acknowledged that he "was too optimistic" about the proximity of that development. "That's a tough problem."

In these latter years of his life, Suppes is still publishing and teaching and still trying out new ideas with CAI. His latest was a program that would let gifted students from kindergarten through high school try their hand at advanced work in math and the sciences. Like most of his CCC products, the program wasn't heavy on teacher interaction. "It was designed not to require a tutor," Suppes said. "They're just for troubleshooting"—that is, responding mostly through e-mail. Suppes does differ from Papert, however, in that he has no illusion that his products will revolutionize education. He is simply trying to find a way around weak teachers, which he seems to regard as education's Achilles' heel. "There's a lot of bullshit about teachers. Let's not think they're all beautiful flowers about to bloom. We'd all like to be tutored by Aristotle. But that's not possible."

THE DIGITAL DIVIDE, TAKE TWO

Not long after the country was introduced to Dial-A-Drill, another red flag went up about the growing gap between rich and poor as regards technology's opportunities. Following a *USA Today* survey, which found that 91 percent of the U.S. population believed students needed to learn how to use computers to be prepared for the future, EPIE, the watchdog group on educational software, launched a small pilot program to start including the poor. Today's seemingly sudden discovery of what everyone calls the digital divide had a name then, too. EPIE's Ken Komoski called it the "virtual ghetto."

That ghetto was growing fast, even in 1983. Congressional studies at the time estimated that 25 percent of the nation's children—a total of 10 million youngsters, by Komoski's count—were living in or near poverty. Other studies indicated that two times as many rich schools had computers as poor schools did.[35] So, armed with a $150,000 grant, EPIE got a handful of schools in the San Francisco area to help their students' families get dis-

son, Stephens & Company, an investment banking firm in New York and San Francisco that dived into new technology with uncommon aggressiveness (and later went out of business), gathered five hundred people for a national first: a conference on the investment opportunities in educational computing.

In a keynote address at the conference, Senator Bob Kerrey, a Nebraska Democrat, asked for the investors' help in building "a concrete vision of a home-based learning center," something, Kerrey said, "our current educational institutions are probably incapable" of doing. The investors had been well primed for Kerrey's message. Robertson, Stephens had handed out a report defining the educational technology market as a $2.2 billion-a-year enterprise, an investment opportunity that the firm called "one of the nation's most promising." The company's analysts also noted that "several powerful forces are beginning to converge that are now driving technology into a central, mainstream role of delivering curriculum into classrooms, reinforced by products used in homes." That notion—that we'd come upon a time of sudden "convergence"—popped up frequently in the mid-1990s, animating both business and public perceptions that a "new economy" had finally arrived. (As indication of this fact, one of the new magazines launched to focus exclusively on technology in education was called *Converge.*) Drawing on the companion public perception that schools were failing to prepare students for this new world (or for the old one), Robertson, Stephens said it was time for a "new paradigm" of lifelong learning. That paradigm, the firm argued, was a ripe business opportunity, because when compared with the cost of standard textbooks, the new technologies would be seen as a bargain.[52]

All of this led the nation's top policy makers to suddenly get very serious about school technology. In December 1995, the Clinton administration issued a report entitled "The Kickstart Initiative," which gave birth to the

example, to get one Apple IIG; a Wisconsin school proudly announced that it had collected $500,000 in receipts to buy two computers worth roughly $3,000 apiece. In other words, for every dollar that people spent at their grocery stores, the schools got seven tenths of one cent worth of credit toward a computer. As small as this cost was for the grocers, market analysts at the time fully expected the stores to pass this cost back to the consumer. For its part, Service Marketing Group also seemed to be doing well. After buying the computers wholesale from Apple, it sold them at close to retail rates to the grocers—a markup estimated to have been approximately 40 percent. See "'Apples for Students': Computers for Schools, Profits for Marketers," by Peter West, *Education Week*, October 23, 1991; *Giving Kids the Business: The Commercialization of America's Schools*, by Alex Molnar, Westview Press, 1996, p. 23.

federal government's first nationwide campaign to computerize the classroom. The report drew heavily on the research done years earlier by Linda Roberts, whom Clinton had now picked to be his top adviser on school computing, serving as director of the Department of Education's Office of Educational Technology.

The Kickstart Initiative was bolstered by yet another report, from a presidential technology task force composed of thirty-six leaders of industry, education, and assorted interest groups. In its report, the task force cited numerous studies ostensibly proving that computers significantly enhance student achievement. As academic experts and the media attempted to digest this material, the quality of the evidence for these claims was occasionally called into question. But why would the White House generate such problematic data? Part of the answer may have resided in the makeup of its task force. According to accounts of the task force's deliberations, all thirty-six members were unequivocal technology advocates. Two thirds of them worked in the high-tech and entertainment industries. Perhaps not surprisingly, when I asked several members what discussion the group had had about the potential downside of computerized education, they said there hadn't been any.

Soon after the launch of Kickstart, the schools were treated to another national initiative, called NetDay. Volunteer enthusiasts with drills and screwdrivers were sent to schools across the country, where they scrambled to retrofit old school buildings for Internet access. The first state to capitalize on the NetDay buzz was California, which launched a statewide campaign in March 1996 to wire 12,000 schools in one day. When the wiring day arrived, school participation was far below expectations (numbering around 4,000), even in technology-conscious San Francisco. In the city papers, school officials wondered how they were supposed to support an Internet program when they didn't even have the money to repair crumbling buildings, install electrical outlets, and hire the dozens of new teachers recently required in order to reduce class size.

Naysayers may want to lump in the Internet with televisions, radios, video players, and other powerful technologies that are huge cultural mainstays but that somehow didn't make much of a dent in schools. That fate may someday befall the Net. But at this point, its power seemed far too vast, its resources far too prodigious, and its presence far too pervasive to be so casually dismissed. In a sense, the Net almost supplanted the computer. By the turn of the new century, many people in and outside school were making little use of the high-end software that was abundantly available online

CHAPTER 2

Fooling the Poor with Computers: Harlem, New York

On a leafy spring day, I am climbing fences in Harlem one morning with Carlton McKinson, a technology coordinator for New York City school district 5. Having taken the wrong subway, we are now two highways and an old, crumbling baseball stadium away from our destination: a local elementary school. This means we are late for one of McKinson's standard appointments—to connect some computers to the Internet in several stressed-out, underfunded sixth-grade classrooms. For the teachers who await McKinson, however, this would be anything but a standard day.

Since the early 1990s, national politicians and local policy makers have talked almost incessantly about the importance of halting the development of a society of technological haves and have-nots. Some of the most ambitious initiatives to result from these pitches have occurred in New York City, which is an ideal test tube for this kind of work. More than 70 percent of the city's students are Hispanic or black, and large numbers of them are commonly classified as financial have-nots. One would think that several decades of frustration in trying to rescue the poor through technology would provide these activists with sobering lessons. However, as is commonly the case with recurring public policy drives, by the time a new iteration of the concept comes along, almost everyone has forgotten what happened the last time. In the meantime, new lessons were available that could be of enormous value, if only everyone wasn't looking the other way.

The current governmental approach to the idea of computing equity was perhaps irrevocably set during the Clinton administration, helped in no small part by Vice-President Al Gore's enthusiasm for all things technological and the public's simultaneous excitement during the 1990s' high-tech boom. As Linda Roberts, director of the Office of Educational Technology under Clinton, wrote in 1997, the department was "investing in technology as a form of seed capital to attract state, local, private, and nonprofit investments, and to help close the educational-technology gap between rich and poor."[1]

While the George W. Bush administration has taken a somewhat calmer approach to this issue, it has nonetheless continued to make it a priority, by accelerating technology funding for poor schools. When the computers finally arrive in the poorer classrooms, however, reality casts this "educational-technology gap" quite differently than it has been depicted by either administration. Those differences, if seen clearly, could redefine popular images of what people mean when they speak of the digital divide. Whatever the contours of this picture are, they can be easily seen in Harlem, a place that has become legendary as the quintessence of inner-city poverty.

INTERNET DREAMS

After checking in and teaming up with two installation technicians, McKinson takes his entourage to a sixth-grade classroom and knocks on the door. Immediately, the teacher next door, a small, feisty man in his thirties whom I'll call Ben, bursts out of his room. "You're here to fix the computers?" he asks. "I can't believe it. Come in here. You gotta see this." In the far corner of his classroom is a cluster of four computers—a scene that had recently been duplicated in all of the city's sixth-, seventh-, and eighth-grade classrooms. Their arrival—roughly thirty thousand of them, at a cost of $100 million to $150 million (including installation and training)—was part of a 1996 mayoral initiative called Project Smart. Its largesse was supposed to trickle down to grades four and five and, ultimately, to every other classroom in the city. But the funding never got that far.

"These things haven't worked since day one!" Ben says. "They spend fifteen thousand dollars on each room and then they forget about it." After some exploration, it turns out that two machines do work properly but lack Internet connections; one works intermittently; and one, whose hard drive cries repeatedly like a broken mechanical doll, can't move beyond its opening screen. The school had been wired for the Internet four months earlier,